

Effects of Communication on Student Learning

by Craig R. Murie
North Dakota State University
M. Ed. Mathematics Education

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Through my experience, which has been cultivated over twenty-nine years of teaching high school mathematics, I wondered why the grades of the students on tests weren't as good as I thought they should be. At first I thought that maybe the students were the ones to blame: They weren't doing their homework, they did not fully understand the material, or they weren't spending enough time studying. For the past three years I have been teaching at the college level. I continued to see the same problems regarding the results of tests with the students.



I thought that maybe it was the way that I was teaching the material. I have always been a lecture-reaction type teacher. I would explain the concept and work out some example problems, ask if there were any questions, and then have the students work out a couple of problems independently. I would then have them work on the assignment alone or in small groups. I liked the idea of small groups because I thought that maybe they would be able to answer questions about the material that we covered. I have always thought that students communicate well with each other when it comes to explaining the process of doing the problems.

The small groups were a group of students that liked to work together, usually grouped by the students themselves. They typically worked with friends of their own ability. I would walk around the room and give them help if they had questions. I would try to help them as I looked at their paper and saw that they were having a problem understanding the concept. The next day I would answer any questions on the homework, collect the homework, and then give a quiz on the homework. This would continue until the end of the chapter when there would be a day of review where I would go over what would be on the test. The students would work on the problems on the review sheet and again, I would walk around the room and answer questions as they worked alone or in small groups.

The next day a cumulative test was given. I would give the test, correct it, and hand the test back to the students. We would go over the test together and they would ask questions if they chose.

I found that it was the same students asking the same questions. It was usually the students that understood the material who were asking the questions. The ones that needed the help would not ask for it. Usually, I believe, it was because they did not want to look "dumb" in front of their friends. They were the ones that did not do very well on the tests. Students that were having problems were not getting the help that they needed because they were afraid to ask for help. As a teacher I assumed that what I was telling the students was being absorbed and they completely understood everything that I was teaching.

In retrospect I do believe that there was a connection between the students that were asking the questions and their achievement level on the tests.



By the first test I could see who was struggling because of the results of the test. In most cases, the students that were not asking questions were the ones that were struggling. I had no clue about their struggle with the test because their homework scores were okay and their quiz scores were fine. I discovered after the first test that they were getting by, by copying someone else's homework and understanding the

one lesson enough to do the quiz. After the first test, I would try to talk to the student individually, but not in front of the class. I would try to explain to them that I was there to help them. Most of the time I could get them to set up a time where we could work one-on-one, or they would get help from one of their friends. I would try to set up a schedule where we could meet either before class or after class about once a week to check on their progress. This cycle would continue until the end of the year. In some cases this method worked and in others it didn't. I still wasn't satisfied with the overall scores of the tests.

I found that this was not very effective with all students. If a student did not have confidence or did not ask for help (mainly because of fear, I presume), they usually fell by the wayside and did not do very well in the class.

Some of my behaviors worked (i.e. one-on-one, etc.). Through my years of experience I have been able to pick up a few techniques that seemed effective in increasing student confidence (or at least comfort) levels in the class.

- Take away fear
 - o Humor.
 - Humor relaxes the students. For example, I would often make fun of myself.
 - o Early Success.
 - Eye contact of a student is important here. If the student looks at you when you ask the question, they know the answer and you can call on them. This is very important for the self-esteem of the student.
 - If they don't look you in the eye, don't call on them as you might embarrass them and you could lose them for the term.
 - o Tell the students that you have their best interests in mind and that you want them to be successful.
 - o Make sure that the students have no fear of you so that they know that they can come to you if they are having problems.
 - o Keep the process simple early on, so that students succeed.
 - o Have the students explain the process of how to do the problem back to you as you do the problem on the board.

However, I believed what I really needed to do was change the behaviors of the students.

Statement of the Problem:

In the past, I needed to modify my behaviors if I expected all of the students to learn what was being taught. Clearly, this was not enough. I began to wonder what effect student behavior changes would have. I knew that I had to do something different in my classroom if I expected all of the students to understand the material. I felt that **the main problem was the lack of communication in the classroom**, from student to student and student to teacher. Because of this lack of communication, I did not know that a student did not understand the material until he or she had taken the first test. If the communication could increase, I was hoping that I could quickly spot students not understanding and provide more opportunity for them to understand the material prior to the test. The most significant change would be to take the majority of the focus off of me during a class and placing it with the students, making them a more active part of the learning process.

Research Question:

The main research question for this project was: Will a high amount of communication (student to student and student to teacher) affect student learning?

Methodology:

Subjects

I began this study in the Fall 2003 semester with a single section of Math 99. Math 99 is a remedial math course that is made up of the basic fundamentals of Algebra. It meets three days a week for a semester (seventeen weeks). There were nine sections of Math 99, taught by seven instructors, and approximately two hundred students. Math 99 has a supervisor that teaches the web-based class and makes out the exams. All sections of Math 99 use the same exams. All of the teachers had input into the questions of each exam and had to approve each. Each of the instructors corrects their own exams. There is a uniform grading system for each problem so that each exam is corrected the same as any other exam.

Written Strategies

Throughout the study the students kept a journal of each day's lesson. At the end of each week they turned in an index card containing the concepts covered each day of that week. Students were to write their journals in such a fashion that if another student had missed class he or she could read another student's journal entry and be able to understand what was done. This requirement was based on a belief that students learn in different ways: by listening, by speaking (repeating what they had learned), and by writing what they had learned. If they could explain how to do the problems, then I believed they should know the material.



I had the students keep a journal of each day's lesson. I had them write down the main idea on an index card, explaining the process as if they were explaining it to a student that had missed the lesson. I would go over each of the index cards and then during the next class we would discuss the explanations. The idea was to get the students to see how others had done the explaining of the process and for each of them to see the importance of the communication that I was trying to get them to use.

Cooperative Learning Strategies

In addition to the journal and index card requirements, I employed various Kagan Structures of Cooperative Learning to increase the amount and type of communication in the classroom. Cooperative learning is a teaching arrangement that refers to small, heterogeneous groups of students working together to achieve a common goal. Students work together to learn and are responsible for their teammates' learning as well as their own. The basic elements are:

- **Positive Interdependence** - occurs when gains of individuals or teams are positively correlated.
- **Individual Accountability** - occurs when all students in a group are held accountable for doing a share of the work and for mastery of the material to be learned.
- **Equal Participation** - occurs when each member of the group is afforded equal shares of responsibility and input.
- **Simultaneous Interaction** - occurs when class time is designed to allow many student interactions during the period. (*Dotson 2000*)

Hundreds of studies have been undertaken to measure the success of cooperative learning as an instructional method regarding social skills, student learning, and achievement across all levels from primary grades through college. The general consensus is that cooperative learning can and usually does result in positive student outcomes in all domains. However, very few studies have been published that specifically target the use of **Dr. Spencer Kagan's Structures of Cooperative Learning** as teaching methods to increase student achievement. (*Dotson 2000*)

Cooperative Learning Structures are methods of organizing the interaction of individuals in a

classroom. Step-by-step procedures are used to present, practice, and review material. Some regulate interaction between pairs, some are best for teamwork, and others involve the entire class. The following examples illustrate a few of these instructional methods used:

- **Inside-Outside Circle:** In concentric circles, students rotate to face new partners and then answer or discuss teacher questions.
- **Rally Table:** In pairs, students alternate generating written responses or solving problems.
- **One Stray:** On each team, one teammate "strays" from his or her team to a new team to share information.
- **Rally Robin:** In pairs, students alternate generating oral responses.
- **Rally Coach:** Partners take turns, one solving a problem while the other coaches.
- **Showdown:** One teammate reads a question or problem aloud. Students work independently to solve the problem, then show their answers when a teammate calls, "Showdown!" They then celebrate the correct answer or coach to get the correct answer (*Kagan 1994*).

I decided that I would use Kagan Structures of Cooperative Learning on the second unit of my Math 99 course. I would incorporate multiple Kagan Structures to prepare students for the second test of the semester. I chose to do it at this time to compare the results from the first exam that was done by the lecture/question method to the results of the second exam to see if the new technique would have an effect.

Student Responses

Before I started this method I had the students fill out an anonymous questionnaire about the first exam. The questions asked were:

1. What is your reaction to the test?
2. What could I (teacher) do to make you feel better prepared?
3. What do you plan to do to be better prepared for the next exam?

A few of the reactions of the students:

Responses to Question 1:

- I think it was a fair test.
- I didn't think the test was too bad. I was really worried before hand because I wasn't sure what to expect.
- The test wasn't bad, I was just a little unprepared for it.

Responses to Question 2:

- More quizzes and turn in homework problems or correct in class so I know my answers are right.
- Nothing that I can think of – you try to get everyone involved which is good.
- Do a little more review.

Responses to Question 3:

- Study more/do more problems.
- Study and do more practice problems.
- Study longer and more often and ask more questions.

The last response about asking more questions led me to believe that what I was planning with the Kagan structures would be effective. With the Kagan Structures of Cooperative Learning, the students

were forced to ask questions of me or of another student(s) on a daily basis.

Implementation

This phase of the project began with the introduction of a unit involving equations and inequalities through solving application problems, or "story" problems, as most students know them.

The technique used to solve application problems is the **Five Step Method**:

1. **Familiarize yourself with the problem.**
2. **Translate to mathematical language. (This often means writing an equation.)**
3. **Carry out some mathematical manipulation. (This often means solving an equation.)**
4. **Check your possible answer in the original problem.**
5. **State the answer clearly. This means that they will be able to write in a sentence the answer to the problem such as, "The area of a rectangle that is six inches wide by eight inches long is forty-eight square inches."**

To start teaching this concept I had the students try to do an application problem individually. I had them try to do the first problem in the assignment, which read:

Three less than twice a number is 19. What is the number?

I did not give them explicit directions other than to find the answer. After about three minutes, I asked for the correct answer. About half of the students had the correct answer. I then asked those students to explain out loud to the class how they got the answer. Most of the students who had the correct answer could tell me how to set up the problem. I put the ideas on the board; and then I went through the five-step plan in the book using the board to demonstrate the techniques with the given problem.

1. What are you looking for? **The number. Let $x =$ the number.**
2. What is the equation? **$2x - 3 = 19$**
3. What is the answer? **$x = 11$**
4. Did the answer check? **Yes, $2(11) - 3 = 22 - 3 = 19$.**
5. State the answer. **"Three less than twice a number is nineteen" is the number 11.**

The goal of the discussion about the problem was to make sure that each student did it in five steps and answered each of the steps.

To teach this concept I used the **Kagan Structure "Inside-Outside Circle"** which is made up of concentric circles where students rotate to face new partners and then ask/answer a question. The students in the inner circle are the question askers; and those in the outer circle work the problem and answer the questions. I had the class split into two groups. On this particular day I had nineteen students in class. I divided them into groups of nine and ten. The groups are then divided so that five students will ask the five questions. In this case I adjusted the Five-step technique into the following five questions:



1. **What are you looking for?**
2. **What is the equation?**
3. **What is the answer?**

4. Did the answer check?

5. State the answer.

For this class I had the inside group put their desks in a circle facing outward. This group would be the ones asking the questions, so I had them work the designated problem together. They checked each step with each other to make sure that the problem was done correctly. Each member of the outside group would work the same problem alone. As each person completed the problem, they would individually start their way around the circle with question number one. The student at station one would ask, "What are you looking for?" After the student stated the answer correctly, they would move to the next question. At this station they would have to state the equation that would be used to solve the problem. If this were correct, they would move to the next station.

This continued until each student had completed one problem and had completed each station correctly. The idea of this exercise was to have each student communicate each step of the problem correctly. We were only able to get one group to do one problem and work their way around the circle before the class period ended.

While the students were in the process of doing **Inside-Outside Circle**, I noticed that one of the students did not get out of his desk and go around the circle. I asked him what was wrong and he said that he did not understand what the word "sum" meant. I sat with him and explained what it meant and then he went through the five-step process with me. He said that he understood how to do it and then went around the circle. If I had done the lecture method, he would not have asked a question and would have been lost.

Already I was feeling the success of this approach.

The next day a student stopped by my office and asked if we could do the circle exercise again. He was on the inside circle and wanted a chance on the outside circle. I was really excited about this, as it appeared to be making a positive impact on this student's learning.

At the start of the next class we started in the same groups and changed it so that the people that were on the inside moved to the outside and vice versa. They worked on the next problem that they had done in the homework. It took us about ten minutes to complete the exercise.

One dilemma that I have at the college level is student attendance. Because students choose not to attend class every session they miss the material and method that was discussed. Two students were in class on day two who were not present for the previous class. However, the other students were able to explain what we were doing. This is where the journaling played a key part in the use of communication for better learning. The students had journaled after the class the previous day and were able to communicate to these two students how we were doing the problems. I wondered if attendance would be affected by the new teaching approach.

After we had completed the **Inside-Outside Circle**, I divided the class into groups of three to continue working on solving application problems with the five-step method. The instructions were that each group had to turn in five problems from the assignment for grading. Each of the problems had to have all five steps for each problem. They were given half an hour to complete the assignment. I moved around the room, listening as they worked together. I noticed a lot of positive conversation going on between the students as they were explaining to each other how to write down the problem correctly. They were doing a good job of making sure that each person in the group understood the concept completely. This was different than when I taught in High School because now there was interaction between the students rather than just one person doing all of the talking.

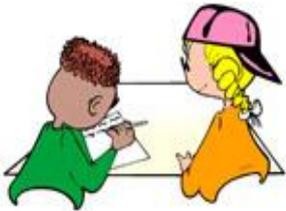
If a student had a question, I would put the problem on the board and explain it to the person asking the question, making sure that I spoke loud enough that all of the students could hear my explanation if they chose. As I was going over a problem I could see different students looking and listening as I went through the problem. If they were having a problem with the second step of writing the equation, they

listened to my explanation and/or interaction with the student(s) that had asked the question.

The idea behind doing this exercise was that the students would have another form of communication to understand the process. I was hoping that all of the people in the group would talk equal amounts. Looking back at it now, I should have had one student be the leader for one problem and then have a different student be the leader so that each person could be a leader. This would force each student to explain the method. I incorporated this into a future lesson.

Some observations from this exercise:

1. More of the students really understood the techniques, as they were able to explain it to each other.
2. Some students were better at explaining the concept to students who were struggling. What I was looking for was that each student would be able to explain each of the techniques to another student.
3. Some students that were struggling were willing to ask for help and really got a lot out of the exercise. This was a change from before as most students would not ask for help and would struggle with the material.
4. Some students let the others in the group do the work and didn't do much to contribute to the process of doing the problems.



In the past I would have started the next class period with a quiz on one of the problems that we had turned in, as I felt this was the way to measure understanding. This way I would have more of a measurement of knowing if the students actually understood what we were doing. The next time that I do an activity like this I will make the groups have only two people in it and make each student turn in a paper. I would use the "**Rally Coach**" method where one person would solve a problem while the other one coaches.

I felt at the end of this class that most of the students had an understanding of what we were trying to accomplish in solving application problems with the five-step method. This feeling was reinforced upon correcting the papers. I found that all of the papers turned in had all five problems correctly completed in the five-step method. Since the papers were handed in by group, I assessed individual understanding of the process with a quiz on solving application problems using the five-step technique. The quiz contained two problems worth one point for each of the steps, totaling ten points.

Five students had been absent the previous period. Two of the five were there for the quiz. The average for the quiz was 9.3 out of 10. See Table 1 below.

Table 1. Scores of Quiz

Score	Number of students	Absences
10	13	0
9	2	0
8	1	1
7	1	2
5	1	2

The average for the students that had attended the class was 9.9 out of 10. The results of the quiz indicated to me that the students who had taken part in the lesson activities understood the concept.

The next class was a lesson on solving inequalities. The method I chose for this lesson was a straight lecture with my asking students questions and having them work on example problems. The reason I chose this method is that solving inequalities is essentially the same as solving equations. I expected

they could transfer the newly learned concepts to this new assignment. The students did not have trouble with this concept, as they were able to transfer the idea as I had expected.

We spent the last fifteen minutes of the class working with a partner doing problems. They ended up getting about half of the assignment done in class. I felt that the students were comfortable working with each other and asking for help if they needed clarification with what was going on. In my high school classes when we did group work, one person did all of the talking. In this class every person was communicating with each other. The last five minutes of class I asked them to journal the concept of the lesson.

As the class was leaving, one of the students waited around to talk to me. He said that the methods that we had used to solve the application problems had really made sense to him after we had gone through the various techniques. He said that he now felt comfortable with doing word problems and said that he felt that he would be able to handle them in the next exam.

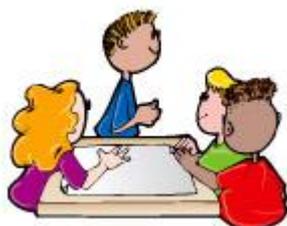
The next class was spent solving application problems with inequalities. The first part of the period I introduced and explained terms such as: "is at least," "is at most," "cannot exceed," and determining which inequality sign to use with each term. The process of solving an application problem with inequalities is the same as solving the application problems with equations. The same five-step process is used with the replacement of an equals sign by one of the inequality signs.

The Kagan Structures that I chose to use for this were **"Rally Coach"** and **"Rally Table."** The students were broken into pairs. The first process was "rally coach" where partners take turns, one solving the problem while the other coaches. This means that one student would tell the other person how to solve the problem and the second person would write down the steps that the "coach" is explaining. The students did one problem while the other coached and then reversed the roles. I felt that this really worked well as the students were able to explain to each other the process. They caught on quite easily as they remembered the process from the other lesson. The students that showed up for class really understand the concepts being taught.



The next class we continued working on these problems in class where we used **"Rally Table."** With this strategy, students work in pairs and alternate solving problems. I had each student do a different problem; for instance, student A did #1 and student B did #2. The **"Rally Coach"** structure provided a guarantee that the students would then discuss the problems with each other. When they went to problems 3 and 4, I had them change partners. We continued this until the class period was over. We were able to get twelve problems done so that each person was able to work with six other people. I felt that we accomplished more in these two sessions than if I would have done the lecture method. I believe that they learned more because they had to explain the process to another person in a non-threatening manner. Every student had the opportunity to explain the process to another student and to have the process explained to him or her.

The last two lessons dealt with graphing linear equations and graphing using intercepts. I showed them the process and then broke them into groups of three with both of these. I had the students work together and do the problems in class. The process of communication worked well as each student was involved in explaining the process. As I moved around the room I was able to see this process in action.



The last lesson was to graph a linear equation by finding the x-intercept and the y-intercept. To do this lesson I chose the Kagan Structure of **"One-Stray."** The class was broken down into groups of three. The assignment had six sections in it. Each of the groups of three was assigned one section and was charged with figuring out how to do the problems within that section. The

process of "One-Stray" is that after the students in the group have figured out how to do the problem from their section, one person from a group will stray to a new group to share the information of how to do problems from their section. This continued for the period with different people moving to different groups. By the time that the class was over each person had each section explained to them and each person had explained their section to at least one other group. Additionally, at the end of each of the classes I had the students journal the process of the lesson.

We now had finished the material that was to be on the exam. The exam was made up of the following:

- | |
|--|
| • Problem solving, using the five-step process |
| • Solving inequalities |
| • Solving applications with inequalities |
| • Graphing linear equations |
| • Graphing linear equations using intercepts |

The next class was used as review day. I made a review sheet for each student containing problems of each type and I divided the class into groups of three. The students would work on a problem in their groups. Each person had to know how to do the problem and how to explain working out the problem. We used the method of one student from each group rotating to another group. In the new group the students worked out another problem until all three again could do the problem and explain the problem. We continued this process until the end of the class with the exam scheduled for the next class session.

The exam had two versions, each consisted of the same type of problems but in a different order.

Unit Assessment

The exam was made up of twenty-six problems broken down as follows:

- 1 definition of a term from the unit
- 1 evaluating of a polynomial
- 1 finding the intercepts
- 1 combining like terms
- 4 graphs
 - 2 using the t-graph
 - 2 using intercept
- 5 solving equations
- 2 percent problems
- 4 solving inequalities and graphing
- 4 word problems, making an expression
- 3 application problems (one is treated as a bonus problem)
 - 2 with equations
 - 1 with an inequality

Of the twenty-six problems, twenty-four were worth four points each and the two five-step problems were worth five points each. The total number of points possible was 106. The score for the exam was the total points.

The grading was as follows:

A: 90-106

B: 80-89

C: 70-79

D: 60-69

F: 0-59

I felt that the students who had been to class each day were fully prepared for the exam. They were able to do each type of problem and explain how to do each type of problem. The time period between the first exam and the second exam was made up of twelve class periods. Twenty-two students took the exam. Of the twenty-two students, nine did not miss a class, six missed one class, one missed two classes, one missed three classes, one missed four classes, two missed five classes, one missed six classes, and one missed eight classes. (See Table 2 below)

Table 2. Students Absences

Students	Absences
9	0
6	1
1	2
1	3
1	4
2	5
1	6
1	8

Results:

The results of the exam were 5 A's, 8 B's, 5 C's, 2 D's, and 2 F's. The average score of the two "story" problems was 8.18 out of 10. Each problem was worth 5 points, one point for each of the steps. (See Table 3 below)

Table 3. Results of Exam 2.

EXAM A			EXAM B		
SCORE	5-pt score (2 problems)	Absences	SCORE	5-pt score (2 problems)	Absences
104	10	0	90	8	3
101	10	0	90	10	4
99	10	0	85	8	0
88	10	1	82	6	1
84	10	0	82	9	0
83	10	5	80	8	0
83	10	0	80	9	1
78	10	1	75	8	1
61	1	5	74	10	2
59	5	4	73	6	0
			61	6	6

The significance of the "story" problems was the main part of the communication process for my study. I wanted to emphasize these problems because of the difference between my experience as a teacher at the high school vs. college level; this is where the students have the greatest difficulty.

The results of the second exam were better than the average of the first exam. The process of more communication did increase the scores on the exam.

Typically the scores decrease across the board for the second exam. One thing that is very noticeable is the average score of students that missed less than five classes. There were eighteen students in this category and their average score was 81.4%. Fourteen of the students' grades increased from the first exam by an average of 77.18%. Four missing five or more classes did worse on the second exam by an average of 7%. The students that missed class five or more times decreased by an average of 16.5%.

The average score for the first exam was 72.18% and the average for the second exam was 79.00%. Students that missed less than five classes had an average of 81.4%. The second exam was considerably harder than the first exam because of the application (story) problems. (See Table 4 below)

Table 4. Comparison of exam scores.

Exam 1	Exam 2		Absences
91	104	Increase 13	0
97	101	Increase 4	0
84	99	Increase 15	0
85	83	Decrease 2	0
75	82	Increase 7	0
83	85	Increase 2	0
71	80	Increase 9	0
54	73	Increase 19	0
34	42	Increase 8	0
85	86	Increase 1	1
83	78	Decrease 5	1
57	80	Increase 23	1
86	90	Increase 4	1
86	75	Decrease 11	1
93	82	Decrease 11	1
65	74	Increase 9	2
50	61	Increase 11	3
80	90	Increase 10	4
96	83	Decrease 13	5
79	70	Decrease 9	5
82	61	Decrease 21	6
82	59	Decrease 23	8

A comparison of all the test scores of students enrolled in Math 99 indicates my students scored above

the average. The overall average of the exam (including my class) was 61.27%. (See Table 5 below)

Table 5. Exam 2 Scores.

Section	Average Score
1	48.30
2	61.13
3	57.95
4	79.00
5	67.32
6	60.53
7	72.30
8	51.50
9	53.47

Student Responses (Post)

The day that I handed the tests back I asked the students to write down their comments on what they thought of the techniques that I used to teach this section of the class. Following are their comments:

- *"For the first time, I understand the concept of doing "story" problems."*
- *"I like the technique that was used. Everything made sense to me."*
- *"Making me put down each of the steps made me understand how to do the problems. I was able to understand how to do the problems and was able to get the correct answer."*
- *"I felt that I knew how to do the problems and this just showed me that I knew how to do it."*
- *"This works."*
- *"Being able to talk and explain to another person how to do the problem really helped me to do the problems."*
- *"Working with another person made it so that I wasn't intimidated and I could see that we had the same problems when it came to working with "story" problems."*
- *"Talking it out with another person made the process clear to me."*
- *"I knew how to do these type of problems before. I don't like doing all of the steps."*
- *"Checking the answer made it work for me."*
- *"I finally learned how to do a "story" problem."*

Conclusion:

Does the amount of communication affect student learning? Yes, I believe that it has a positive effect. The results of the tests were quite good in comparison to the results of the first exam. In the past the second test was usually 10% to 15% lower on the average than the first exam, whereas in this semester it increased. For the students who came to class regularly, it was significantly higher. Additionally, students enrolled in my section outperformed students from other sections, which did not employ cooperative learning strategies.

I know that I will always teach application "story" problems with this method. I feel that the students

understand the process of how to do these problems because they communicate with each other in how to do the problems. I also feel that they understand it more because they have to explain the process to someone else. **The comments made by the students are proof enough to me that this process of communication through the Kagan Cooperative Learning Structures is the way to teach.** I want more student engagement in the class by communication with learner groups. When these students get out into the real world they will need to communicate with others to be successful and by using the different Kagan styles they learn how to communicate with a purpose. I believe in this process and will continue to use it as long as I continue to teach.

References

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