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Student Understanding and Achievement When Focusing on Peer-led Reviews

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Student Understanding and Achievement When Focusing on Peer-led Reviews and Calculator Usage

Abstract

In this action research study of my classroom of eighth through twelfth grade Algebra I, I investigated how student understanding and achievement was affected when peer-led reviews became the main discussion method of each mathematical concept. I discovered that peer-led reviews improved student involvement and allowed students the opportunity to learn instead of only being taught. As a result of this research, I plan to implement peer-led reviews as a constant in all of my math classes. In addition, I plan to continue to evaluate the process of peer-led reviews and make adjustments when necessary to evoke the best opportunity for each student to learn.

The topic of my inquiry is peer-led review and what happens to student achievement and student understanding of mathematical concepts. I came to select this topic because of the experiences I gained through Math in the Middle. Many of the problems that I was asked to do during my time in Math in the Middle would have been nearly impossible if it would not have been for the assistance and presentations of classmates. I wanted to see what would happen to my students' mathematical understanding when I implemented peer-led reviews. As a teacher pursuing a master's degree, I felt a degree of accomplishment and understanding after a peer-led review, and I wanted to determine if the same results would be true for my students.

I found it interesting how all of the different groups of teachers with varying backgrounds worked together to reach the end goal. I was very impressed from what I learned and from what my colleagues I spoke with had learned from our peer-led reviews in Math in the Middle. I had reservations about the effectiveness of peer-led reviews in a junior high or high school classroom. First of all I always thought that as professionals many of us probably worked a little bit harder and were more focused than my students. I believe that to some degree the structure of the work given to junior high or high school students does play some role in their level of focus each student dedicates to his or her studies. I had seen the degree of thinking involved with our Math in the Middle program so I wanted to research the effects of the same style of learning environment on my own classroom.

My classroom used to be set up much like the traditional mathematics classroom. I would lecture for a majority of the time while students would take notes and complete examples. At the conclusion of my lecture, I would ask for any questions before I made a homework assignment that students would have an opportunity to get started with but rarely finish within the class

period. I have now migrated away from the teacher-centered classroom where I would lecture practically everyday to a classroom that is more inviting to thought and discussion. In the average week I currently lead a lecture for two or three days a week, but my lectures are much shorter in order to leave more time for peer review and peer tutoring.

In mathematics as well as various other disciplines I find that the most crucial part of the lesson is the review after the students have began their assignment or even after they have completed their assignment. This review time is often just an extension of the lesson but looks back at what the students have learned and allows students another opportunity to see what it is they are expected to do. It has seemed to me that students do not put much value in review and that review is simply a waste of their time. In order to change this, I made a prediction that peer-led reviews would give them the opportunity to feel ownership in their work and begin to value time set aside for review. While doing peer-led reviews it was also my goal that lower-achieving students would close the achievement gap between them and the higher-achieving students. This is of course only valuable if the level of achievement does not drop for any particular group.

As an educator, I am always looking for practices that will improve student achievement and understanding for all students. It has some philosophical value to believe that if I have higher-achieving students helping lower-achieving students then both groups will see gains in their achievement over a length of time. This topic relates to my current classroom practices because in order to meet some of the National Council of Teachers of Mathematics (NCTM) standards I have been working on communication and problem solving. This action research project has given me the catalyst that now drives my classroom instead of the state standards driving my classroom.

Problem Statement

This topic and the problem of practice are worth knowing about because it gives educators an avenue that allows for all students to show improvement. This topic is different from implementing a gifted and talented program or a low-achievement learning program because this program has the ability to affect every student in your classroom in a positive manner. Through the NCTM standards, classroom teachers have became much more aware of the importance of teaching communication skills in mathematics. Through peer-led reviews, students are able to practice their communication of mathematics on a daily basis. Communication is very important because it allows students to communicate with other mathematicians as well as communicate with people who have less mathematical experience. The ability to communicate with a wide variety of people will prove to be a valuable asset upon graduation.

The process of communication in mathematics is relevant to almost every individual who wants our youth to be educated and pursue excellence. During various Math in the Middle classes there have been discussions about the importance of staying competitive within a world of mathematicians and scientists, and it is through methods like peer review that the United States will be able to foster the thinking skills needed to develop new ideas. Peer-led reviews have the ability to build upon manners, communication skills, and mathematical competence. By improving these skills teachers not only increase the number of opportunities to prepare students for careers in an ever-changing world, but also teachers are also preparing them to succeed on assessments.

Literature Review

As the idea of cooperative and group learning has re-entered the educational forefront, many ideas of how to utilize peer assistance have arisen. One method of peer learning is done through peer-led reviews. The research presented provides evidence of three major themes of peer-led reviews: student achievement, method of review, and student attitude.

Student Achievement

Student achievement is something not only measured with a test score but also by constant feedback gathered by the teacher. In an attempt to improve understanding, peer tutoring can be a very impressive tool to achieve greater student understanding. Mathes (2001) discusses the improvement of reading through peer tutoring. Although this may seem disconnected from mathematics I find just the opposite to be true. Reading is a major part of mathematics, as many of my Cohort 4 colleagues discussed at various times. In order to improve our mathematics is it also essential to improve upon our reading and comprehension skills. With this is mind, I have included these rogue articles not because they are unrelated but more so because there is a value of learning that is found in every content area. The crossing over of positive methods of learning from other content areas leads to the assumption that mathematics can also be impacted positively.

Peer reviews are a strategy not only utilized in mathematics classrooms but in various classrooms. Fuchs and Fuchs (1997) had 20 teachers implement peer tutoring. They had another 20 teachers who did not use peer tutoring. Their findings were that regardless of the type of learner, the students in the peer-tutoring classrooms showed greater reading progress (Fuchs & Fuchs, 1997). Improving reading ability is a key ingredient in improving how students understand and complete story problems. Through improvement of reading, students were able to

improve upon their mathematics. In addition, it is noteworthy to realize that this study found improvement in reading regardless of learning type. This same improvement would be seen with math students regardless of the type of learner.

Fraivillig, Murphy, and Fuson (1999) studied three components of mathematics curriculum. These three components were: eliciting solution methods, supporting conceptual understanding, and extending mathematical thinking. Their findings were that teachers usually supported mathematical thinking but rarely extended their thinking. The goal of the NCTM standards is to change from the traditional classroom that focuses on students being able to reproduce existing solution methods to classrooms that support the idea of an involved learner (NCTM, 2000). This has led to a redefined role that, for many teachers, more closely resembles a moderator as students work together to elicit thought.

Watson (2000) discusses how teachers can assess students in an informal setting. Watson identifies the purpose of her study to identify components of practices of teachers acting as assessors of students' mathematics in normal classroom work. Watson realized the importance of informal assessments done by teachers and connected these informal assessments with student perception of mathematics. Watson studied teachers who had been trained in informal assessments by listening to audiotape from their classroom as well as giving the teachers a series of interview questions to determine the teacher's level of assessment. For example, Watson discusses monitoring student responses to questions and student presentations. Informal judgments and decisions that teachers make every day in their classrooms can affect student achievement. Therefore it is important for teachers to be skillful assessors of student progress.

Berry and Houston (1995) dealt with the use of posters as a medium, through which peers can present their work. Through their research, they found that the use of a poster served as an

effective tool in helping students to solidify and synthesize new knowledge. The authors also made the connection that students were able to process information better when information was presented visually. The use of posters was especially effective because it allowed for easier recall of information due to the ease of displaying relevant posters in a designated area during the lesson.

Graven (2004) studied how teachers were able to teach mathematics better and how they understood it better when they had confidence in what they had learned. The notion of confidence is pivotal in understanding and explaining mathematics. This argument emerges from an education program that is structured to enhance participation in a community of practice.

The main component of student achievement and the consistent finding in almost all of the research was that student achievement increased when exposed to a more hands-on learning style where students were able to interact with each other and exchange ideas. In addition, Berry and Houston (1995) studied the usage of posters as a teaching tool. This is relevant information for my action research because many times students will complete the problem they are to present on some type of poster that can be hung throughout the room. In addition to the direct improvement in student achievement, Watson (2000) studied teachers and their ability to successfully assess students in an informal setting. This is relevant to the situation as well because during peer-led reviews a teacher has to be constantly conducting informal assessments in order to monitor student understanding.

Method of Review

The method of review in a classroom is quite varied. The research I read all dealt with the use of peer-led reviews as some variation of tutoring. I was unable to find research on peer-led reviews in a mathematics classroom so I have included research in other content areas. Although

it is important to not make the assumption that each procedure used in a different content area will have the same result in a mathematics classroom, it is important to utilize this information to help better understand peer-led reviews in a mathematics classroom.

Berry and Houston (1995) discuss the use of posters with mathematical students. Posters are widely used as a source of display when students present mathematical solutions to other students. Students seemed to learn more about their peers' work by using a poster in comparison to only an explanation.

Fuchs, Fuchs, Mathes, and Simmons (1997) studied making classrooms more responsive to diversity through using peer-assisted learning. The study was done on 20 teachers who implemented peer-tutoring programs for 15 weeks. Another 20 teachers did not implement peer-tutoring programs. There were a total of 20 classrooms that were studied with half receiving no change in instruction while the other half implemented peer-assisted learning strategies. The goal was to study the effectiveness of a class-wide peer-tutoring program in reading for varying learner types. The authors speak of how teachers do not have enough time to prepare a lesson plan for every student. The diversity of these students is too great to adequately teach to each division. In an effort to improve this gap and not teach to only a select few students, the authors introduce the use of peer tutoring to bridge the gap. In general they say that teachers tend to make fewer efforts to accommodate those lower-achieving students and that peer tutoring is a way of solving this problem.

Heward, Heron, and Cook (1982) discussed how the method of review can be moderated and guided in a way to maximize results. The researchers utilize tutor huddles in order to improve the instruction the tutors bestowed upon the students being tutored. The authors say that clearly one on one instruction is the most intense and personal type of instruction that can lead to

the greatest improvements. In their study, they took 28 students in elementary and worked with vocabulary. The students were grouped in either a tutor group or a tutee group. The program was implemented over a five-month period. The researchers utilized a tutor huddle in order to improve the quality of one-on-one instruction. The other students would work on certain tasks while the huddle was being conducted. During the huddle, the students would be given a certain group of words and they would offer definitions until they were confident they each knew the definitions of the words. I can see this crossing over into the mathematics classroom. A group of "tutors" could meet for about five minutes a day and discuss how to complete certain questions before we divided up into tutors and non-tutors. There are two advantages of peer tutoring: first, the tutors are readily available because they come from the same class setting, and second, the entire class is able to participate in direct instruction. Research has shown significant academic gains by students tutored by their peers in mathematics (Heward, Heron, & Cook, 1982).

Fraivillig, Murphy, Fuson (1999) discuss the movement toward an inquiry-based classroom but do not believe teachers should serve solely as a facilitator who just elicits student thinking. Instead, they insist that teachers should intervene and advance children's thinking. This idea is rooted from the belief by some individuals that a teacher may utilize some inquiry methods to reduce their workload. Instead, Fraivillig, Murphy, and Fuson report that teachers should not turn the reins of the classroom over but rather push students to advance the thinking of the student.

Watson (2000) says that informal assessments that teachers make each and every day are a form of assessment. These assessments can influence expectations which will significantly affect students' mathematical experience. Teachers are expected to utilize their classroom experience to develop knowledge of their students' mathematical achievements and their

potential. Watson found that informal assessments were best utilized when teachers were probing and prompting answers from their students.

McNair (2000) studied the productivity of classroom discussions. He studied mathematics classroom discussions because he said it is an important factor in determining learning outcomes. In the paper, he analyzed three main points of classroom discussions: subject, purpose, and frame. McNair discusses how the text of a mathematics classroom discussion is as important as the textbook that is used. The same effort that is made to improve instructional materials such as textbooks and handouts should be applied to improving mathematical discussions. Teachers are encouraged to provide explicit comments and directions about the nature of the activity to help shape the discussion into a positive and educational experience.

Pape, Bell, and Yetkin (2003) say self-regulated learners are active participants in their own learning and are able to draw from a large repertoire of strategies to solve problems. This type of learning is consistent with the NCTM standards and the NCTM standards help to make self-regulated learners possible. One method used in their study was where students were asked to make daily observations and to record their methods and strategies they used to learn mathematics. The authors also studied how students were able to make connections better when they were self-regulated. It was found that this was due in large part to a curriculum pace that better matched the individual student. The study was a collaborative effort of a seventh grade mathematics teacher and a university faculty member to develop students' mathematical thinking. One thing that was learned from the study was to use multiple representations of an idea and to assign mathematical tasks that were rich in thought and that provoked thought.

Jaworski (2003) studied the effectiveness of learning mathematics through co-learning partnerships. These co-learning partnerships may be in the form of a peer-assisted setting or even

a learning community that leans upon its members for mathematical ideas. A large portion of the research is based upon the importance of teacher learning groups and how that ability to exchange ideas is important not only for teachers but also for students. Jaworski suggests that the learning of mathematics is done best when the learning takes place in a supportive community through which knowledge can be fostered and understanding can by evaluated by various subjects. This type of learning allows for new norms to emerge that can influence how information is being taught. This is the foundation of the co-learning relationship presented in the paper.

Chiu (2004) studied how teacher interventions conducted during cooperative learning affected student progress. The study was done on groups of ninth-grade students who were assigned algebra problems. Chiu found that teacher interventions were important in keeping students on task but that too many interventions would actually lead to less time on task. Chiu promotes cooperative learning. Chiu says that a group of students taking part in cooperative learning work together to achieve shared goals. In a perfect scenario, students help one another and produce better results than if they were working alone. Cooperative learning groups have been used by teachers to improve achievement, motivation, and racial attitudes. Success of a cooperative learning group is dependent upon which students the teacher chooses to place together. Even if the groups are planned successfully, there will still be instances where teacher intervention will prove to be important.

Mathes, Torgesen, and Allor (2001) studied the feasibility and effectiveness of peer-assisted learning strategies. Their study was done on first-graders three times per week for 16 weeks. The study was done in 36 different schools with random placement of students into each of those classrooms. The authors found that peer-assisted learning strategies yielded great returns

for every level of learner. The authors point out that most classrooms are filled with diversity, whether it is diversity of background or diversity of ability. It is very difficult for a single classroom teacher to administer adequate instruction to all students due to their varied backgrounds and ability levels. The medicine for this ailment is found in peer-assisted instruction. It has a long supported history of creating academic success for a variety of learner types and in various subject areas.

The method of review is an important aspect of verifying the validity of peer-led reviews. Although some of these articles are discussing peer-based learning strategies in content areas other than mathematics, it is noteworthy to see the results. The one consistent message throughout the method of review section that can be found in each of the articles is the effectiveness of using peer-led learning activities to not only improve student understanding and student achievement, but also to increase the amount of one-on-one instruction that each child is able to receive. The ability to create an environment where students help other students makes peer-led reviews connect to each of these studies.

Student Attitude

Student attitude is an important part in learning in any field and in any content area. I read articles that are not all directly related to mathematics but that do deal with peer review and student attitudes. It was difficult to find articles that dealt with both peer-led review and dealt with mathematics. I included articles that contained either of the two in order to help provide evidence for peer-led reviews in a learning environment.

Berry and Houston (1995) studied the use of poster as an instructional device. They found that through the use of posters, students generally had a very positive attitude toward the activity at hand. With an improved attitude toward learning, Berry and Houston found that

students had a better learning experience with better retention. They concluded that a portion of the improved retention was due to improved student attitude.

Bentz and Fuchs (1996) conducted a study investigating the effects of providing training and practice in helping behaviors during peer tutoring in mathematics. It is appropriate to question how this affects student achievement. Simple: it affects the way that peers “assist” one another. In order for learning to take place it is important that the tutor does not simply solve the problem for the other student. Instead, it is important that the student being tutored is steered in the right direction without anyone taking the wheel. This study used 20 general educators in classrooms with second through fourth grade students. The entire classes participated for a 29-week study. The classrooms were assigned randomly to two different treatments: one in which training was given and one in which training was not administered. The study indicated that students who received the training engaged in a greater number of trained-helping behaviors than those who did not train. The study also found that tutors who received training instructed a fellow student more often that the problem needed correction. In addition, students who were trained also offered conceptual help at a greater rate on word problems in order to help make the problem more understandable. The research by Bentz and Fuchs showed that training can lead to an improved student attitude through a greater sense of accomplishment by the student being assisted.

McNair (2000) discusses the importance of mathematical discussions in a mathematical classroom. Although not all discussion leads to further thought, McNair did point out that by enlisting students to help move the content across the educational spectrum, more students will become involved. McNair also stresses the importance of teachers carefully improving their

discussions to foster learning for the entire class. This involvement will help to diminish mathematical scares and improve student attitude.

Jaworski (2003) speaks of learning done in a community and how this learning community promotes a positive attitude toward learning in various subject areas but specifically in mathematics. Through learning in a community, students begin to see how others arrive at a solution and how others think about a problem. Through this interaction, students are able to feel better about the learning process and begin to feel a sense of ownership in the process. Once the students feel a sense of ownership in the process, the students begin to put more effort into the classroom.

Mathes, Torgesen, and Allor (2001) support peer-assisted learning, which gives the diverse classroom more instruction for struggling students. By giving students instructional support through peer-assisted learning a sense of companionship and support are created. This in turn leads to improved self-confidence.

Chiu (2004) promotes cooperative learning because in general Chiu found that the results produced in cooperative learning were better than results produced by an individual. When aligned in correct cooperative groups, students are given opportunities to input knowledge into the group. Through this exchange of knowledge for that common goal, students are able to gain improved confidence in their abilities. This is true for each level of learner.

Pape, Bell, and Yetkin (2003) say self-regulated learners are active participants in their own learning and are able to draw from a large repertoire of strategies to solve problems. Through this enlightenment of skills, students are then given confidence in their abilities. In addition, the authors also stress to assign problems rich in mathematical context and heavy in thinking. The research also shows improved results when problems are given that interest the

students. This interest in the problem gives students a better incentive to be motivated to work toward a solution.

Regarding student attitude, the research referenced provides an educational compass of how peer-led reviews can change a classroom and the learning process that takes place. For example, Berry and Houston (1995) speak about how posters improve student attitude, which in turn improved retention. This is relevant due to the nature of peer-led reviews. In addition, the studies presented shine light on the benefits of peer-to-peer interactions in a classroom whether it be direct peer-tutoring or learning through a learning community. The basis of all of the studies is that in essence student attitude is improved, which in turn provides a learning environment that fosters better retention and a greater desire to succeed.

In conclusion, the literature presented shows a connection between student achievement, method of review, and student attitude. It is vitally important not only to be able to educate students, but also to be able to excite students so they are motivated to be life-long learners. If teachers are able to make students more successful in math and science classes it is possible that students will have greater interest and greater confidence to pursue careers in both math and science. This review of related literature has discussed methods to improve student research, the findings of different methods of review, and findings of student attitude with various presentation techniques. The gap that remains between this literature and my action research of peer-led reviews is that the literature does not specifically discuss peer-led reviews in most cases. The literature can be related to peer-led reviews either because it is discussing a method related to peer-led reviews or because the literature has been derived from research in some type of learning community. It is important to study peer-led reviews because the literature available does not address peer-led reviews.

Purpose Statement

The point of studying peer-led reviews is to identify the strengths or weaknesses of peer-led reviews in a middle school to high school mathematics classroom. Peer-led reviews are important to teachers as a method of invoking thought and inquiry in a mathematics classroom. Through thought and inquiry students are better equipped to solve problems the world will present to them. I am seeking to understand the validity and the usefulness of peer-led reviews in a mathematics classroom filled with students from middle school to high school. I have witnessed the benefits of peer-led reviews for teachers working toward a master's degree in mathematics but I was unsure if the process of peer-led reviews with younger students would yield the same positive results as I had witnessed in Math in the Middle. The overall purpose of my project is to determine the influence of peer-led reviews in mathematics instruction on student achievement. I examined the research themes of student achievement as more emphasis is placed on peer-led review. My research questions were the following:

1. What happens to students' assessment scores when exposed to consistent peer-led reviews?
2. How will consistent peer-led review sessions change students' oral communication skills in mathematics?
3. What happens to my teaching when I implement peer-led reviews?

Method

In order to conduct this study I had to change the way that I taught mathematics. In the past I had done much of the lecturing myself and generally spent a majority of the time writing notes on the board while I expected students to soak up the information. In order to conduct this study I had to give up some "control" of the classroom to the students. This "control" that I gave

to the students dealt only with who was to be presenting some of the mathematics during class. Instead of me giving the information on assignments, now I focused more on students helping other students as the main source of "lecture." Peer-led reviews occurred each day as I would have a minimum of 15 minutes each class period where students would share ideas and thoughts about the assignments. At least once each week students would have one day of peer-led review time. During this period of class, the students would present selected problems from a problem-solving worksheet to the class. The rest of the class would present any additional solutions or methods to solving the problem at the completion of the original presenter's presentation. In addition to the problem-solving questions that were being presented, students also had an opportunity to ask questions about similar problems that they had been assigned during the week.

I collected three main sources of data. The three sources of data I collected were: teacher journals, student interviews, and student work, which included a pre- and post-test. I gathered the data by collecting student work that they had completed. I also set up times to journal, which proved to be more difficult than I had expected. The student interviews were the most difficult pieces of information to gather as I had a large group of students who rode the bus home. Because of some of the students' transportation arrangements it was nearly impossible to get time either before or after school to conduct student interviews. In order to collect this data for my study, I decided to hand out the student interview questions and have students answer the questions in writing (see Appendix A for interview questions). I also administered pre- and post-surveys to students (Appendix B).

I organized the data I collected by reserving a file drawer where I placed each piece of data gathered into a special folder. I analyzed the data by comparing the pre-test with the post-test. In addition, I compared the evolution of student work over the course of the study. I looked

at student interview responses to get a general feel for how the students were doing and what each student's perception of the peer-led reviews was on his or her learning experience.

During my data collection I ran into several issues that made the collection of data more difficult. The major difficulty that I ran into was student absenteeism; not necessarily meaning only one or two students being gone, but rather situations where nearly the entire class was absent. For example, during a two-week stretch I had over half of my students only twice as many of them took part in state Future Farmers of America, state nutritional competition, a track meet, and some standardized testing. In addition, my school also had a snow day in that same time frame so it was very difficult to get a full day or a full class for learning. I have taught for five years and during about a month stretch this spring it was the most difficult time I have ever experienced in having quality class time where a majority of the students were present.

Findings

My average day of teaching during this action research project would obviously vary depending upon if we had a problem-solving set to review or if we were working on a concept first before peer-review time. I briefly describe both days as each of the different styles was an integral part of my action research project.

If it was a problem-solving set review day the students would first come in with a majority if not all of their problems on the problem set completed. They needed to have reasonable explanations to justify their answers and they needed to be prepared to present at least one problem from the set. The students would come in, sit down, discuss some of the problems with their peers and sign up for problems they were willing to present. After allowing the students to discuss and share with their peers in smaller groups the class would then begin their presentations or peer-led reviews of the problems. Normally the peer-led review would last the

remainder of the class period and sometimes spill over into the following day as well. During this time, the students would present a problem and then their peers would have the opportunity to ask questions. After most of the questions about a particular question had been answered, I would ask for any alternative methods. At this time, normally at least one student would volunteer and alternate method to reach a solution. Many times the alternate method used to reach the solution would cover concepts that were either from future chapters or were from past chapters. Most of the times I would take the students work before the peer-led reviews were started and photocopy the work and then give them the original to make any corrections or additions they felt were needed. This gave me the opportunity to make them accountable for their own work prior to the review but it also allowed me to give them the freedom to make corrections and altercations they saw were needed.

The second type of average day in my classroom was a bit more traditional for a portion of the period. First, the students would come in, sit down and review problems with each other on an assignment from their book. This assignment may be all concept-type problems or may include some problem-solving problems as well. After the initial five minutes of review, I would then ask for any questions. Generally, if a question was asked of me I would try to evoke a response to the question from one of the peers of the person who had asked the question. At times, I would be left to answer the question because either everyone was confused or no peer was willing to share their insight. After the question and answer session with me, the students would then correct their papers with answers I supplied to them. At the conclusion of the grading session, I would then ask again for any questions. Once again, I tried to reflect any questions to me back to the students in order to engage them in thought. After this period of teacher and peer review I would then introduce a new concept with a short introductory lesson on the topic. At the

conclusion, the students would have time to start the problems and to work together on the problem-solving set that was assigned for a different day. During the final 15 to 20 minutes the students were able to speak to one another and help one another on difficult concepts. I would circulate throughout the room to see if my assistance was needed but I generally reflected questions back to the students at the completion of the period.

My first research question is “what happens to students’ assessment scores when exposed to consistent peer led review?” The initial test that I gave after implementing my peer-led reviews did not indicate an improvement in test scores. The chart below shows the test scores from the first test after implementing peer-led reviews. As my findings will indicate, these test scores are not very appealing but I realized that not only had I changed my classroom to be centered on peer-led reviews, but I also had changed the test to focus more on problem solving. These poor test scores may be attributed to more problem-solving questions rather than concept-style questions.

Student	Test score as a percentage
A	81.25
B	78.125
C	62.5
D	55.21
E	73.96
F	54.17
G	85.42
H	85.42
I	94.79
J	93.75
K	94.79

Due school scheduling and outside activities such as state standard testing, I did not give another chapter test until after I completed data collection. Therefore, I cannot compare the first chapter test scores with another chapter test scores. Generally, the student scores on the test were about the same as the class performance on other tests I gave this year. I did find that in the pre-test and the post-test that students presented similar amounts of work for each test but the explanations on the post-test were more detailed and easier to follow. See Appendix C for a student's work on the pre-test and the post-test, which shows similar work but better explanations on the post-test. Because of this work and other findings I make the assertion that students' assessment scores when exposed to consistent peer-led reviews improve. Part of this improvement is from the improved understanding of how to justify an answer as seen in Appendix C and in my teacher journal. On, April 1, I wrote

> This year I was amazed by how students were working through the problems on paper and were drawing pictures and making short explanations for themselves as they were working. I had tested these same students in the fall and you would have been hard pressed to find more than two lines of work amongst the entire class. The change was significant and definitely worth noting.

This quote solidified my assertion that peer-led review improved student assessment scores because the improved showing of work also resulted in better scores.

My assertion that students who are exposed to consistent peer-led reviews will improve their assessment scores is a very powerful assertion that gives peer-led reviews a great deal of importance in the classroom. In my journal entry dated, March 20, I wrote:

> I am seeing student retention improving with each week. In the past it seems that students forget what they have learned as soon as the lesson is over, with peer-led reviews the concepts keep coming up and students are constantly reminded of the concept even after the lesson is over. This has to help when it comes to test time.

Through peer-led reviews my classroom had greater opportunities for review of old concepts, which led to improved assessment scores because the concepts were fresh in the students' minds.

My second research question is "How will consistent peer-led review sessions change students' oral communication skills in mathematics?" It is hard to measure the amount of change that occurred in oral communication skills in mathematics through the students' work. However, there is a difference from the pre-test to the post-test, which shows a difference in written mathematics communication (see Appendix C). Even though I cannot say this is a direct reflection of the students' improvement in oral communication with mathematics I do hope there is a correlation between students' oral and written communication. In my journals writings there are entries about how well the students are able to speak about mathematics. In my journal entry dated March 24, I wrote:

> The students are speaking about mathematics more fluently than ever before. I am very impressed with their ability to connect mathematics vocabulary words from previous chapters with their current lessons. Never before have I felt that I have taught vocabulary in mathematics effectively.

Students' mathematical vocabulary is greatly improved from when the research was launched. Evidence of this improvement in oral communication is found by comparing the March 24 journal entry with the March 3 journal entry in which I wrote, "When we go to discuss problems I feel like the students do not understand how to communicate effectively. They struggle with the

vocabulary needed to effectively convey their question or their response." By having to communicate back and forth during peer-led reviews the students had to practice using certain mathematical terms.

Another aspect of oral communication is the ability of students to ask for help. In mathematics there are some concepts that are quite difficult to discuss unless the students are able to utilize proper mathematical terms. For example, when speaking about linear equations, if a student does not understand certain vocabulary terms such as y-intercept and x-intercept it becomes hard to analyze data in real-life situations because of the importance of these terms. Through the peer-led reviews, my students became more confident in their abilities to ask questions about mathematical concepts. Because each student needed to be able to understand the questions and the explanations of the peer-led reviews, students began to focus more on the vocabulary involved with the work. In my journal entry dated March 13, I wrote, "The students seem to realize that they cannot communicate effectively amongst each other without at least a broad understanding of the vocabulary of the lesson. The students are beginning to use the vocabulary in order to help their presentation." At times they would ask for clarification of a vocabulary term or in other situations they would just stop the presentation and ask what a certain term meant.

In Math 807T for Math in the Middle, we studied mathematics of the everyday world. We were required to write some of our assignments up as if we were communicating with an individual who was not a mathematician. I bring this up because as I was writing up the projects I did wonder what level at which I should I be and how much explanation a reader would need. I really found this interesting and relevant when I reflected upon my research question about mathematical oral communication. My students who went through peer-led reviews are more

prepared to read and understand a mathematician's writings than any of my other students. This opportunity for them to learn mathematical vocabulary was more rich and rewarding than writing the terms on a piece of paper and possibly never communicating verbally with those terms. Through peer-led reviews students were forced to communicate mathematically and as a result they began to utilize the mathematical vocabulary.

My third research question was "what happens to my teaching when I implement peer-led reviews?" This question has many answers but if I were asked to sum it up I would say that peer-led reviews have made me a more productive teacher who challenges students to think on their own and to work through problems rather than giving up. Of course, there are more effects that just those, but through peer-led reviews I have been able to change my teaching style and I have been able to positively affect students.

In my journal entries there are numerous times where I commented on my teaching and how it had been affected. First, I became less time-oriented and more concerned with student understanding. In order to do this I had to set aside at least one and sometimes two class periods per week where all we did was go over problem-solving sets in a peer-review session. Evidence of this can be found in my first journal entry dated February 20: "I have already noticed that in order to conduct this action research I must release some of the reins of teaching. I must allow the students more time to think and communicate rather than dictating the class through lecture." At first this was challenging for me, as I wanted to rush through the book and hit all the concepts. I also felt rushed because I knew state standards were coming up as well as some other things.

Evidence of my changing teaching methods and changing instructional pace can also be found in my journal entry dated March 1, in which I wrote: "I have really noticed that through

this process I have began to be less concerned with the amount of time a lesson takes and more concerned with the amount of understanding that I find in the students." What I noticed was when my class would work through a problem-solving set, the peer-led reviews would bring up concepts that we had never covered. One day we covered the log function even though the log function is only briefly mentioned at the end of the book.

In my journal entry dated April 20, I wrote about the benefits of not rushing through material just to complete it but rather to spend enough time on the concept to gain an understanding:

> "We are not going to finish the book. I have never finished the book but I had hoped to get further this year. Although I made it to the same place as I have in the past, I do feel that through peer-led review we have actually hit upon the final chapters of the book and gained a better understanding of the previous chapters through class discussions and presentations."

The implementation of peer-led reviews has allowed me to become less time-oriented while increasing my focus on understanding. Through peer-led reviews my class has been able to cover additional concepts while developing a greater mastery of the main concepts.

In addition to changing my time-first ideology to understanding-first ideology, this action research project has also made me a more observant teacher. In my April 20 journal entry I wrote,

> "Throughout this process I have grown as a teacher. I have become less concerned with time and more concerned with understanding. Although peer-led reviews may seem to slow down the instruction of mathematics, I believe that it actually allows for a deeper understanding or mathematics."

Through peer-led reviews I was able to slow the pace of the class without cutting short the depth of concepts or the number of concepts. Peer-led reviews took my eyes off the clock and gave me more opportunities to assess and monitor students.

Throughout this process, my role has switched from being a lecturer to being a listener and a facilitator. In this role, I was better equipped to assess student understanding on a day-to-day level. I wrote about this role in my March 24 journal entry:

> "I feel so much more able and equipped to actually monitor the progress of my students. I constantly get to hear from them on each and every assignment instead of just grading a paper after they have either failed or passed."

Through the interactions I was able to obtain more of a real understanding of if students actually understood a concept or if they just got shown how to do it.

On March 8, I wrote in my journal the following: "Peer-led reviews have given me an opportunity to better monitor student progress. I get a real look into how they are doing**."** I have always been troubled by the inability to scout out if a student actually understands the concept or is just duplicating a process they have been shown by the teacher. Through the discussions in the peer-led review sessions, I was able to get a pretty good grasp on student understanding. One of my favorite questions to ask during the peer-led review sessions was "can you explain why that works?" Generally, students who understood the concept were able to give me some type of explanation and students who did not understand the concept would give replies like "I don't know" or "because it works." I wrote about this in my March 17 journal entry saying, "Usually if a student understands the process he or she will try to explain, if the student says, 'I don't know' or 'because it does' I usually inferred that the student did not understand the concept enough." Granted, some of these responses were due to effort but through this interaction I could make a

student review the process in front of the whole class so the rest of the students not only received the initial conclusion, they also received a review of the solution.

My classroom changed quite a bit due to the nature of my peer-led reviews. I released the reins and allowed for a more interactive and less “organized” classroom. I use the word “organized” lightly because I no longer think that being organized has to mean the students come in sit down, open their notebooks, and then the teacher starts lecturing. When I walk into my room I want exactly the opposite to be happening. I want the students to be communicating about the problems they had on the previous assignment, and through peer review, I want them to gain an understanding of what is happening. With this method of classroom management, it will appear to be much less “organized” and sometimes chaotic in appearance, the students will be learning immediately. In addition to this immediate learning that begins to take place, this time of peer review and reflection gives me time to get things prepared and do the necessary housekeeping issues such as attendance and other preparatory work. I wrote about this in my February 20 journal entry, “I have already noticed better usage of class time because students can now start reviewing while I take care of certain ‘housekeeping’ tasks.” In addition to this initial journal entry I also wrote about the improved classroom management through peer-led reviews in a later journal entry dated, March 24, I wrote:

> “My classroom has become so much more organized with peer-led reviews. This is completely opposite of what I thought would happen but by implementing peer led reviews I have the opportunity to get more done in one class period. For example, when students come in they immediately get into groups and review the previous lesson. In addition, at the end of the day it also gives me an opportunity to circulate throughout the room to look over student work and to listen to student discussions.”

The transition from a teacher-centered classroom to a classroom with peer-led reviews was less organized in the beginning but as my journal entries indicate, allowed me to become more organized and efficient over time.

I have come to some conclusions through my action research project. First, I believe students think at a higher level when processing problem-solving sets in a group discussion than they do in completing concept-style questions. My evidence to support this comes from my teacher journal entry dated March 24, in which I wrote: “I have seen students who used to sit it out when it came to answering questions and classroom discussions become a key ingredient in our peer-led reviews.” In addition, I also made this entry in my March 13 journal entry, “The biggest thing that I think is happening is that normally poor students are interacting and providing insight into some of the most complex problems.” This was evident more and more often as I worked through the action research.

I also have found evidence in student work where students who are unsure of how to do the algorithm will work toward and answer in a different manner than using the algorithm. If it is a concept-style question that the student is dealing with, many times they will either just guess without showing any work or put down “I don’t know.” In an interview a student said in response to being asked how she felt peer reviews had affected her understanding of mathematics, “the reviews have helped me understand the importance of showing my work. They (the presenters) went through step-by-step so we all knew how we got the answer” (April 27). This interview response shows how students now were not only reporting an answer, but instead were thinking about each level of the question to a degree in which the student is able to explain each level to his or her peers. This illustrates higher-level thinking by students.

I also found that if students are confident in their answer then they are more open to share their method. I tried a couple of methods of showing if a student had a correct answer before they presented. One of these methods was simply handing out an answer sheet prior to presentations and the other was less formal where I would just walk around and either tell them they were on the right track or that they needed to rethink the problem. My evidence to support that students are more open to show their method if they know their work is correct comes from my journal and an interview question. In my journal entry dated March 17 I wrote:

> "Today I walked around and looked at some of the students work before they presented. I looked mostly at the problems the student was going to present and asked some questions of their method and how they arrived at that answer. After a brief discussion I either told them that their answer was on the right track or I told them they may need to think about it a bit more. When it came time to present, the students who were told they were on the right track presented the problems with a great deal of confidence. Those I had told need to rethink the process were very tentative in their presentation even if they had completely redone their work."

It appears the students want to look intelligent in front of their classmates and that knowing the answer they have is correct does in fact improve the presentation.

In my March 20 journal entry I said, "I have witnessed time and time again students doing a better job of selling their product when they are told their answer is correct. This seems to help out when it comes to classroom discussions." This is very telling of how students gained confidence in their presentations when they were aware of their answer being correct. In an interview question in my April 27 interviews, I asked if the strength of students' presentations depended upon if they knew the problem is right or wrong. From the student interviews I

received mixed results with seven responding yes and five responding no. The fact that about half of the class said yes and half the class said no indicates that for this particular class it was not an overwhelmingly important issue in the eyes of the students.

By giving students a sense of security before they presented problems it allowed for a richer discussion in class. Less time was used doubting what they presented and more time was used by the presenter eager to answer questions because he or she knew what they did had worked. This also allowed for other students who arrived at the same answer through a different method to feel like they also knew what was going on and it gave them an opportunity to speak up and share their unique method.

Throughout my action research I also noticed that students were able to bridge the gap between instruction and application when they are exposed to problem solving and peer review. Through the peer-review process, they become much more capable of applying their knowledge to an application. My support for this first comes from my March 17 teacher journal where I wrote:

> "I have found that students are able to start applying their knowledge now with peer-led reviews and problem solving. I am very pleased with how the peer-led reviews of problem solving are going. The students seem to be better suited for applying the conceptual problems to real-life events. It has been amazing to listen to the discussions between students when they are presenting their problems and also when presenting alternate solutions. There is no doubt they are bridging the gap between concept and application."

In addition to this, in response to how have peer-led reviews changed the classroom, a student said, "good, it gives us more than one way to look at problems". By allowing students to now

connect application with concept they have another way to look at problems. Another student replied to the interview question ‘how did peer-led reviews change the classroom’ by saying, “We understand it better. It gives us more than one way to understand problems” (March 10). In my March 29 journal entry I wrote, “Through peer-led reviews my students now can look at a concept problem and get an estimate of their answer based upon their knowledge or real-life application.”

During the course of the peer-led reviews I had wondered, how will what I am teaching them correlate to the state standard tests? My district’s testing is provided online through a consortium of schools and each standard has 15 questions associated with the state standard on an individual test. Some of these tests are primarily concept-based where others are more problem-solving based. The one problem I have always had with these tests is that they can be general and it is hard for students to generalize what they have learned during class. I found that my students who took part in the action research project were more prepared for the state standards than I had assumed. In my journal entry dated April 1, I wrote:

> “In the past, students have had some difficulty in passing some of these tests as they require greater use of application of a concept. This year I was amazed by how students were working through the problems on paper and were drawing pictures and making short explanations for themselves as they were working. I had tested these same students in the fall and you would have been hard pressed to find more than two lines of work amongst the entire class. The change was significant and definitely worth noting.”

To me, this may be the most telling piece of evidence. Although I should not compare this group of students with any other class I have taught, I can say that I have never witnessed as much

scratch paper work on the state standards as I saw from the students who participated in the action research.

I have found throughout this action research project that my peer-led reviews have created higher-level thinkers and with that the students who generally struggle with math are now showing better understanding. One student said, “they make some people pay attention” when asked how have peer-led reviews changed his or her classroom. These are the people who would not take a note when I would lecture and who would look up but their thoughts were off topic. What I found and included in my journal was that students who were normally failing or near failing in math classes were now making positive contributions to class. I knew they were getting it because they started to communicate. Another student commented that “we feel more comfortable asking other students questions.” This not only allowed them to feel more comfortable it also allowed the wall between learning and embarrassment to be torn down which led to higher-level thinkers. Another journal entry of mine has this support for my findings of creating higher-level thinkers and it says, “Students are now taking concept problems and relating their answers to a real-life situation to check its validity. They no longer only think about how to solve for ‘x’, they also think about what does ‘x’ stand for?” (April 20). This in itself gives me confidence that the students who participated in my action research project became higher-level thinkers.

Conclusion

As an educator, my findings speak volumes about the power of doing over the power of being told. I had a college professor in my undergraduate work who told me, “no one can be taught but everyone can learn.” This saying may not have stuck with me except for the fact that this professor taught with this saying as his center. He worked hard to allow us to learn but he

rarely made anyone feel as if they were being “taught.” I relate this to my action research project. The peer-led reviews were allowing students to learn. Through this method, students also became stronger in other areas of mathematics such as communication and application.

Jaworski (2003) agreed that learning as a community was very positive in all subjects but especially in mathematics. Jaworski speaks of how learning in a community promotes a positive attitude. I believe that these peer-led reviews created a learning community within my classroom. Before I introduced peer-led reviews much of the learning was done through communication waves where the lines only ran to me, the teacher. Now students realize that there are communications lines not only to me but also intertwined to every single member of the class.

Another outcome of the peer-led reviews that I feel very strongly about are how they allow me a better understanding of where students are at in regards to understanding. Watson (2000) agrees with this by saying that informal assessment was found to best be done when teachers were probing and prompting answers from their students. This is exactly what my peer-led reviews allowed me to do; they allowed me to probe for answers in various different ways to check for student understanding.

Mathes, Torgesen, and Allor (2001) support peer-assisted learning which gives the diverse classroom more instruction for struggling students. By giving students instructional support through peer-assisted learning a sense of companionship and support are created. This in turn leads to improved self-confidence. This research agrees with my findings of how peer reviews improve student confidence and also create that community of learners. Through this students are more likely to explain their work and ask others for help.

Implications

As a result of my study I plan to implement peer-led reviews in all of my mathematics classes next year. I plan to utilize problem-solving sets and to make available at least one day each week where all my class will do is peer-led review. In addition to teaching mathematics I also teach some science classes. I would also like to start implementing some of my peer-led review methods into my science classes and see how the change topic affects the outcome of peer-led reviews. In addition, I would like to try to promote peer-led reviews to the entire mathematics department at my school. Through this I could gain valuable knowledge from teachers of higher level mathematics and lower level mathematics and over time we could get a feel for the results that peer-led reviews have upon the mathematical skills of students. This study has forever changed the way I look at mathematics education and has forever changed the way I operate my mathematics classroom. My focus will be to maximize student involvement and allow the students the opportunity to learn instead of being taught. By taking these steps I am confident I will be allowing students who have experienced my classroom an opportunity to think at a higher level and the opportunity to use their knowledge and contacts to work through most any mathematical problem.

References

Bentz J. & Fuchs L. (1996).Improving peers' helping behavior to students with learning disabilities during mathematics peer tutoring. *Learning Disability Quarterly, 19*(4), 202-215.

Berry J. & Houston K. (1995).Using posters as a means of communication and assessment. *Educational Studies in Mathematics, 29*(1), 21-27.

Chiu, M. M. (2004).Adapting teacher interventions to student needs during cooperative learning: How to Improve Student Problem Solving and Time On-Task *American Educational Research Journal, 41*(2), 365-399.

Fraivillig J., Murphy L., & Fuson K. (1999).Advancing children's mathematical thinking in everyday mathematics classrooms. *Journal for Research in Mathematics Education, 30*(2), 148-170

Fuchs D., Mathes P., & Simmons D. (1997).Peer-assisted learning strategies: Making Classrooms More Responsive to Diversity. *American Education Research Journal, 34*(1), 174-206.

Graven, Mellony. (2004).Investigating mathematics teacher learning within an in-service community of practice: The Centrality of Confidence. *Educational Studies in Mathematics, 57*(2), 177-211.

Heward W., Heron T., & Cook N. (1982).Key element in a classwide peer tutoring system. *The Elementary School Journal, 83*(2), 114-123.

Jaworski, B. (2003).Research practice into influencing mathematics teaching and learning development. *Educational Studies in Mathematics, 54*(2), 249-282.

Mathes P., Torgesen J., & Allor J. (2001).The effect of peer-assisted literacy strategies for first-grade readers with and without additional computer assisted instruction. *American Education Research Journal, 38*(2), 371-410.

McNair, R. (2000).Working in mathematics frame: maximizing the potential to learn from students' mathematics classroom discussion. *Education Studies in Mathematics, 42*(2), 197-209.

National Council of Teachers of Mathematics. (2000). *Principles and Standards for School Mathematics.* Reston, VA: Author.

Pape S., Bell C., & Yetkin I. (2003).Developing mathematical thinking and self-regulated learning: a teaching experiment in a seventh-grade mathematics classroom. *Educational Studies in Mathematics, 53*(3), 179-202.

Watson, A. (2000). Mathematics teachers acting as informal assessors: practices, problems, and recommendations. *Educational Studies in Mathematics, 41*(1), 69-91.

Appendix A: Student Interview Questions

What was the math concept that was covered today in math class?

How well do you feel you understand the concept covered today?

How did the presenters today enhance the learning of today's class?

What could the presenters have done different to help more students?

What could I, the teacher, have done different to improve the presentations of problems?

How do you feel peer led reviews have changed the classroom?

How do you feel peer led reviews have effected your understanding of mathematics?

Does the strength of your presentation depend upon if you know the problem is right or wrong?

What were some things that went well today in the peer led reviews?

What were some things that went poorly in the peer led reviews?

How could I, as the teacher, arrange the peer led reviews to be most helpful?

Appendix B: Student Survey Questions

Student Pre-Survey

Rank the following in order from 1 to 7 in regards to how you best learn math

___Working in groups during class
___ Having a classmate explain the concept to me during class
___Looking through the examples in the text and developing my own plan
___A teacher led lecture
___Working alone to determine the correct response
___My parent/guardian guiding me through the assignment
___Using the online tutorials provided by the book

Answer the following questions with your first and most honest response:

	Disagree	Neutral	Agree
I like to present my solutions to the class	1	2	3
I like to learn from classmates in math class	1	2	3
I would prefer to ask a classmate a question Rather than the teacher.	1	2	3
I like to work in a group	1	2	3
I like to speak in front of the class	1	2	3
I like to present solutions to problems in class	1	2	3
I like to present solutions to problems where I know I have the correct solution	1	2	3
I understand math problems better when a Fellow student presents their method versus The teachers explanation	1	2	3
I like to assist classmates when they are having Trouble with a concept.	1	2	3
There is more than one possible way to solve A problem	1	2	3
The teacher should do most of the presenting			

Of problems and examples in a math class	1	2	3
I like math	1	2	3
I am interested in math	1	2	3
Math will play a large roll in my life	1	2	3
I am the only one that struggles with math.	1	2	3

Student Post-Survey

Rank the following in order from 1 to 7 in regards to how you best learn math

___Working in groups during class
___ Having a classmate explain the concept to me during class
___Looking through the examples in the text and developing my own plan
___A teacher led lecture
___Working alone to determine the correct response
___My parent/guardian guiding me through the assignment
___Using the online tutorials provided by the book

Answer the following questions with your first and most honest response:

	Disagree	Neutral	Agree
I like to present my solutions to the class	1	2	3
I like to learn from classmates in math class	1	2	3
I would prefer to ask a classmate a question Rather than the teacher.	1	2	3
I like to work in a group	1	2	3
I like to speak in front of the class	1	2	3
I like to present solutions to problems in class	1	2	3
I like to present solutions to problems where I know I have the correct solution	1	2	3

I understand math problems better when a
Fellow student presents their method versus

The teachers explanation	1	2	3
I like to assist classmates when they are having Trouble with a concept.	1	2	3
There is more than one possible way to solve A problem	1	2	3
The teacher should do most of the presenting Of problems and examples in a math class	1	2	3
I like math	1	2	3
I am interested in math	1	2	3
Math will play a large roll in my life	1	2	3
I am the only one that struggles with math.	1	2	3

Appendix C: Student Pre and Post Test Example

Pre Test

Rice and Water Problem Name

A. It takes 5 cups of water to cook 3 cups of rice. How much water is needed to cook 7.5 cups of rice? 11 2/3 cups of water

B. Obtain, a formula that relates the number of cups of rice to the number of cups of water, and formulate the result as a graph.

C. Obtain the "inverse" relationship which relates cups of water to cups of rice, and draw the graph.

5c - 3c y = 1 2/3x 3/5 = 3/5 cups of rice per 1 cup of water

1 2/3c - 1c

Post Test

Rice and Water Problem Name

A. It takes 5 cups of water to cook 3 cups of rice. How much water is needed to cook 7.5 cups of rice?

B. Obtain, a formula that relates the number of cups of rice to the number of cups of water, and formulate the result as a graph.

C. Obtain the "inverse" relationship which relates cups of water to cups of rice, and draw the graph.

A) 5c w = 3c r

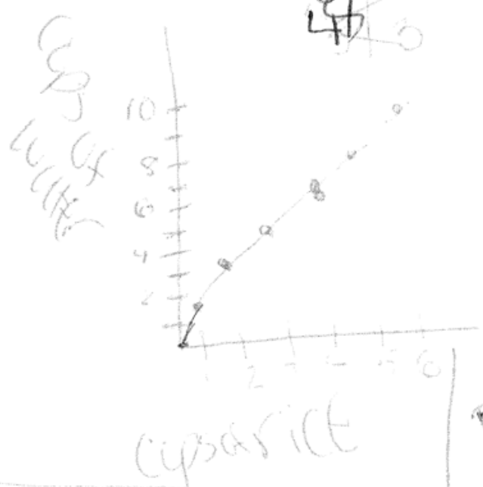
3x = 37.5

12.5c of water

B) w = 5/3r

5 ÷ 3 = 1 2/3 cut

1 2/3R = W



Explanation

A) I did the cross mult. 5/3 and x/7.5 and get 3x = 37.5 which is 12.5 c of water

B) I got an equation of w = 1 2/3 r because 5/3 = 1 2/3 and then I graphed it

C) you take 3 ÷ 5 and get 3/5 so you have r = 3/5 w