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This Master's Research Project has been approved

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ABSTRACT

Cooperative learning has been around for many years, however it has not been a prevalent instructional strategy used at the high school level, especially in mathematics. The purpose of this research project was to determine how cooperative learning impacts students’ understanding of math content. The research also examined the levels of bloom’s taxonomy that could be reached by implementing cooperative learning in the classroom. Cooperative learning is a very structured teaching strategy that uses various group activities to reach a common goal. It is used to deliver material to the students through methods of social interaction, teamwork, problem solving, hands-on experiences, and critical thinking.

This study was conducted at a rural high school with 25 participants from two, ninth grade Algebra I College Prep classes. Data for the study was combined and collected through surveys, interviews, and assessments. The surveys and interviews were used to create a base for the research; to determine students’ attitudes about learning mathematics as well as working with others. This assisted in determining how students would be grouped and what type of cooperative learning activities would be used. Two consecutive lessons were chosen to be taught during the study. The information was delivered to the students through direct instruction, lecture and note taking which is standard practice for these classes. A pre-test was given and scored. Then the students participated in a cooperative learning activity, followed by a post test. The pre and post tests were given to compare the students’ knowledge of the content prior to and after the implementation of various cooperative learning activities. The assessments included standard recall, comprehension, and application questions as well as higher level thinking questions for analyzing and evaluation.

The results of the surveys and interviews did not show a change in attitude when comparing responses prior to and after the cooperative learning exercises. However, when analyzing the pre and post test scores from two different lessons that incorporated cooperative learning after the pre-test, there was an overall increase in test scores. The results of this research determine that cooperative has a positive impact on students’ ability to understand mathematics. It is my recommendation that teachers integrate this instructional strategy into their lesson plans and unit plans from the beginning and throughout the school year to offer all students multiple opportunities to learn math content.
CHAPTER 1
INTRODUCTION:

Purpose:

The purpose of this project is to examine how the implementation of cooperative learning in the math classroom impacts students’ ability to understand math content. The research will attempt to determine if cooperative learning does not only increase the development of knowledge among students, but also allows students to reach higher levels of understanding using the framework of Bloom’s Taxonomy.

Cooperative learning has been around for many years, however it has not become a prevalent instructional strategy used in the secondary schools, especially in the teaching of mathematics. This research conducts a study using various cooperative learning approaches. The common core state standards for mathematics (CCSSM) emphasize problem solving skills and career preparation. The 8 mathematical practices within the CCSSM explicitly discuss the types of skills the students are expected to learn and acquire. Some of these practices are solving problems through perseverance, constructing viable arguments, and reasoning abstractly and quantitatively. So now more than ever, students need to learn these critical skills for the curriculum and for everyday life. I investigated how cooperative learning helps students develop and master these skills. Through this process I wanted to determine students’ individual strengths and struggles to properly plan cooperative learning activities that allow students to gain confidence and deepen skills they already possess as well as plan activities that integrate skills they possess and skills they may struggle with as to help develop those weaker skills.
Problem:

Students are not learning content well enough, at a deep enough level for long term retention, or to achieve thinking at higher levels of Bloom’s Taxonomy. Students, often times are considered to be a good student or to be doing well if they are simply recalling vocabulary, formulas, or notes on a topic long enough to regurgitate it on a quiz or test. However, often times, students don’t actually retain the information past the assessment and couldn’t use the concepts in any other types of contexts. For example, a student in my Algebra Emphasis class struggled with a concept on measuring and how to read lengths of measurement. That student came into class one day super excited that he learned how to use a ruler! He explained his invigorating accomplishment by describing how his dad is a carpenter and works with rulers and measurements every day and how his dad was able to spend time with the student to show him some of the things he does, how he does it and why it’s so important! That solidifies how critical it is for students to conceptualize material and not simply remember it for a short amount of time. This student will likely always remember the concept of measurement and how to use measurement devices because of this hands on, conversational experience. By applying new knowledge to real world situations and providing an environment that promotes student thinking and discussion creates a deeper understanding of the content and allows students to apply their knowledge. Cooperative learning provides opportunities to have experiences and will help solve the problem of low level understanding and short term retention.
Background/Definitions:

Cooperative learning is students working together to accomplish shared learning goals and maximize their own and their teammates achievement. (Cooperation in the Classroom by Johnson, Johnson, and Holubec, 1993.) This process involves students typically working in small groups toward a common goal. Within cooperative learning groups there are specific roles that each group member possesses to insure that all students are contributing and learning. In cooperative learning it is important for group members to understand that they are part of a team working toward a common goal and that the successes or failures of the group will be shared by all members. Therefore all members of the group need to contribute and assist others in learning. Through cooperative learning students learn to talk, and discuss problems with each other and encourages interaction among students and helps establish positive relationships among peers. This collaboration promotes teamwork, social skills, problem solving skills, decision making skills and critical thinking skills. Group success being dependent on the direct effect of each individual’s contribution helps students to be accountable for their own learning. It is also important to make clear what cooperative learning is not. Cooperative learning is not simply separating students into groups to work on a problem with no direction or individual responsibility. It is not students sitting in a group working individually on problems and comparing answers or letting one student do all the work while the others copy or watch.

Cooperative learning can be used in a variety of ways using various modalities and strategies. Arrangements can be informal and quick, used as a way to keep the idea of cooperative learning flowing throughout daily or weekly instruction. Or it can be arranged in a more formal, long term structure to cover a full lesson or as a summative assessment for an
entire unit. Two popular examples of quick cooperative learning strategies would be the Think-Pair-Share method and the Numbered Heads Together method. The Think-Pair-Share method groups students together allowing them time to think about a question or problem individually, then time to discuss their individual idea with their group and then a chance for students to be called upon to share their own and other group member responses. The Numbered Heads Together method consists of students being grouped together into teams and each team counting off by numbers to be assigned a particular number. The teacher then asks a question or poses a problem. The group collaborates to answer the question and to make sure each member knows and understands the answer. The teacher will call one of the numbers such as 3 and the number 3 member of each group will have to give the answer their group determined. Two popular examples for the more formal cooperative learning strategies would be the Jigsaw and Inside-Outside Circle. The Jigsaw approach assigns each teammate with special topic to learn. Then the group members from all the groups with that same topic group together and work together to learn that topic. Once they are finished, they return to original group and teach the rest of the group what they learned. This gives students individual accountability to learn the material because they are responsible for teaching it to the rest of their group. It also promotes collaboration through face to face discussion and communication skills. The Inside-Outside Circle approach has students arranged in two concentric circles facing each other. The students are given question cards with answers listed on the bottom. The students ask each other and answer the questions from the card and then rotate. After a few rotations, the students switch cards. This is a good exercise for a test review or additional practice on a lesson (Foster, 1993).
The implementation of cooperative learning shifts the classroom dynamic from teacher led instruction of giving information to the teacher facilitating learning. It requires the guidance from a teacher that can help develop these cooperative learning skills and take the proper steps to teach students how to effectively work in groups. A large amount of planning and preparation is required to set up these cooperative learning techniques in the classroom. From experience and discussion with other teacher, that is one reason why it is not implemented as much as it could be. Teachers find it difficult to organize and train students how to use it properly. Teachers and students alike are more comfortable with the traditional direct instruction approach because that’s what they are familiar with and used to. Direct instruction is also often preferred because the teacher has more control, is good for teaching basic facts, and planning is simplified because it is a whole group approach. However, several teachers do implement cooperative learning because it fosters so many more skills than traditional instruction and it can be used to help all types of students with different skill levels and learning styles to succeed. Cooperative learning is also known to have a longer lasting effect on students. When working in a cooperative learning environment, students tend to enjoy learning more, learn concepts at a deeper level and retain information longer.

Another term that will be seen throughout this research is Bloom’s Taxonomy. Bloom’s Taxonomy is a classification of learning objectives under the cognitive domain, which was originally created in 1956 and since revised to include the learning objectives in order to be Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating. Bloom’s Taxonomy was created to promote higher level thinking among students in the classroom. The
research will discover what levels of taxonomy can be reached through cooperative learning in mathematics.

A brief description of the levels of Bloom’s Taxonomy taken from Thousand, Villa, and Nevin (2007) are as follows: Remembering - Recall of basic facts and previous learned information. Understanding - Comprehending the meaning, translation, interpolation, and interpretation of instructions and problems. State a problem in one's own words. Applying - Use a concept in a new situation or unprompted use of an abstraction. Applies what was learned in the classroom into novel situations in the work place. Analyzing - Separates material or concepts into component parts so that its organizational structure may be understood. Distinguishes between facts and inferences. Evaluating - Make judgments about the value of ideas or materials. Creating - Builds a structure or pattern from diverse elements. Put parts together to form a whole, with emphasis on creating a new meaning or structure.

Conclusion:

Students at all skill levels deserve to achieve academic success. And especially in the math classroom students need to find enjoyment, purpose, and understanding in the content they learn. Cooperative learning gives students the opportunity for differentiated instruction so that students have a variety of learning strategies that may best suite their strengths and needs, while promoting social interaction among peers. The question for this research is: How does Cooperative Learning impact the level of understanding of content in Mathematics? I hope to discover that implementing cooperative learning in the math classroom will allow more students to demonstrate academic success and develop a deeper level of understanding that
rates higher up the scale of Bloom’s Taxonomy. I want students to be involved in collaborative experiences that include discussion, the use of various multiple intelligences, individual accountability, and real life scenarios that will lead to the enjoyment of learning math content and being better prepared for life after graduation by learning lifelong techniques for cooperation, teamwork, decision making skills, and problem solving skills.
CHAPTER 2

LITERATURE REVIEW

Cooperative learning is an important topic to research because it is a topic that has been in the forefront of teaching strategies in recent years. There is a big push to incorporate variation in instruction, with cooperative learning being the hot topic over other small group strategies and definitely direct instruction. There is a need for all types of instruction because all students learn differently and it is the goal of teachers to provide ways for students to have the best opportunity to learn. The literature on cooperative learning has one common theme throughout which is cooperative learning has a positive effect on student achievement.

Although most authors seemed convinced that attitudes would increase positively through experiencing cooperative learning, most results did not consistently prove that to be the case. Research also shows a strong need for differentiated instruction. This is a huge issue because direct instruction is still used as the most common type of instruction to teach math. Most of the research also pointed out that cooperative learning not only helps students learn the necessary material, but it also provides them with a deeper understanding of the content. It allows for students to communicate with each other in the safe environment of their own small group and often times experience hands on activities that students can actually see what they are learning. The research is limited in providing readers with detailed descriptions of how the cooperative learning strategy was used or what type of lesson the activity was used for. That would have given readers ideas of how they could attempt the implementation in their classrooms as they transition from all direct instruction to integrating cooperative learning as part of a new differentiated instruction model.
Shafiuddin, M. (2010) conducted a study to compare traditional teaching of mathematics, which is assumed to be direct instruction with heavy weight given to the lecture component, and the cooperative learning strategy. The study worked with two groups of students including high, average, and low achievers. One group was taught using the traditional method, while an experimental group was taught the same mathematical material using cooperative learning with the jigsaw method. The hypotheses were: 1. The post-test scores would be significantly different between the traditional group and the cooperative learning group. 2. The post-test score would be significantly different between low, average, and high achieving students with the traditional group. And 3. The post-test scores would be significantly different between the low, average, and high achieving students within the cooperative learning group. The results proved the hypotheses to be true for 1 and 2. However, there was not a significant different in the test scores between high, average, and low achieving students within the cooperative learning group. Since there was no significant difference, this means all types of students performed about the same on the test. Hence, the cooperative learning method made a significant increase of achievement on the lower level students. This is exciting because the struggling students are a challenge for teachers to effectively transmit information to and this study shows that cooperative learning in mathematics, which is difficult for so many students to learn, can make it achievable.

Zakaria, E., Lu, C. C., & Daud, M. Y. (2010) concluded by conducting a study using the cooperative learning strategy of Student Teams Achievement Divisions, that students who are given a more hands on approach using social skills, face to face interaction with individual accountability have a better attitude toward mathematics as well as learning more content.
This study is consistent with another study that showed benefits of the implementing cooperative learning, such as promoting deeper learning of material, achieving better grades, learning social skills and civic values, learning higher order critical thinking skills, and promoting overall personal growth.

Research suggests the implementation of cooperative learning does increase student achievement, but not all students prefer small group or cooperative learning according to Zakaria, E., Solfitrī, T., Daud, Y., & Abidin, Z. Z. (2013). Although, this is a suggested method to increase student achievement, it should not be the only method used in the classroom. Teachers need to incorporate a variety of learning strategies to be sure to connect with all the students and how they best learn.

Cooperative learning has been proven to increase student achievement in content knowledge and level of understanding. However it must be implemented properly to be effective. There are many different methods to use for cooperative learning that can help a variety of students learn. Specific approaches and activities may be geared toward the use of specific modalities such as auditory, kinesthetic, and visual learning styles. But if students are not grouped properly, the exercise might not be as successful as it could and students may not benefit or enjoy it as much. In a study done by Westbrook, (2011), two groups of students were created, one group randomly selected, the other group by learning style. The research was to determine which group would display greater ability learning the standards or display better attitudes towards problem solving. When the qualitative and quantitative data were analyzed, the results demonstrated that the hand-picked group by learning style did not show significant gains when compared to random cooperative groups (Westbrook, 2011). It is not
suggested that all groups be selected randomly. However, teachers need to be aware and reflective when conducting cooperative learning exercises to learn and be aware of which groupings work best, which do not and what changes need to be made for next time. The type of activity, learning goals, skill level of students, and learning styles of students all need to be considered when planning a cooperative learning activity. This is another example of how time consuming preparation for such activities can be and why many teachers refrain from using it.
CHAPTER 3

METHODS

Introduction:

This study was conducted to determine how cooperative learning impacts student’s level of understanding of mathematics content. The study was conducted over a 4 week period where I functioned as both the teacher and the researcher. The data was collected through student pre-surveys, student pre-interviews, pre-assessments, formative assessments during performance tasks, post-assessments, post surveys, and post interviews. The data collected was analyzed qualitatively and quantitatively.

Setting and Participants:

This study was conducted in a rural high school in southeastern Ohio. During the 2011-2012 school year the Ohio Department of Education gave this school an Effective rating on the school’s report card (Ohio Department of Education [ODE], 2012). The school has a total enrollment average of 669, which is made up of 99.2% white/non-Hispanic students, with 19.8% of the total being students with disabilities and 59.6% of students considered economically disadvantaged (ODE, 2012).

The study was done on two 9th grade Algebra I, College Preparation classes that I have observed, co-taught, and taught during the first semester. I took over teaching these classes as part of my professional internship for my Master’s Program as well as conducting the research during the second semester. The first class being the First Period of the day. This class, here on out called Class A, consists of 13 students, six girls and seven boys. The current grades before
the end of the first semester range from one A to four D’s with most in the average B/C range.

The second class for the study is during the Fifth Period of the day, called Class B. Class B consists of 12 students, seven girls and five boys. Current grades before end of semester for this class range from three A’s to one D with the remainder in the B/C range. Neither class has students with disabilities or special needs.

Class A and Class B are well behaved classes over all. Class A has a few students that are very chatty, which can be a distraction for some of the other students that struggle to stay focused. However, the few times they have experienced group work, they have done well staying on task with only minimal guidance and few reminders to stay focused. This class does seem to enjoy group activities. Class B is a very quiet class, especially at the beginning of the year. There aren’t any students that are chatty or disruptive. There does tend to be some individual competition within the class among a handful of students. This can be a good class characteristic, but care needs to be taken not to let the other students feel left out or insignificant because they don’t share in the competition. During the group exercises Class B has experienced, the students tend to try working individually without much face to face contact. As the year progresses and more activities the students are involved in, they seem to be coming around. At the beginning of the year they seemed to have a negative attitude toward group work but little by little they are showing more interest and collaboration.

Data Collection and Procedures

Surveys
Student surveys were used to collect data at the beginning of the study. The pre-survey consisted of 20 questions that were answered on a Likert Scale with possible responses of strongly agree, agree, undecided/neither, disagree, or strongly disagree. The survey was to discover students’ attitudes toward math and group activities versus individual assignments. There were questions to determine how they viewed themselves as far as skill level and ability to learn mathematics. There were also questions to gauge the students’ personality as far as if they viewed themselves as outgoing and social or reserved and shy. The survey included questions to determine the learning styles of the students using the multiple intelligences such as visual, tactile, kinesthetic, logical, interpersonal, or intrapersonal to list a few. A post-survey was given to the students as well at the conclusion of the study. There were the same questions as in the pre-survey to determine any changes in attitudes after the cooperative learning activities.

The purpose of the pre-survey was to develop a base for the research. I needed to discover how students feel about group learning and about themselves as learners. Analyzing the data assisted with determining the type of cooperative learning activities that were used in the classes and how students were grouped for the activities. Having this information determined the best grouping of students for various cooperative learning activities to allow for the best possible chance of a successful experience. The post-survey determined if there was a change in student attitudes about working in groups. It also was meant to determine if the students felt differently about the enjoyment or ability to learn mathematics. The post-survey was used to unveil if the students gained more confidence in learning mathematics and if they
thought they learned more using this cooperative learning approach rather than the sole use of direct instruction.

Interviews

Student interviews were also conducted. Pre-interviews were done at the beginning of the study prior to the cooperative learning activities. Data collected from the interview had some overlap with the survey. The interview allowed for more open-ended questions to be answered in sentence form, while the surveys were limited in responses. The interview also consisted of questions pertaining to students’ ideas of the importance of mathematics outside the classroom and throughout adult life. There were questions to find out what role students think mathematics has in their future. Other questions were to discuss the student’s feelings of their own capabilities in math as far as learning math, understanding the concepts, and retention. The post-interview was conducted at the conclusion of the study and was the same as the pre-interview, but on a follow-up basis. This was used to compare the student responses with their responses from the pre-interview. It will be used to find out how the students felt about their growth and academic achievement using this variety of instruction.

Pre-assessments

The study began after the pre-surveys and pre-interviews were conducted and analyzed. Lesson plans were prepared in two sections. First, the lessons were prepared using a direct instruction format that includes mostly lecture and formative questioning to check for understanding. This consists of the teacher being in control and being responsible for relaying the content to the students in a very traditional manner using the board to write definitions and practice problems. Individual seatwork and homework was given using problems from the
student workbooks or worksheets. At the end of the week there was a test given, known as the pre-assessment, on the material taught throughout the week. The pre-tests were graded and analyzed.

The purpose of the pre-test was compared later to the post-test after the delivery of cooperative learning. The pre-test has traditional questions that require memorization and recall of procedures and steps for solving problems. The test also includes questions that require students to group multiple concepts from the week’s material in order to solve. There are questions on the test that are real world scenarios using the learned concepts in a different context than the procedural practice problems. These problems do not require the students to know content outside of what they learned, but does require the students to think about what they learned, not just memorization of steps. They needed to think through the problems and use the skills they may not yet have fully developed. The tests was analyzed paying close attention to common mistakes and the types of problems the students seem to struggle with as well as problems they show to master with no difficulty.

Performance Tasks

After the pre-assessment, the students were separated into heterogeneous groups that were pre-determined and they spent additional time on the concepts of the lesson through various cooperative learning strategies. The students’ grades, personalities, and learning modalities were considered when creating the groups for the activities. Males and females were distributed throughout each group. High level students were split among the groups as well as the lower achieving students. I separated very quiet, shy students as well as very outspoken students. This kept all groups as equal as possible and included different
personalities and learning styles. One lesson during the research was over polynomials and the second lesson was over multiplying binomials and factoring. The first cooperative learning activity was the Round Table strategy and the second activity was the group investigation method. The cooperative learning exercises will be called the performance tasks. Throughout the experience I guided and facilitated rather than deliver direct information of the material. The students used individual thinking skills, interaction between peers, collaboration among group members, and individual accountability while working together to solve problems in order to better understand the concepts being taught. These activities included projects, hands-on activities, written reports, the use or construction of diagrams and graphs to name a few. Throughout the activity, I monitored progress to assure the students are staying on task, assist where needed, redirect student thinking if necessary, and ask questions to deepen thinking or spark a new thought process and discussion among the students in each group.

This process allowed me to use formative assessments such as asking questions or collecting pieces of evidence from the groups to gauge their progress and understanding of the material. I recorded qualitative data about what I observed among the groups as far as progress on the task, how students were interacting, what students were contributing more than others, what students seemed to be struggling with the concepts, noted students that were taking leadership roles in helping other students learn, and observed the dialogue within each group to check the level of critical thinking skills being used.

Post-assessments

After the cooperative learning exercise, which lasted 2 days, the students were given a post-assessment with the same types of questions as the pre-test. The test had the same
format as the pre-test for the most accurate comparison. This post-assessment was compared to the pre-assessment and analyzed to determine if the recall, procedural types of problems were answered at a higher rate of accuracy than the pre-assessment and, if the more difficult problems had a higher rate of correct answers as well. The hypothesis is that the more difficult problems that require more thought and compounded concept knowledge would have a low level of completion and accuracy on the pre-test prior to the cooperative learning activity; and the post-test will show more success after the cooperative learning experience.

**Summary**

The process of direct instruction of lesson and pre-assessment followed by a cooperative learning activity with formative assessment and a post-assessment continued through two lessons. Having at least two lessons with this process gives a valuable amount of data to analyze. However, there may be some bias in the research. Since the students had a longer period of time with these lessons and a minimum of two different types of instruction, students may show higher achievement simply because they have had longer time to work with the material and may not be able to show 100% accuracy the impact that cooperative learning had on the students achievement and level of understanding.

Qualitative data was gathered through the surveys, interviews, and formative assessments. Quantitative data was collected through the pre-assessments, and post-assessments. This will gave me a wide variety of data to analyze, which determined how cooperative learning impacts student level of understanding in mathematics.
CHAPTER 4

FINDINGS

Survey

The Algebra classes participated in several tasks, as listed in previous chapters, to produce data regarding students’ personalities, ideas, and learning modalities with respect to math content. At the beginning of the study the 25 participants completed a pre-survey with 20 questions as shown in Table 1. The same survey was completed by the participants at the end of the study as shown in Table 2. I analyzed and compared the results of the pre-survey and the post survey.

Pre vs Post

The data revealed that more than half of the survey questions yielded the same or similar responses between the pre and post survey. There were seven questions that did have significant differences in responses. More students stated that they preferred using hands-on activities in the post survey than they stated in the pre-survey (question #6). It appears that more students do prefer to work alone on math assignments during class time following the study (question #9). The post survey determined that more students only like group work when they can be grouped with friends (question #11). The students veered toward the neutral response from the pre to post survey for question #12 that states the student quits if a math problem seems to be hard. More students feel more comfortable asking questions in small groups after the study than prior to the study (question #16). More students stated they participated when working with groups in the post survey versus the pre-survey (question #20).
### Pre-survey Questions

<table>
<thead>
<tr>
<th>Pre-survey Questions</th>
<th>Strongly Disagree (1)</th>
<th>Disagree (2)</th>
<th>Neutral (3)</th>
<th>Agree (4)</th>
<th>Strongly Agree (5)</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I think math is important to know for the real world</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>13</td>
<td>7</td>
<td>4.08</td>
</tr>
<tr>
<td>2. I typically do not ask questions, even when I do not understand the material.</td>
<td>1</td>
<td>7</td>
<td>9</td>
<td>7</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>3. I am unfamiliar with the term cooperative learning.</td>
<td>5</td>
<td>11</td>
<td>5</td>
<td>4</td>
<td>0</td>
<td>2.32</td>
</tr>
<tr>
<td>4. I like to work in groups to complete math assignments in class.</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>8</td>
<td>11</td>
<td>4.2</td>
</tr>
<tr>
<td>5. I am a visual learner.</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>11</td>
<td>6</td>
<td>3.16</td>
</tr>
<tr>
<td>6. I prefer to learn using hands on approaches.</td>
<td>0</td>
<td>1</td>
<td>9</td>
<td>12</td>
<td>3</td>
<td>3.68</td>
</tr>
<tr>
<td>7. I prefer to have an exact routine each day in math class.</td>
<td>4</td>
<td>4</td>
<td>11</td>
<td>5</td>
<td>1</td>
<td>2.8</td>
</tr>
<tr>
<td>8. Math is my favorite subject.</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>3</td>
<td>1</td>
<td>2.44</td>
</tr>
<tr>
<td>9. During class time, I prefer to work on math assignments alone.</td>
<td>6</td>
<td>6</td>
<td>9</td>
<td>3</td>
<td>1</td>
<td>2.48</td>
</tr>
<tr>
<td>10. During group work, I am the one that usually leads the group.</td>
<td>0</td>
<td>6</td>
<td>15</td>
<td>4</td>
<td>0</td>
<td>2.92</td>
</tr>
<tr>
<td>11. I only like group work when I can be grouped with my friends.</td>
<td>1</td>
<td>5</td>
<td>10</td>
<td>6</td>
<td>3</td>
<td>3.2</td>
</tr>
<tr>
<td>12. When a math problem seems to be hard, I quit.</td>
<td>0</td>
<td>13</td>
<td>7</td>
<td>4</td>
<td>1</td>
<td>2.56</td>
</tr>
<tr>
<td>13. I often know the answers to questions in math class, but do not feel comfortable giving the answer out loud.</td>
<td>2</td>
<td>3</td>
<td>9</td>
<td>7</td>
<td>4</td>
<td>3.32</td>
</tr>
<tr>
<td>14. Math just confuses me and I do not understand it.</td>
<td>3</td>
<td>13</td>
<td>6</td>
<td>3</td>
<td>0</td>
<td>2.36</td>
</tr>
<tr>
<td>15. I don’t like to be called to the board to solve problems.</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>8</td>
<td>3.44</td>
</tr>
<tr>
<td>16. I feel more comfortable asking questions in small groups rather than in front of the entire class.</td>
<td>0</td>
<td>3</td>
<td>7</td>
<td>7</td>
<td>8</td>
<td>3.8</td>
</tr>
<tr>
<td>17. I learn better when I understand how the subject applies to me.</td>
<td>0</td>
<td>2</td>
<td>10</td>
<td>8</td>
<td>5</td>
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<td>9</td>
<td>8</td>
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**Table 1**
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<th>Post survey Questions</th>
<th>Strongly Disagree (1)</th>
<th>Disagree (2)</th>
<th>Neutral (3)</th>
<th>Agree (4)</th>
<th>Strongly Agree (5)</th>
<th>Average</th>
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<td>1. I think math is important to know for the real world.</td>
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<td>4. I like to work in groups to complete math assignments in class.</td>
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<tr>
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<td>7. I prefer to have an exact routine each day in math class.</td>
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<td>10. During group work, I am the one that usually leads the group.</td>
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<tr>
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<tr>
<td>13. I often know the answers to questions in math class, but do not feel comfortable giving the answer out loud.</td>
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<td>3.16</td>
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<tr>
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<td>2</td>
<td>2.64</td>
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<tr>
<td>15. I don’t like to be called to the board to solve problems.</td>
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<td>3.48</td>
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<td>16. I feel more comfortable asking questions in small groups rather than in front of the entire class.</td>
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<td>6</td>
<td>5</td>
<td>3.64</td>
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<tr>
<td>17. I learn better when I understand how the subject applies to me.</td>
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<td>11</td>
<td>10</td>
<td>3</td>
<td>3.6</td>
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<tr>
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<td>8</td>
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**Table 2**
Student Interviews

At the beginning of the study 25 students answered five survey questions. The questions were similar to some of the survey questions but gave an opportunity to an extended response. Question 1 asked what the students like most and least about math class. There were various responses however, most of the responses mentioned group work and activities being what they liked about math class. Frequent responses for what students like least included moving too quickly from topic to topic, or taking notes because it is boring. Additional responses for what the students like least were having homework, doing word problems. There were two that stated they didn’t like to be asked questions directly or be called to the board. Question 2 asked the students to tell the best way they learn math concepts. An overwhelming amount of responses states that taking notes and working practice problems as the best way for them to learn math concepts. Several also responded that group work was the way they best learned. Question 3 asked the students how well they feel they learned the concepts that were taught throughout the year and how well they feel they could apply the knowledge. Most of the students stated they felt they learned the concepts “pretty well and could apply some of the knowledge”. Three students claimed they felt they learned the concepts very well and could apply most of the knowledge. Three students of the 25 claimed they did not learn most concepts and could not apply any concepts. Question 4 asked how the students felt about the importance of the knowledge and use of mathematics in the real world. All but 3 participants stated that math is important and useful in the real world. However, when asked to elaborate, the students only mentioned careers that have evident use of daily math such as accountants,
bankers, and cashiers. One student mentioned construction work and one mentioned math teacher. Several students stated math was important for going grocery shopping and budgeting money. Three students responded that math was not important for the real world or everyday life with one acknowledging only simple math such as addition and subtraction would be useful for everyday life. Question 5 asks how the students feel about the knowledge and use of mathematics to their own future. The responses were all very similar to question 4. Some students responded they didn’t have any career ideas for their future so they didn’t know if math would be important for them. The post interviews were undeniably similar or exact duplicates of the pre-interview. There were no differences to report between the pre and post survey.

**Pre-test/Observations of Cooperative Learning Activities/Post test**

After the pre-survey and pre-interview were conducted, the first lesson that would be studied began. The lesson was on polynomials and initially taught through more traditional methods including direct instruction, lecture, notes, examples, and practice problems. We continued this method throughout the week and the pre-test was given. The pre-test included simple simplifying and solving polynomial problems then progressed to more complicated problems to solve that. These problems were in the same form as the material taught throughout the week and from the homework, which required knowledge and comprehension and application of the material. The pre-test also included questions that involved higher application skills, analysis, and reasoning skills asking for written text in the answer with justification. The scores of the pre-test from the 25 participants are shown in Table 3. The format of the test was strategically written so that all the material needed to complete the test
successfully was taught throughout the week. However, the hypothesis was that the students would be less familiar with the real world, higher level questions and the study would determine how well the students were able to answer those questions correctly using their knowledge from the material covered in class. The following two days after the pre-test were spent on a cooperative learning activity. The strategy used for the cooperative learning was round table. Three groups of students each had one piece of paper and pencil. I gave a question such as list a monomial. The first student was to list any monomial they could think of then pass the paper to the next student. That student needed to list the degree of the monomial. Then pass to the next student, which listed a different monomial. This process continued for a set time. Once the time was up, the group with the most correctly listed monomials with matching degree won. I then moved to another question and repeated the process. A second cooperative learning activity was conducted, Numbered Heads Together. In this exercise the groups were given a higher level question and each group had to discuss and ensure that all the members of the group understood the content and could answer the question. After a set time, discussion was halted, a random number was drawn and the group member that was assigned that number at the beginning of the activity and that member, independently, had to explain and answer their question on the white board given. All selected group members held their board up and presented the answers to the class. Further discussion with the whole group followed to make sure all students understood the material and how the answers were derived. The process was repeated for five higher level questions.

My observations serve as qualitative data for the study. Overall the activities were successful. All the students participated with excitement, although several of the students
grumbled about wanting to select their own groups. It took several reminders to keep the students from helping each other out on their individual tasks. After some time, they got the hang of it and the process ran smoothly.

After the cooperative learning activities were complete, a post test was given. The post test was very similar to the pre-test in format and concepts questioned. The goal was for the students to be more confident with all the material after the cooperative learning activities, especially better prepared to answer the higher level questions. The results from the post-test are shown in Table 3.

As displayed, 12% of the participants that failed the pre-test with a 62% or lower, actually received a passing grade on the post test. The results also show that 16% of the participants increased their score in the post test by 1-4%, a staggering 68% of the participants increased their score by 5% or more, while three scores remained the same, and one participant actually scored lower than on the pre-test by 2%.

The second lesson during the study was on Multiplying Binomials and Factoring. Again, the lesson was taught using traditional methods of direct instruction. And the same process followed with the pre-test for the second lesson as shown in Table 4. The second pre-test was structured the same as the first with problems requiring knowledge and comprehension of material and increasing difficulty with higher application, analyzing, evaluation skills needed to receive a high score. After the pre-test, a different cooperative learning exercise was conducted with the participants. The cooperative learning strategy used was Group Investigation. The students were broken into 4 groups as discussed in previous chapter.
Group Investigation the groups were given 2 complicated, multiple step, real world word problems to solve. The problems were more detailed and intense versions of 2 problems on the pre-test. The purpose of this strategy is for the students to work together to brainstorm and discuss ideas of how to tackle the problem, with access to many available resources, but limited guidance from the teacher. These problems lend themselves to more ways than one to solve with the use of the material taught throughout the week being most helpful. At the completion of the activity, all groups would present their results. I observed Class A and Class B closely during the activity. One group was able to take off running with minimal guidance, worked well together, discussed options for solving, used materials from the classroom to design a model and solved the problems. From Class A, two of the groups struggled at first and needed a bit more guidance to get them in the right direction of how they should envision the problem. Both groups were able to then work diligently through the problems and solve, however both groups chose completely different methods to solve, but used their resources, materials from the classroom and the content knowledge. One group had difficulty visualizing the problems at all, which included the top student in the class. This group struggled to stay focused, which I think was a result of not knowing how to get started. They needed constant guidance throughout each step, which defeated the purpose of the activity. While observing Class B I noticed that the top students in the class, as in Class A, seemed to struggle the most. Some students were unclear on some of the vocabulary used in the problem. One of the problems involved a 4” frame and some students did not know what that meant, so I had to explain and show visual. Two of the groups struggled to make real life, common sense connections to the problem, or reasoning skills to assist in brainstorming, modeling, and
problems solving. The other two groups although struggled more than I anticipated to get started and had to ask several questions throughout each step, they were able to finish the activity.

All groups except one had difficulty explaining the steps and process they used to solve the problem even if they had the correct answer. They lacked the verbal skills and confidence in their project to complete a quality presentation of the results.

After the conclusion of the Group Investigation cooperative learning exercise, with additional time for me to review the problems used in the activity, the post test was given. Again similar to the pre-test, including questions extremely similar to cooperative learning activity. The results of the post-test are shown in Table 4. The results show that 20% of the students scored below passing on the pre-test and 20% failed the post-test as well. One student went from a passing score on the pre-test to a failing score on the post test and one student went from a failing score on the pre-test to a passing score on the post test. Other results conclude that 28% of the participants actually scored lower on the post-test than they did on the pre-test, and 16% had no change in score. However 56% of the participants actually scored higher on the post-test with 16% of those increasing score by 5% or more.

These results determine that the use of cooperative learning does have a positive impact the ability to understand math content. The use of higher level questions determines that the use of cooperative learning activities assists in students reaching higher levels of bloom’s taxonomy.
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<th>Students</th>
<th>% Pre-Test 1 Score</th>
<th>% Post-Test 1 Score</th>
<th>% Difference</th>
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CHAPTER 5

DISCUSSION

The purpose of the study was to determine the impact cooperative learning had on the students’ ability to understand math content. I also used the surveys and interviews as a tool to determine if students’ attitudes would change after experiencing cooperative learning activities. I was pleased to see that the results did yield a positive impact on students’ ability to understand mathematics based on the results of the two pre and post-tests. After reviewing the results for the survey I determined that there was minimal to no change in the participants’ thought process detected in the results between the pre and post survey. However there were some individual questions that had minor preference changes.

It was determined that more students do like hands on activities after participating in the cooperative learning exercises. This could be due to more experience working in groups with hands on learning. This could also indicate that the students felt they learned more through the experience and felt more confident in taking the post test, increased score and therefore had a better attitude toward the activities. On the contrary, however, it was determined that more students stated they preferred to work alone on class work than they did in the pre-survey. This indicates that some students did not enjoy the group experience. This could be due to more noise from students discussing the problems or students wanting to talk
off topic, which then becomes a distraction for these students and they cannot focus on the assigned task.

Another survey that showed difference between pre and post was regarding students wanting only their friends in their groups. I noticed a trend in this request when forming the groups for the activities. Several students requested numerous times for permission to select their own group. I felt there were different reasons for that, both positive and negative. Some students wanted to choose their own group so they could sit and chat with their friends about anything other than math class. Others wanted to be grouped with particular classmates because they wanted to be with higher level students. Some because they were equal level and wanted to work in a group with all higher level students, others because they were at a lower level and wanted the higher level students for assistance or to do the bulk of the work. And others simply wanted to be in a group with their friends because they felt most comfortable having to talk in front of them and were very reserved and shy when working with others outside their comfort zone. I am disappointed to see this experience created more confirmation for those students wanting to work in groups with friends only, rather than produce a more willingness to work with all peers and more confidence in doing so.

Based on the survey from pre to post, more students felt comfortable asking questions in a small groups setting rather than whole group. It can be interpreted that some students weren’t very familiar with being in a group setting, so they weren’t sure how to in the initial survey and after completing the activities they realized they felt comfortable asking questions in a small group setting. I think it is great that the students have multiple opportunities to ask
questions in different settings so they can build confidence in their comfort zone, which will lead to expanding their comfort level in other settings.

Similar to feeling comfortable asking questions in a small group setting, the survey question that asked if the students participated while working in small groups increased as well. This could also be because of the additional exposure to group settings from the pre-survey. I think that if the students participate in the activities, they have a better chance of learning the content, which seemed to be proven in the post test scores.

The interview yielded almost identical results between pre and post. These results show that the cooperative learning activities produced no change in the participants’ attitudes towards math, including the importance of math being incorporated into their future, level of retention, or being able to apply it in a setting outside the classroom. There are several reasons this could be the case. There were only two cooperative learning activities conducted during the course of the study, which may not be enough exposure to alter the students’ thought processes regarding math. Based on lessons that were part of the study may also be a reason the students didn’t see a big difference in real life experiences where math is pertinent.

Although, the second lesson provided an activity with real life scenarios, the students may not have seen the value of the information in a future job setting. Most students stated that they like group activities prior to the study. I actually thought I would notice an increase of students liking group activities between the pre and post because the students were not exposed to many group activities prior to the study. However, both pre and post yielded the same results. I was disappointed to see some students did not think that math would be useful
in daily living or their future career. The participants are in 9th grade and most indicated they have not given thought to their career after high school. Most were aware of the importance of simple math for money purposes such as going shopping, purchases, and budgeting, however after the cooperative learning activities with real life problems, their ideas didn’t change with regards to the importance of needing to know mathematics.

After analyzing the cooperative learning activities, I feel that they both were successful when considering what I should expect for having little exposure to the process. I was surprised to see that the students needed so much guidance with the second cooperative learning activity and how some of the groups were at the point of giving up. Even though the activity was expected to be challenging, the students demonstrated little willingness to try to brainstorm and use any common sense or prior knowledge. They expected me to give them step by step instructions on how to tackle and solve the problems. After much thought, I determined that is somewhat understandable because the students have not been exposed to that type of learning and have grown accustomed to direct instruction with step by step processes of how to solve each problem they will come across in their homework and assessments. Also, some of the groups were easily distracted and quickly got off task. This could be because of minimal exposure to group learning, which takes time to become familiar with proper group learning behavior and processes. It could also be due to the fact the students found the activities challenging and overwhelming to the point of frustration and giving up.

The results showed that the test scores increased from pre-test to post-test by 84% and 56% respectively. This means that the students were more knowledgeable about the content
and were able to better answer even the higher level questions given. I feel that the cooperative learning exercises played a large part in the increase in test scores. The cooperative learning was successful in providing more exposure to the content and differentiation in instruction. Having various learning strategies provides opportunities to all students to learn in the way that best suits them. Looking at the difference between test 1 and test 2, fewer students increased their score and even 28% scored lower on the second test. Although it was only a decrease in 1-3%, there was still evidence of decline. A possible reason for this could be because the second activity created additional confusion for the students. Because it was intentionally structured to offer minimal assistance and guidance, some of the students struggled to comprehend the material and therefore created more confusion and less confidence for them when taking the post test. Another explanation is that the difference in score was due to simpler problems that the students answered correctly on the pre-test, but encountered a minor calculation error in the post test, which does not demonstrate a lack of knowledge from pre to post. This was evident in five of the students’ tests. The other two tests that showed a decrease in score demonstrated lack of content knowledge with no increased comprehension after the cooperative learning activity. However, with the significant increase in scores overall, it can be determined that the cooperative learning did have a positive impact on students understanding on math content.

Afterthoughts and Recommendations

Although the study did prove positive results for the hypothesis, there could have been additional factors that could have increased or otherwise changed the results. There were only 25 participants in the study. Including additional participants to increase the data could have
widened the variation of results or better confirmed what my findings concluded. The study was done over a 4 week period of time from beginning to end. Conducting the study over a longer period of time would have produced more convincing results with more accurate data. The students were not accustomed to group learning and therefore, they were trying to learn the processes of cooperative learning exercises as well as trying to complete tasks for the collection of data. I feel that if the students were exposed to this type of learning consistently they would become familiar with what is expected of them and their thought processes would be altered to the point of proper group behavior and the processes would become automatic. This would allow the students to focus their efforts on the tasks of the activities rather than focusing on the functions of cooperative learning exercises. Conducting the study over a longer period of time would most likely result in change of attitude between the pre and post survey as well. Four weeks, I feel, did not allow sufficient time for the participants to form a different attitude toward math or group learning experiences. I think that incorporating cooperative learning into the overall structure of the classroom would be a benefit because the students routinely have differentiated instruction and the increase of test scores that was shown through this short study would produce higher level students in the long term.

I chose activities that I felt would be most engaging for the participants since they had minimum exposure to cooperative learning. I also wanted to use various strategies, rather than the same cooperative learning strategy for both lessons. The first activity allowed the students to experience time constrained competition that created repetition for lower level blooms taxonomy questions. Another activity allowed students to learn from their peers which, from the surveys and interviews, the students enjoy. The last activity conducted for the second
lesson was the least structured and allowed the students most control, unfortunately created the most confusion.

I have several recommendations for other teachers after conducting this study. I would recommend that teachers start their school year by giving similar surveys and interviews to gather background information about the students, their attitudes toward mathematics, and how they feel they best learn. This information can then be used to frame daily lesson plans and unit plans as well as to give the teacher a starting point for grouping students during cooperative learning activities.

I recommend that cooperative learning and group work be incorporated into the class from the beginning of the year. This will allow students adequate time to get acquainted with the processes and proper procedures of being in a group setting. Once the students become comfortable and confident with these expectations, they will be able to focus more time and effort on the tasks and lessons provided during the activities, rather than time trying to figure out what they are supposed to do.

I recommend cooperative learning be integrated with other types of teaching strategies and not as the only means of teaching any particular concept. In my opinion and through various research, students need a variety of teaching strategies used to offer additional support, confirmation, and confidence for students as well as to offer multiple outlets for students to learn material that they might not otherwise be able to comprehend with exposure to only traditional methods. Although lecture, or direct instruction is very common and often
times affective for some students, it is not the only method and not the method preferred by all.

A variety of cooperative learning strategies should also be used. There are several methods to use, and different methods may be best paired with particular content topics. I recommend teachers keep this in their forethoughts and before beginning a topic, do research to determine what method might work best for the specific topic they are about to teach. This can be very time consuming. However, it will be time well spent and once several topics and various strategies have been used for cooperative learning experiences, it will become simpler and more automatic.

In conclusion, I am pleased with the study and the results. My goal was to determine how the use of cooperative learning would impact students’ understanding of math content, and I believe my research accomplished that goal. I feel that the results of the research proved that cooperative learning has a positive impact on students understanding of mathematics based on the pre and post test scores. The use of higher level questions in the pre and post-tests demonstrated that the cooperative learning activities did assist the students in reaching higher level of bloom’s taxonomy. I will continue to incorporate cooperative learning in my classroom and I hope other teachers will see the benefit cooperative learning provides students and will integrate it into their curriculum as well.
REFERENCES


Zakaria, Effandi1, effandi@ukm.my; Solfitri, Titi2; Daud, Yusoff1; Abiden, Zulkarnain Zainal2. (2013). Effect of Cooperative Learning on Secondary School Students’ Mathematics Achievement Creative Education, 4, 2, 98-100.


APPENDIX A

STUDENT SURVEY

Please complete the survey by marking the box that best describes how you feel about each of the following statements:

<table>
<thead>
<tr>
<th>STATEMENT</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I think math is important to know for the real world.</td>
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<tr>
<td>2. I typically do not ask questions even when I do not understand the material.</td>
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<tr>
<td>3. I am unfamiliar with the term cooperative learning.</td>
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<tr>
<td>4. I like to work in groups to complete math assignments in class.</td>
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<td>5. I am a visual learner.</td>
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<tr>
<td>6. I prefer to learn using hands on approaches.</td>
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<tr>
<td>7. I prefer to have an exact routine each day in math class.</td>
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<tr>
<td>8. Math is my favorite subject.</td>
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<tr>
<td>9. During class time, I prefer to work on math assignments alone.</td>
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<td>10. During group work, I am usually the one that leads the group.</td>
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<td>11. I only like group work when I can be grouped with my friends.</td>
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<tr>
<td>12. When a math problem seems to be hard, I quit.</td>
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<tr>
<td>13. I often know the answers to questions in math class, but do not feel comfortable giving answers out loud.</td>
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<tr>
<td>14. Math just confuses me and I do not understand it.</td>
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<tr>
<td>15. I do not like to be called to the board to solve problems.</td>
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<tr>
<td>16. I feel more comfortable asking questions in small groups rather than in front of the entire class.</td>
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<td>17. I learn better when I understand how the subject applies to me.</td>
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<tr>
<td>18. I enjoy helping others in math class.</td>
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<td></td>
</tr>
<tr>
<td>19. I like reasoning through problems to come up with a solution.</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
20. When working in groups I typically do not participate.

APPENDIX B

STUDENT INTERVIEWS

1. What do you like most about math class? What do you like least about math class? Why?

2. What is the best way you feel you learn mathematics concepts?

3. How well do you think you have learned the concepts that have been taught this year? Do you think you remember most topics? How well do you think you could apply what you’ve learned outside of this math class?

4. How do you feel about the importance of the knowledge and use of mathematics in the real world; in everyday life and in particular careers?

5. How do you feel the knowledge and use of mathematics applies to you and your future?
APPENDIX C

Plagiarism Detection

Original Work
Originality: 100%

No sign of plagiarism was found. That’s what we like to see!

A low originality percentage is indicative of plagiarized papers. Sometimes the score is lower due to long quotations within a document, so please make sure that you use proper citations if this is the case. For more information on our originality scoring process, click here (http://www.PaperRater.com/page/plagiarism-detection).

Spelling

Spelling Suggestions
No errors of this type found in the text.

Grammar

Grammar Suggestions
- Did you mean... showed difference [suggestions: the difference]
- Did you mean... results for [suggestions: of]
- Did you mean... survey. However there [suggestions: However, there]
- Did you mean... felt most comfortable [suggestions: more comfortable]
- Did you mean... small groups [suggestions: group]
- Did you mean... than whole group [suggestions: the whole group]
- Did you mean... budgeting, however after [suggestions: however, after]
- Did you mean... understanding on [suggestions: of]
- Did you mean... the variation [suggestions: variety]
- Did you mean... in change [suggestions: a change, changes, the change]
- Did you mean... be most [suggestions: the most]
- Did you mean... support, confirmation [suggestions: confirm]
- Did you mean... reaching higher level [suggestions: higher level, a higher level]
APPENDIX D

Plagiarism Detection

Original Work
Originality: 86%

This paper appears to be original, but be certain that any included text is properly cited.

A low originality percentage is indicative of plagiarized papers. Sometimes the score is lower due to long quotations within a document, so please make sure that you use proper citations if this is the case. For more information on our originality scoring process, click here (http://www.PaperRater.com/page/plagiarism-detection).

Spelling

Spelling Suggestions

• Did you mean...: entire [suggestions: Entire]

Grammar

Grammar Suggestions

• Did you mean...: to original group [suggestions: the original group]
• Did you mean...: instruction of [suggestions: by]
• Did you mean...: method groups students [suggestions: groups, students]
• Did you mean...: students together allowing [suggestions: together, allowing]
• Did you mean...: examples for [suggestions: of]
• Did you mean...: and previous [suggestions: previously]
• Did you mean...: be Remembering [suggestions: Remembered]
• Did you mean...: math classroom students [suggestions: classroom, students]
• Did you mean...: question for [suggestions: of]
• Did you mean...: differentiated instruction [suggestions: instructional]
• Did you mean...: compare traditional teaching [suggestions: the traditional teaching]
• Did you mean...: is assume [suggestions: assumed]
APPENDIX E

Plagiarism Detection

Original Work
Originality: 71%

This paper appears to be original, but be certain that any included text is properly cited.

The following web pages may contain content matching this document:

- http://profdoc.um.ac.ir/articles/a/1030719.pdf

A low originality percentage is indicative of plagiarized papers. Sometimes the score is lower due to long quotations within a document, so please make sure that you use proper citations if this is the case. For more information on our originality scoring process, click here.

Spelling

Spelling Suggestions

- Did you mean... four D's (suggestions: does)

Grammar

Grammar Suggestions

- Did you mean... significant different (suggestions: difference)
Plagiarism Detection

Original Work
Originality: 100%

No sign of plagiarism was found. That's what we like to see!

A low originality percentage is indicative of plagiarized papers. Sometimes the score is lower due to long quotations within a document, so please make sure that you use proper citations if this is the case. For more information on our originality scoring process, click here (http://www.PaperRater.com/page/plagiarism-detection).

Spelling

Spelling Suggestions
No errors of this type found in the text.

Grammar

Grammar Suggestions

- Did you mean...: and evaluation [suggestions: evaluating]
- Did you mean...: that cooperative [suggestions: the cooperative]
- Did you mean...: years, however it [suggestions: however, it]
- Did you mean...: This research conducts [suggestions: research, conducts]
- Did you mean...: years, however it [suggestions: however, it]
- Did you mean...: often times are [suggestions: times, are]
- Did you mean...: concept on [suggestions: for]
- Did you mean...: integrate skills [suggestions: the skills]
- Did you mean...: Therefore all [suggestions: Therefore, all]
- Did you mean...: skills, Group [suggestions: Group's]
APPENDIX G

Plagiarism Detection

Original Work
Originality: 100%

No sign of plagiarism was found. That's what we like to see!

A low originality percentage is indicative of plagiarized papers. Sometimes the score is lower due to long quotations within a document, so please make sure that you use proper citations if this is the case. For more information on our originality scoring process, click here (http://www.PaperRater.com/page/plagiarism-detection).

Spelling

Spelling Suggestions
- Did you mean... or intrapersonal [suggestions: interpersonal]

Grammar

Grammar Suggestions
- Did you mean... know content [suggestions: the content]
- Did you mean... tests was analyzed [suggestions: were analyzed]
- Did you mean... information of [suggestions: about, on]
- Did you mean... monitored progress [suggestions: the progress]
- Did you mean... that the more difficult [suggestions: the most difficult]
- Did you mean... impacts student level [suggestions: the student level]
- Did you mean... the students [suggestions: student, students', student's]
- Did you mean... data was collected [suggestions: were collected]
- Did you mean... The post [suggestions: postal]
APPENDIX H

Plagiarism Detection

Original Work
Originality: 100%

No sign of plagiarism was found. That's what we like to see!

A low originality percentage is indicative of plagiarized papers. Sometimes the score is lower due to long quotations within a document, so please make sure that you use proper citations if this is the case. For more information on our originality scoring process, click here (http://www.PaperRater.com/page/plagiarism-detection).

Spelling

Spelling Suggestions

- Did you mean... any monomial [suggestions: mammal, minimal]
- Did you mean... the monomial [suggestions: minimal]
- Did you mean... listed monomials [suggestions: mammals]
- Did you mean... the white board [suggestions: whiteboard]
- Did you mean... to brainstorm [suggestions: brainstorm]

Grammar

Grammar Suggestions

- Did you mean... responses for [suggestions: to]
- Did you mean... important for [suggestions: in]
- Did you mean... their future so [suggestions: future, so]
- Did you mean... survey questions but [suggestions: questions, but]
- Did you mean... opportunity to [suggestions: for]
- Did you mean... various responses however [suggestions: responses, however]
- Did you mean... traditional methods including [suggestions: methods, including]
- Did you mean... polynomial problems then [suggestions: problems, then]
- Did you mean... with matching degree [suggestions: a matching degree]
APPENDIX I

A determination has been made that the following research study is exempt from IRB review because it involves:

Category 1. research conducted in established or commonly accepted educational settings, involving normal educational practices

Project Title: How Cooperative Learning Impacts the Ability to Understand Math Content

Primary Investigator: Amy Y. Rann

Co-Investigator(s):

Advisor: Ralph Martin

Department: Education

Robin Stack, CIP, Human Subjects Research Coordinator
Office of Research Compliance

May 14, 2014

The approval remains in effect provided the study is conducted exactly as described in your application for review. Any additions or modifications to the project must be approved (as an amendment) prior to implementation.