The College at Brockport: State University of New York
Digital Commons @Brockport

Education and Human Development Master's Theses

Education and Human Development

Fall 2012

Pairing and Comparing in the Middle School Mathematics Classroom

Elizabeth A. Clark
The College at Brockport, eclar3@brockport.edu

PAIRING AND COMPARING IN THE MIDDLE SCHOOL MATHEMATICS CLASSROOM

By:

Elizabeth A. Clark

A thesis submitted to the Department of Education of the State
University of New York College at Brockport in partial
fulfillment of the requirements for the degree of
Master of Education-Adolescent Mathematics
December 7, 2012

Table of Contents

List of Illustrations

Abstract

This study was designed to examine the effects of cooperative learning in the middle school mathematics classroom. This action research project seeks to answer the question of does cooperative learning improve academic performance of middle school mathematics students. The study took place in two parallel middle school mathematics classrooms in a district of New York's Southern Tier. There was an experimental group and a control group. The experimental group participated in a pair and compare teaching strategy following daily independent practice of the day's lesson, as well as an open ended group task. The control group did not participate in this cooperative learning strategy and continued with teacher directed instruction. This was a quantitative action research study in which a t-test was used to analyze results of a formal assessment following two weeks of this intervention. In addition, some qualitative observations were made and have been included into the data results where they provide meaning. It was hypothesized that students in the experimental class would perform better after the use of cooperative learning. The t score indicated that although there was a difference, it was not a significant difference.

Chapter 1: Introduction

Cooperative learning is an educational process in which speaking, listening, writing, and reflection, as crucial tools of active learning, take place (Köse, Şahin, Ergü, & Gezer. 2010). The purpose of this study is to examine the effects of cooperative learning in the middle school mathematics classroom. This action research project seeks to answer the question of does cooperative learning improve academic performance of middle school mathematics students. Teachers often struggle with this instructional method because one member of the group may do most of the learning tasks while other students are "along for the ride." In other situations, cooperative learning groups work independent of each other, thereby defeating the purpose of this instructional strategy. How to help students remain on task while working together is often a concern of teachers. There have been countless studies done on this cooperative learning, indicating the importance of this topic. This research considers advantages and disadvantages of cooperative learning and problem solving in two eighth grade mathematics classrooms by examining the performance of students in these classes. This is a quantitative study, but there is qualitative data to include where it provides meaning.

There is substantial research on the different perspectives that teachers have on cooperative learning concerning the different implementation strategies at various age levels, the methods of implementation, and the variance in the overall academic achievement of students. The literature reports varying results on academic performance after cooperative learning. Teachers often seem more comfortable with traditional instruction, possibly because of the difficulties implementing this instructional method. However, when teachers want to understand this method of instruction better, they often experiment with different methods of implementation in hopes of making cooperative learning more efficient and effective. It is important to consider cooperative learning in the context of nurturing the development of positive and peaceful interactions between students, attention to detail, and social and academic confidence. These qualities are often an integral part of teachers' educational philosophy because, not only do teachers want to teach students mathematics and problem solving skills, they also want to prepare their students to be well-rounded productive members of society. Cooperative learning should promote the motivation, retention and engagement of all learners, while holding them accountable for their roles in the process. Even though most teachers use direct instruction, cooperative learning is a strategy that may support student learning.

There are many ways to utilize cooperative learning in the classroom, thereby making teacher perceptions and training an important aspect of successful implementation. It is vital that students' roles and expectations, as well as teacher roles are clearly understood. To ensure that students are on task and taking a share of the work load, each student must have a task at hand. Also, each student must share personal accountability and responsibility for the success of the group in order to make a group truly cooperative. Correcting one's errors or a partner's errors is a strategy worth researching as a means to encourage these characteristics.

The literature reports that cooperative learning has achievement benefits, as well as social benefits, such as improved confidence and interaction with peers. This is evident when specific roles and tasks are given to group members, and teachers' perspectives and execution of cooperative learning are more advanced. This research hypothesizes that reviewing peer work will improve students' detail orientation skills, thereby improving achievement scores. The findings may be beneficial towards helping teachers to employ specific cooperative learning strategies in their classrooms.

Chapter 2: Literature Review

The purpose of this study is to examine the effects of cooperative learning in the middle school mathematics classroom. The question discussed in this study is what are some of the advantages and disadvantages of peer review of work, and does it improve academic performance. This study focuses on two eighth grade mathematics classrooms and examined the academic achievement of these classes after a period of daily pairing and comparing of work. Since this research took place in a middle school classroom, some of the literature review is focused on the effects of cooperative learning in middle schools. Sterns (1999) work indicates that the middle school lends itself to change more readily than the high school. A group of researchers and educators at Harold Wiggs Middle School in El Paso Texas used the middle school priority and innate middle school characteristics in order to make a difference in the quality of instruction resulting in improved student achievement (Stearns 1999). They found that by working together, children learned to listen to the teacher and to each other in a way that was self-edifying. Students shared ideas and encouraged each other's efforts. In addition, group activities became an excellent vehicle by which students achieved successes and gained peer recognition, an important issue with all students (Stearns 1999).

There have been countless studies on the benefits, detriments, advantages, and disadvantages of cooperative learning. In addition, there are many ways to utilize this strategy in the classroom. Cooperative learning is usually perceived as a generic name for a number of instructional techniques. Among those are group investigations, student team learning, structural approach, and learning together (Köse, Şahin, Ergü, & Gezer. 2010). One thing that advocates of this teaching style can agree upon is that in order for cooperative learning to be effective, it is vital that the students properly understand what is expected from them and how they will interact with others (Köse, Şahin, Ergü, & Gezer. 2010). With this in mind, the pair and compare approach after completion of independent work was chosen for this action research project. Students knew the expectation was to agree upon all answers, and if they did not agree they needed to explain to each other why their answer was correct or incorrect. Teachers have different perspectives on cooperative learning concerning the different strategies at various age levels, methods of implementation, and overall academic achievement of students that had participated in cooperative learning.

Preparing students for group work involves basic communication and social skills. In healthy, interactive groups, leadership is shared and participation is equal (Farivar & Webb, 1994). Farviar and Webb outline several steps to help build effective group problem solving. The first step is class building. It is important for students to know each other, be comfortable in class, and participate in activities that help them become acquainted with each other. The second step in preparation for group work is learning how to work with others (Farivar & Webb, 1994). It is essential to teach three kinds of communication skills: basic communication skills, teambuilding and small-group social skills. Basic communication skills involve students having the ability to listen attentively, work with fellow students without putting them down and ensure all group members participate equally. Ways to promote team building include establishing a group name or identity, or making a list of things the group members have in common. In small-group social interaction, students should be able to articulate ideas, talk about the work, get the group back on task, and check for agreement. To be really effective participants in small-group problem solving, students need helping skills (Farivar & Webb, 1994). This is a sequential process. Before students can be effective help givers, students need to be able to communicate positively with other students without putting them down, to understand the importance of cooperation and two-way communication, and to be receptive to other students' questions and difficulties (Farivar & Webb, 1994). This requires a commitment from the teacher to help develop these skills which can take a significant amount of time, but can prove to be effective. According to the authors of this article, implementation of these steps resulted in positive effects on students' ability to obtain explanations from their teammates about how to solve problems. Positive effects were also obtained on student achievement.

There is research that examined the opinions of trained teachers on cooperative learning regarding the possibility of successful implementation. The study took place in Kuwait, in which 20 primary stage senior teachers attended a training course on cooperative learning. Following the training, the study adopted a descriptive methodology utilizing questionnaire. The study revealed that a majority of the participants showed a high frequency of satisfaction with cooperative learning as a learning strategy (Al-Yaseen, 2011). In addition, 85% indicated that cooperative learning helps them to wrap the lesson with a summary of achieved educational objectives. This went in accordance with another item on the questionnaire: "clarity of the expected learning objectives," in which 80% responded with high frequency regarding its significant impact. Similarly, 80% of participants felt that cooperative learning helps teachers apply positive reinforcement (Al-Yaseen, 2011). Seventy percent of teachers pointed out that cooperative learning would encourage them to explain cooperative roles of students (Al-Yaseen, 2011). Based on the analysis of the questionnaire items, it is demonstrated that primary stage teachers have a solid understanding of what cooperative learning is and its advantages on them and their students. The teachers realized that cooperative learning was not a matter of a seating plan. Cooperative learning goes beyond that to involve students in an in depth learning process, which involves proper application of good social skills. It raises student awareness of both individual and group responsibilities. Included amongst the study's recommendations were intense teacher training in cooperative learning, encourage teachers to see the benefits of cooperative learning on their educational outcomes, and provide the needed facilities to provide a positive and attractive learning environment (Al-Yaseen, 2011).

A teacher's understanding, perceptions and implementation of cooperative learning is most certainly an important piece to the puzzle. A study done in western New York of exemplar teachers used a survey to examine self-reported relative use of cooperative learning (Lopata, Miller, & Miller, 2003). One aspect of the survey analyzed teacher use of a structured model of cooperative learning that specifies four basic elements of the strategy. The first, positive interdependence, requires that students recognize their dependence upon one another to reach a common goal. The second, individual accountability, requires individual responsibility for learning of content. The third, face-to-face interaction, involves student valuing of group meetings and interaction. The fourth element, group process, should be embedded throughout the learning experience (Lopata, Miller, & Miller, 2003). In addition, several teacher characteristics were studied to determine whether individual characteristics were associated with relative use of cooperative learning. Fifty-four schools were invited to participate in the study, in which all principals agreed to identify four exemplar teachers from his or her building. There were 216 teachers identified, and of those, 130 usable surveys were returned. There were 92 elementary teachers and 38 middle school teachers. The survey used in this study was researcher generated on the basis of the aforementioned four elements of cooperative learning. Each teacher was required to rate his or her actual and preferred level of use for individual cooperative-learning elements using a 5-point scale (Lopata, Miller, &

Miller, 2003). Survey results indicated that exemplar teachers' overall actual use of cooperative learning fell significantly below the level at which they would prefer to be practicing cooperative learning. This discrepancy also was reported for each of the four elements of cooperative learning: positive interdependence, individual accountability, face-to-face interaction, and group process (Lopata, Miller, & Miller, 2003). It should be noted that those with exposure to cooperative learning through staff development demonstrated a significantly smaller gap between actual and preferred use than those with no exposure to cooperative learning through staff development. A teachers' use, or lack thereof, of cooperative learning can be attributed to many factors such as the increasing demands and pressures on teachers to meet academic standards using individualized tests. Overall the studies' findings suggest that proper exposure to cooperative learning, as well as professional development for teachers in this area can impact their actual use of this strategy, as well as their satisfaction in the successful execution of it.

There has also been qualitative research done to further understand implementation methods for cooperative learning. One qualitative study included five middle school math and science teachers. The researcher used ethnographic inquiry to explore variations in the natural implementation of a research-based cooperative model. Specifically, ethnographic inquiry was used to investigate participating teachers' understanding and use of cooperative learning in their classrooms without researcher control or support (Siegel, 2005). The study included classroom observations and interviews. All teachers in the study described cooperative learning as involving students working together to complete tasks. Teacher concepts of cooperative learning also included reference to instructional components in which they were trained (Siegel, 2005). Other commonalities observed also related to planning for such experiences. Teachers repeatedly referred to contextual factors that influenced their planning decisions. These included (a) learning objectives, (b) the relationship between student ability and difficulty of course content, (c) curricular time constraints, and (d) collegial support (Siegel, 2005). In the discussion of the study, the researcher identified three primary findings. First, participating teachers developed concepts of cooperative learning based on their professional development and classroom experiences that included both components of instruction and roles for teachers and students (Siegel, 2005). Second, lesson planning was influenced by teaching style and context. This second finding includes lesson objectives, perceptions about students' ability, task difficulty, curricular constraints, and opportunities for collegial support. Third, the enactment of cooperative learning in the classroom was related to both teacher plans for the use of cooperative learning and degree of teaching expertise which facilitated the execution of those plans (Siegel, 2005). This study confirms that proper understanding and appropriate training for teachers should be consistent among teachers trying to engage in cooperative learning. It suggests that teachers may benefit from attention to ways in which their role in the classroom will change, as well as to key instructional components. It also recommends that teachers would benefit from considering how cooperative learning methods be integrated into their current teaching style. The participants of this study found it easier to use cooperative leaning as part of their current lessons, or work with another teacher to develop new lessons. Additionally, teachers may want to think about how cooperative learning activities fit with course requirements and student ability when planning cooperative learning lessons (Siegel, 2005). Teachers in the current study used cooperative learning for approximately half their class time. Thus teachers may find it easier to use it for only part of the total instructional time available.

For many teachers, the goals for incorporating cooperative leaning to their instructional strategy are to increase students' engagement, and thereby improve achievement through working with peers. However this sometimes morphs into discouragement as a result of some of the experiences and observations. Often times, teachers will observe one member of a group doing most or all of the tasks while the others are along for the ride. Also observed by some teachers is groups assigning each other tasks that are independent of each other, thereby avoiding all interaction with each other. Remaining on task is consistently an issue as well. Students adopting the role of help-giver showed behavior very similar to that of the teacher: doing most of the work, providing mostly low-level help and infrequently monitoring other students' level of understanding (Webb, Nemer, & Ing, 2006). Although teacher experience with cooperative learning is occasionally less than rewarding, there is much research that contradicts this.

Perhaps teacher disillusionment may stem from a frequent misconception. A common misunderstanding of cooperative learning is the belief that any type of group work is cooperative learning (Schul, 2011). It is group work designed to nurture strong social interdependence amongst students. In cooperative learning, student groups are assigned a task for which each member's contribution is essential for the good of the whole group (Schul, 2011). Each student must have a task at hand and must share personal accountability and responsibility for the success of the group in order to make a group truly cooperative. Professional development experiences focused on cooperative learning seems to promise to enliven the twenty-first century classroom by nurturing various skills. Teachers would like to see some of these skills flourish, such as peaceful confrontation, a concern for others and a sense of responsibility. Unlike teacher-centered activities, cooperative learning allows for a respect of opinion among students and between the teacher and students (Schul, 2011). Cooperative learning can also be a means through which students learn to peacefully confront and negotiate with others (Schul, 2011). In addition, it can help mend unhealthy isolation among groups that are often based on racial stereotypes that hinder progressive societal growth (Schul, 2011). To this avail, it is imperative that cooperative learning is implemented appropriately. It is a technique that should be honed and mastered by all school teachers who dare to make their classrooms into laboratories of and for democracy in the twenty-first century (Schul, 2011).

There is literature that reports on ways to make cooperative learning more productive, efficient and beneficial. A group of researchers conducted a semester-long program of peer learning in middle school mathematics classrooms. They described specific conditions for effective helping, receiving help and teacher responsibilities.

They concluded that the first step in ensuring that helping is productive is to raise teachers' and students' awareness of their responsibilities. The researchers further concluded that the next step to ensure productive helping is to design instruction and practice activities to enable participants to carry out these responsibilities (Webb, Farivar, Mastergeorge, 2002). In this study, specific conditions and responsibilities were established for help seeker and help giver. Help seekers must (a) be aware that he or she needs help, (b) be willing to seek help, (c) identify someone who can provide help, (d) use effective strategies to elicit help, and (e) be willing to reassess his or her strategies for obtaining help. The existence of these conditions was evident in their results. Students' level of responsiveness to help they received was significantly related to their learning outcomes. Among students who demonstrated difficulty initially, those who showed one or more instances of reworking or explaining how to solve the problem after they received help were much more likely to solve this type of problem correctly on the posttest than were students who never responded at high levels (Webb, Farivar, Mastergeorge, 2002). All members of the group are potential help-givers. To provide elaborated explanations requires both a willingness and an ability to do so. Willingness to give elaborated help depends partly on group norms supporting working together and helping others, as well as a focus on understanding and learning (Webb, Farivar, Mastergeorge, 2002). Another major responsibility of help-givers is to provide help-seekers with opportunities to solve problems by themselves (Webb, Farivar, Mastergeorge, 2002). These responsibilities for help givers can be confirmed by other studies. Researchers theorize that giving explanations promotes learning by encouraging the explainer to reorganize and clarify material, to recognize misconceptions, to fill in gaps in his or her own understanding, to internalize and acquire new strategies and knowledge, and to develop new perspectives and understanding (Webb, Nemer, & Ing, 2006).

A study took place in a large middle school near a large city in the Midwest in which peer-assisted learning strategies (PALS) were implemented in inclusive mathematics classrooms. A team of 150 seventh-grade students with diverse mathematical abilities engaged in a project to learn PALS skills in order to regularly assist one another in mathematical problem-solving (Kroeger, Kouche, 2006). Throughout this study, a variety of instructional methods were used, while PALS served as a remediation tool for areas where students demonstrated difficulties with concepts. One feature of the PALS strategy is the existence of reciprocity between students with stronger and weaker skills. Unlike traditional tutoring practice, PALS procedures reverse the roles of tutor and tutee. As a result, students with less proficient skills, has the opportunity to teach and lead the process of working through problems. In addition, the students with more expert skills, are afforded practice time and feedback. Students are paired and given roles of player and coach. While the player is busy working out the math problem using pencil and paper or manipulatives, the coach is keeping score, using a script to and check and guide the player's process (Kroeger, Kouche, 2006). The overall structure of the PALS program creates a climate of reduced anxiety (Kroeger, Kouche, 2006). The researchers in this study chose to use a split-list procedure when pairing students. An entire class of students was ranked according to ability and then split in half. The student with the highest assessment is paired with the highest student of the lower assessment. Therefore, students do not experience the significant gap in ability that normally exists in traditional tutoring models. For the first time in this veteran teacher's career, she found 100% of her students engaged the entire class time when PALS was taking place. She also saw confidence levels rise in many of her lower ability students. She also used a short writing exercise to found out students' feelings towards PALS. The net result was increased engagement and positive response to intervention in a content area notoriously challenging for middle school students in general and certainly for students identified with learning disabilities in mathematics (Kroeger, Kouche, 2006). The researchers recommend this intervention as a means for increasing engagement and opportunities to respond for all students.

As this action research reports on the achievement of students participating in error correction in an effort to engage all learners and hold them accountable for their roles in the process, there is also literature that explored the topic of error-correction. This experiment took place in two parallel classrooms in an Italian secondary school. One class corrected through traditional methods that were teacher led, the other through cooperative learning as data was compared over time and differences were highlighted. The paper presented students' scored in a pretest, test and post-test; the students' opinions about the activity; and the communicative exchanges, which occurred within cooperative groups (Servetti, 2010). The use of cooperative learning was tried during lessons of English as a foreign language. Both classes reviewed the difference between the present perfect tense and the simple past tense through grammar explanation in class. Then both classes were given a grammar test on the grammar topic taught (pretest). The teacher checked all tests by underlining errors, but not thoroughly correcting the errors. Following this test, the control group followed a traditional correction lesson led by the teacher. Exercises in the test were examined, grammar rules were reviewed and common mistakes were corrected on the blackboard. The experimental group carried out a cooperative activity on their mistakes. Students were divided into small mixed-ability groups and they all received an anonymous list of the most common mistakes made by themselves or their classmates. They read the sentences they had to correct, discussed the different options of correction, reviewed grammar rules together, and finally chose corrections that the whole group agreed upon (Servetti, 2010). In the lesson after the correction lesson both classes were given another test on the same grammar topic to test short-term results, and a third and final test (post-test) was given six weeks after the correction lessons, in order to test long-term results. The analogy of the experiment suggests all students had a similar proficiency level at the beginning of the case study. In the second test both classes had a very similar mean improvement, their scores were analogous and no statistically relevant difference ($p = 0.72$) was found between groups (Servetti, 2010). This very similar improvement in both classes could probably indicate that both classes benefitted from both types of error correction activities in a similar way. (Servetti, 2010). A relevant difference, however, was found following the third test. The control group had a mean score of 55, while the experimental group had a mean score of 69.75. Although this is a relevant difference, the statistical analysis of the students' results shows that this is not relevant from a statistical point of view. Further analysis of differences between the second and third test highlights a better progress in the sample class. The group decreased scores (-3.67), but the control class registered a loss much more consistent (-18.64) (Servetti, 2010). From a statistical point of view, this is significant. In addition, an anonymous questionnaire given to the students who experienced the cooperative activity revealed that 94 percent found the activity useful for their learning and for revising grammar rules. Moreover, the tape scripts show that all the students took part in the activity quite evenly, so low-proficiency and timid students were active in discussing alternatives and grammar rules with more skilled classmates (Servetti, 2010). The researcher concluded that although both correction methods were beneficial for students in the short-term, the cooperative correction had a longer-lasting positive effect.

There are studies that report more general and overall results of cooperative learning on achievement and attitude towards mathematics. An international study found that a cooperative learning approach resulted in higher achievement than traditional approaches (Zakaria, E., Lu Chung, C., & Daud, M., 2010). The study used a pretest and posttest to compare the results of a control group and experimental group. The experimental group used a cooperative model of student teams-achievement divisions (STAD) for a period of two weeks (Zakaria, E., Lu Chung, C., & Daud, M., 2010). The tests were used to measure the students' mastery of fractions. Statistical analysis of the mean scores on the pretest showed that there was not a significant difference between the two groups at the onset of the project. The results of the statistical analysis of the posttest indicate a significant difference between the control and experimental groups. The control group had a mean score of 50.18, while the experimental group had a mean score of 56.18 on the posttest (Zakaria, E., Lu Chung, C., & Daud, M., 2010). The researchers theorize that this difference could be attributed to the students' involvement in explaining and receiving explanation in which the concepts could be easily understood. Cooperative learning gives more space and opportunities for students to discuss, solve problems, create solutions, provide ideas and help each other (Zakaria, E., Lu Chung, C., & Daud, M., 2010). In addition, this study also indicated that the cooperative learning approach improved attitudes toward mathematics. The researchers of this study concluded that math teachers need to be aware of the benefits and importance of cooperative learning and thus changing the practice of teacher-centered teaching methods to student-centered teaching methods (Zakaria, E., Lu Chung, C., & Daud, M., 2010).

Another study was conducted at a high school by two different mathematics teachers in a rural, Midwestern, predominantly Caucasian, middle-class district. Two general mathematics classrooms were differentially taught a unit on percentages, one with a cooperative and the other with an individualistic goal (Sherman & Thomas, 1986). The teacher instructing the cooperative class used two pedagogical strategies: student teams and achievement divisions (STAD) and team games and tournaments (TGT). Students were divided into five small four-member groups that were heterogeneous with regard to academic ability as well as sex. A majority of the 25-

day unit of instruction was spent using a STAD structure. Although teacher lecturing was utilized, all drill exercises and related studying were accomplished in class using peer tutoring (Sherman & Thomas, 1986). The instructor of the individualistic made use of individual drill and homework exercises as well as teacher lectures and textbooks assignments. The teachers cooperatively designed a 30-item pretest. This same test was used as a posttest, as the scores were used to contrast achievement. While neither group significantly differed from the other on a pretest, the cooperative group demonstrated significantly higher achievement on the posttest that the individualistic group (Sherman & Thomas, 1986). The data strongly supports theories concerning the effectiveness and motivating qualities associated with intergroup competition among small cooperating classroom groups (Sherman & Thomas, 1986). The author concluded that teachers of general mathematics and other disciplines should give this approach serious and favorable consideration.

As previously mentioned, not all cooperative learning has proven to show an increase in achievement. An international study was designed to explore the effect of cooperative learning on academic achievement of 8th grade students in the subject of social studies. The study sample consisted of 35 students who were divided into an experimental group (N = 18) and a control group (N = 17). The experimental group was exposed to cooperative learning while the control group continued with routine, traditional teacher-led instruction. An achievement test was designed to be used as a posttest, as well as to guide the study and make comparisons. Prior academic performance was used to form the experimental and control groups. Throughout this study, there were five lesson plans designed for traditional instruction. The experimental group received follow up worksheets for each of the five lessons which were to be used for cooperative practice. Following this time period, students were given an individual posttest. It was concluded that mean pretest score of experimental and mean pretest score of control group did not differ and both the groups were equal before the experiment (Parveen, Mahmood, Mahmood, & Arif 2011). It was also concluded that the experimental group and control group did not differ in their academic performance as a result of teaching through cooperative learning and routine way of teaching (Parveen, Mahmood, Mahmood, & Arif 2011). In reading this study, it is unclear as to specifics for the cooperative learning. It did not state if students were given individual tasks or responsibilities. The study also did not state how the students interacted with each other. This is something that teachers may want to incorporate into their study and practice of cooperative learning in order to explore the effects when students are given clear objectives and responsibilities. Although this study may be valid, useful and helpful, there is opportunity for further study. There are many other studies to show that cooperative learning does make a positive difference in student achievement and teachers may use this opportunity for further study in their classrooms.

Chapter 3: Research Question

This research considers advantages and disadvantages of cooperative learning and problem solving in an eighth grade mathematics classrooms. This is done by comparing the academic performance of this class to another eighth grade mathematics class that did not participate in cooperative learning while utilizing a traditional teacher-directed instructional practice. This action research project attempts to answer the question: Does cooperative learning improve academic performance?

Chapter 4: Methodology

This study took place in two parallel middle school math classrooms in a district of New York's Southern Tier. A pair and compare strategy was used in the experimental classroom following daily independent practice of the lesson at hand. Pairing and comparing is a slight deviation from the popular think, pair, and share strategy. While think, pair, and share typically involves students thinking independently about a question and then discussing with their partner(s), pair and compare has students review work that his or her partner has completed independently. Following a lesson in which guided notes were utilized, students completed independent practice. Upon completion, students joined their partners and reviewed each other's work and answers. Students were instructed to come to a consensus on answers. If there was a discrepancy on answers, students were to discuss and correct the partner in error. This strategy was a change in typical instruction for the classroom, but not a complete overhaul of classroom routine. This took place for a period of three weeks. This amount of time was chosen as it was the length of a unit. The unit of choice was an eighth grade geometry unit, required by the New York State curriculum standards established in 2005. Concepts in the unit included the intersection of lines, the angles formed and their relationships, and the resulting angles of parallel lines crossed by a transversal. Not only do students study angle pairs and their relationships, they must also be able to derive equations and solve for missing angles algebraically. This unit was conducive to my study because it incorporates not only geometric and algebraic concepts, but also weaves many opportunities for written responses of justification throughout. By this, I mean students were to identify, in writing, what type of angles were being dealt with, their relationship to each other and how they know this. During this time period, the control group continued with teacher directed instruction, independent practice and teacher correction of said practice. Achievement scores on the quiz that followed served as my comparison. Cooperative learning is a vast topic, but this project narrows the topic and focuses on specific cooperative learning techniques.

This action research project took place in two eighth grade math classrooms. For much of the process, a specific type of cooperative learning was employed. Also included in the study was one day of solving an open ended problem using a team and task oriented model. The research took place in a rural district in New York's southern tier in the fall of 2011. Total enrollment in the district for the 2010-11 school year was 1811. Of that population, 46% were eligible for free lunch, while 12% were receiving reduced-price lunch. Also to be noted for that school year, 94% of the students were white, while 4% were African American, 1% Asian, and 1% Multiracial. The average size of an eighth grade math class was 22.

Students were assigned a partner to compare, share and review their class-work with. When assigning partners, ability, strengths, weaknesses, processing speed, fluency and the pace in which each individual typically works at were considered. Pairs were both homogeneous and heterogeneous by ability. For example, in some cases students that typically performed well and interacted with classmates positively were placed with students that typically struggled with mathematical concepts and would benefit from working with a strong mathematics student. In other cases, as a classroom management strategy, students that usually worked at the same pace were paired together. This was done in an effort to have them complete the independent practice approximately the same time and then begin comparing answers. One class (Class #1) was chosen as the experimental group and the other class (Class #2) was chosen as the control group. The classes involved with this study were chosen for the varying nature of abilities present in each. The learning standards established by New York State in 2005 require eighth grade math students to gain a significant amount of algebraic knowledge. When entering eighth grade, students are expected to be able to solve multi-step algebraic equations, in addition to being fluent in all basic arithmetic facts for positive and negative numbers, including fractions. The eighth grade math curriculum standards attempt to build on this knowledge by expecting students to perform basic mathematical operations on polynomials. Students also learn significant relationships among different types of angle pairs, while applying algebra to these relationships. Both classes have students at each end of the spectrum, with several students that excel in mathematics and several that struggle. There are students in each class that grasps concepts quickly and understand these beyond procedural knowledge. There are also students in each class whose mathematical skills are not at grade level, as they are not fluent in basic arithmetic facts. Of these students, some of them use a calculator as required by their Individualized Education Plan (IEP). Also in both classes, a consultant teacher is present. In this district a consultant is a special education teacher that can take on a variety of roles. In these particular classrooms, the consultant teacher is responsible for assisting special education students with academic and behavioral needs. Specifically, during lesson presentations, the consultant teacher moves about the room, making sure students are on task, as well as keeping up with guided notes. When students are working on assignments in the classroom, either individually or cooperatively, the consultant provides additional support to special education students, reads or restates directions, and helps to keep students focused on the task at hand. Outside of the classroom, the consultant teacher prepares notes for students who have difficulty writing them during class, as well as provides testing accommodations in alternative settings. Class #1 consists of 6 special education students and 17 general education students. Class #2 consists of 6 special education students and 11 general education students. All special education students in class #1 have learning disabilities in reading and verbal comprehension. Other special education classifications in this class include two students that show signs of dyslexia, and two students that have much difficulty in sequencing, scanning and retaining information. Processing speed is low and the ability to define words and answer comprehension questions is affected. On the contrary, the special education needs in class #2 are much different. This class consists of two students with autism, two who are classified as emotionally disturbed, a blind student and one with a disability in reading, writing and math comprehension.

This was a quantitative action research study on the effects of achievement levels after two weeks of a compare and share approach in the classroom. In addition, some qualitative observations were made and have been woven into the data results where they provide meaning. There was an experimental group and a control group. The experimental group (Class #1) participated in a pair and compare teaching strategy, as well as an open ended group task. The control group (Class #2) did not participate in this cooperative learning strategy and continued with teacher directed instruction. Class #1 consists of 6 special education students and 17 general education students. Class #2 consists of 6 special education students and 11 general education students. Among the varying nature of abilities in both of these classrooms, the significant variable in this study is the use of cooperative learning.

The mathematical concept during this time of study was geometry themed. This unit opened with the study of the Pythagorean Theorem, followed by the study of intersecting lines, the angles formed by these lines and their relationship. After two days of studying the Pythagorean Theorem, Class #1 was presented with the open ended task of proving this theorem (see Appendix A). The class was randomly numbered and placed into heterogeneous groups of four. The tasks were specifically stated on their hand-outs and the groups were directed to assign each member one of those tasks. The tasks walked students through measuring the sides of a right triangle and then cutting out squares with side lengths matching those of the right triangle.

Students were then asked to physically show how the sum of the areas of the two smaller squares equals the area of the larger square. The word area was not specifically stated on the task sheet which made this an open ended assignment. This portion of the study was conducting in a qualitative nature, in which I informally noted observations.

Following the study of the Pythagorean Theorem, the days that followed consisted of traditional guided notes on intersecting lines and the angles formed by them. The intervention came after spending time on these lessons. Each day's notes consisted of approximately 5 practice exercises (see Appendix B for example of guided notes). After teaching the lesson, Class #1 to completed the practice problems first independently. Upon completion of these, they were to compare and share with their partners. Students in Class #1 had been assigned partners to work with, and were to continue working with these same partners throughout the duration of the study. In these pairs, students compared their answers. When coming to an answer that they did not agree upon, they were instructed to determine what they both thought to be the correct answer. It was expected that answers would be clearly justified to each partner, with elaborated explanations. Also, it was expected that students with the correct answer would look over their partners work to find procedural or conceptual misunderstandings. While students were comparing and sharing, the teacher walked around the classroom to monitor progress. Students would often ask questions, but they were encouraged to speak with their partners first. At times, if the teacher believed that students needed guidance in reaching an answer, or saw that students had agreed upon an incorrect answer, the teacher would offer advice and guidance. When time permitted, the teacher would review correct answers with the entire class in the remaining minutes of the period. After several days of doing this, the teacher moved away from this practice as to hold students more accountable. This portion of the study was quantitative in nature and results were formally recorded and statistically analyzed after students were assesses on a quiz.

At the end of the two weeks of this study, students took a formal quiz (see Appendix C). Descriptive statistics were then calculated and a t-test was used to determine if there was a significant difference. It was hypothesized that students in Class #1 would perform better after the use of cooperative learning.

Chapter 5: Data Collected

On the following pages, the quantitative data is organized into several tables. The results of the formal assessment can be found in table 1. The quiz was out of a total of 35 points and percentages earned are shown. The descriptive statistics are organized into table 2. The t-test that compares the results of the two classes can be found in table 3. Class #1, the experimental group had a lower mean on the quiz than the control group. The t score indicates that although there is a difference, it is not a significant difference. Class #1 had a standard deviation of 19 and a range of 74, while Class #2 had a standard deviation of 12.9 and a range of 40.

The qualitative data collected includes observations and notes taken by the teacher while monitoring the classes. The day of team work to complete the open ended task resulted in many instances of frustration. There were several groups of students that failed to read the entire task sheet which resulted in the false notion that they had completed the task after the mere cutting of squares. It was after the teacher informed them of incompletion that the frustration began to fester. Noted quotes included: "Just tell us what to do," "I have no clue what you want us to do," and "I don't get it." Several groups just began to stare at the squares they had cut out, rather than picking them up to try to fit them together physically. Once the squares had been cut and individual tasks were complete, it was noted that several groups had one member completing the remainder of the work, without input from the team members.

Qualitative data for the pair and compare strategy included both positive and negative observations. On occasion it was observed that students said things such as "Well I don't know how you got that answer," and the pair would continue on comparing rather than coming to a consensus on that particular problem. Also sometimes when students did not agree, the partner with the correct answer seemed to lose confidence and second guess their answer. This resulted in them asking the teacher for reassurance. On the positive side, there were many conversations that were indicative of student learning and understanding. The teacher stressed the importance of identifying angle types and their relationship before doing anything else. Thus students were heard explaining to their partners these concepts and were observed using diagrams to show the student partner the angle types. This often resulted in students reworking an exercise.

Table 1

Assessment Results for Control and Experiment Groups

Class 1	*Class 2*
74	77
100	89
91	89
54	57
57	91
46	83
100	66
80	94
80	91
66	63
97	86
86	91
77	69
26	97
57	66
71	97
71	77
94	
94	
69	
83	
89	
94	

Table 2

Descriptive Statistics Comparing Class #1 and Class #2

	Class #1	Class #2
Mean	76.3	81.4
Standard Error	4.0	3.1
Median	80	86
Mode	94	91
Standard Deviation	19.0	12.9
Sample Variance	361.2	166.4
Kurtosis	0.7	-1.1
Skewness	-0.9	-0.5
Range	74	40
Minimum	26	57
Maximum	100	97
Sum	1726	1383
Count	23	17
Confidence Level (95%)	8.2	6.6

Chapter 6: Data Analysis

The aspect of the data that was found to be most intriguing was the lower mean in the experimental group. Although the t test does not indicate a significant difference, this result is not what was expected due to the positive conversations that were heard in class. It is worth noting here the existence of outliers in Class #1. This is not typical of their performance thus far in the school year. When the outliers were removed from each group Class #1 did have a higher average than Class #2, but still there was not a significant difference. When considering the outliers it was important to take the standard deviation and range into account. Class #2 has scores that were more centrally located as their standard deviation is considerably smaller in value.

Table 3

t-Test Comparing Class #1 and Class #2

t:Test:Two-Sample Assuming Equal Variances

	Variable #1	Variable #2
Mean	76.3	81.4
Variance	361.2	166.4
Observations	23	17
Pooled Variance	279.2	
Hypothesized Mean Difference	0	
Df	38	
t-Stat	0.9	
P(T <= *t*) one-tail	0.2	
t Critical one-tail	1.7	
P(T <= *t*) two-tail	0.4	
t Critical	2.0	

The aspect of the data that was found to be most intriguing was the lower mean in the experimental group. Although the t test does not indicate a significant difference, this result is not what was expected due to the positive conversations that were heard in class. It is worth noting here the existence of outliers in Class #1. This is not typical of their performance thus far in the school year. When the outliers were removed from each group Class #1 did have a higher average than Class #2, but still there was not a significant difference. When considering the outliers it was important to take the standard deviation and range into account. Class #2 has scores that were more centrally located as their standard deviation is considerably smaller in value.

In this analysis, it was hard for the researcher to ignore the varying nature of special education needs present in these classes. The lowest scores earned in Class #1 all came from special education students that have disabilities in reading comprehension. These students typically perform well in mathematics, but this particular assessment involved a significant amount of vocabulary (fill in the blank section), reading comprehension and written justifications. It was this characteristic of the assessment that presented these students with the most difficulty. Thus more should be done on cooperative learning and integrating mathematical literacy into learning activities. On the other hand, the special education needs in Class #2 generally did not play a role in their reading comprehension. Given an assessment with less vocabulary and reading comprehension, it would be expected that Class #1 would have a high performance.

Due to the positive conversations that the teacher heard and noted during the research, the insignificant quantitative results were surprising. While students were observed helping other students and in turn strengthening their own grasp of a concept, there was not a significant difference in performance. However, the benefit of including the qualitative observations is that it was observed and noted that students realized mistakes and misunderstandings and reworked problems after hearing other students share an explanation. Qualitative observations allowed for a deeper understanding of what was happening at the student level, while quantitative research allowed for the mean comparison of groups. Students working with the same partner seemed to help build interpersonal skills, helped students recognize and explain procedural or arithmetic errors, and helped students becoming familiar with each other's work. This may be comparable to the role of the teacher since teachers can often recognize student work without seeing a name on a paper. Teachers also learn to recognize common misconceptions, and it was noted that students in the experimental group also did this when working together. The one disappointing aspect that was observed was students saying "OK, I get it," after making a mistake but not stopping to fix it. This may be indicative of students not yet understanding the material or not being motivated to correct their errors and move forward in their understanding.

The observations with the open ended task were not as positive. This may be because the students were accustomed to direct instruction, which raised their levels of frustration. However it was encouraging to see a couple of groups tackle this challenge head on. They picked their squares up and the scissors to try to see how they could fit together, as if putting a puzzle together. All groups needed additional verbal guidance from the teacher before doing this task. This activity appears to have impacted the quiz scores significantly. The goal was for students to understand the Pythagorean Theorem at a deeper conceptual level, but this was not measured due to the procedural nature of the quiz questions pertaining to this topic.

Chapter 7: Implications

The pair and compare approach is certainly a strategy that teachers should consider using in their classrooms. With continued use, students may become increasingly aware of their responsibilities, as well as accountability. It is important for students to recognize their peers' misunderstandings and in the process verbalize their own understanding and perhaps fill in gaps of their knowledge. The use of the same student partners throughout this unit went well and was considered as an efficient use of class time. It was also beneficial because the students become very familiar with each other's work and were more knowledgeable of their partner's strengths and weaknesses.

With the common core standards coming into effect in the very near future, open-ended and investigative activities may start to become the norm. Although experience with pair and share cooperative learning may require more work from the teacher, students may become more accustomed to this type of learning, and it may help to motivate some learners. Direct instruction will remain necessary, but investigative activities may be a way to deepen students' understanding of concepts, or to obtain an alternative perspective on a topic.

In future research, student motivation and attitudes for learning should be included. Pair and compare cooperative learning may increase students' attitudes towards learning mathematics. Any positive conversations between students were noted, yet this research did not include analysis of such affective measures. In addition, it may be beneficial to consider including a pre-test on a concept in the research prior to implementing a new strategy. Also up for contemplation is the type of analysis that would be appropriate for the qualitative data. It would be interesting to rank observations made. For instance, in this particular study, classifying different levels of help given could highlight other findings. Help could be ranked from procedural help to higher lever conceptual help.

Though the findings were unexpected, this was a worthwhile exercise in action research. It is imperative to collect data systematically, but in analysis all relevant variables need to be considered. In addition to the intervention at hand, there are many factors that can affect results of a study.

Appendix A

Today you will prove why the Pythagorean Theorem works. Each person in your group should be assigned a task.

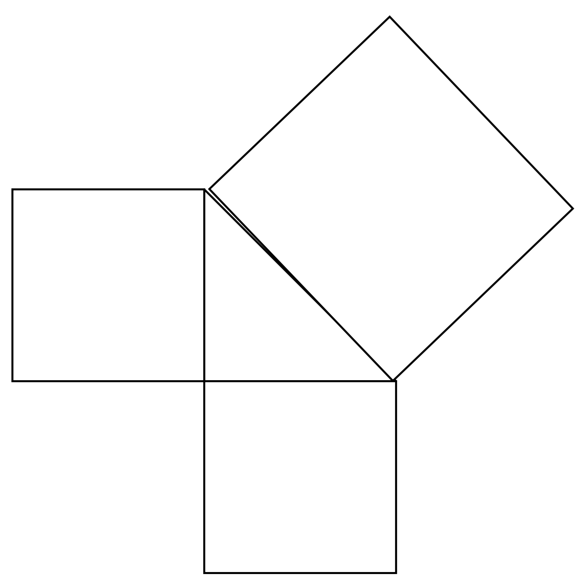
Task 1: Measure the sides of your triangle (**in centimeters**) and test whether it works in the Pythagorean Theorem.

Task 2: Draw and cut out a square whose sides have the same length as the shorter leg. **We are measuring in centimeters.**

Task 3: Draw and cut out a square whose sides have the same length as the longer leg. **We are measuring in centimeters.**

Task 4: Draw and cut out a square whose sides have the same length as the hypotenuse. **We are measuring in centimeters.**

When these tasks are complete, you should be able to form a figure that looks like this:



Now, as a group, you must show that the sum of the areas of the two smaller squares, equals the area of the larger square. In other words, show why $a^2 + b^2 = c^2$ (Hint: you may need to do some more cutting)

Appendix B

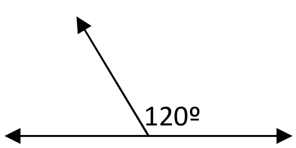
Vocabulary	Definition	Looks Like
Straight Angle		
Supplementary Angles		
Linear Pair		
Right Angle		
Complementary Angles		

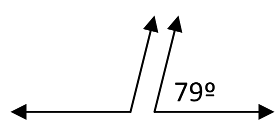
- The _________________ of an angle is the other angle in a supplementary pair.
- The _________________of an angle is the other angle in a complementary pair.

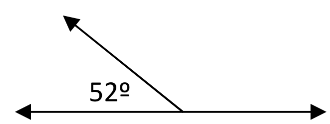
II. Supplementary Angles

- To find the supplement of an angle, subtract from ________.

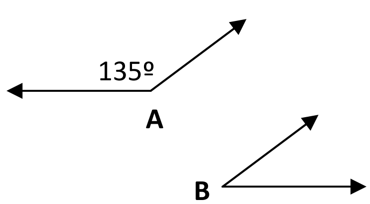
The following angle pairs are supplementary. Fill in the missing angle.







Angles A and B below are supplementary. What is m∠B?

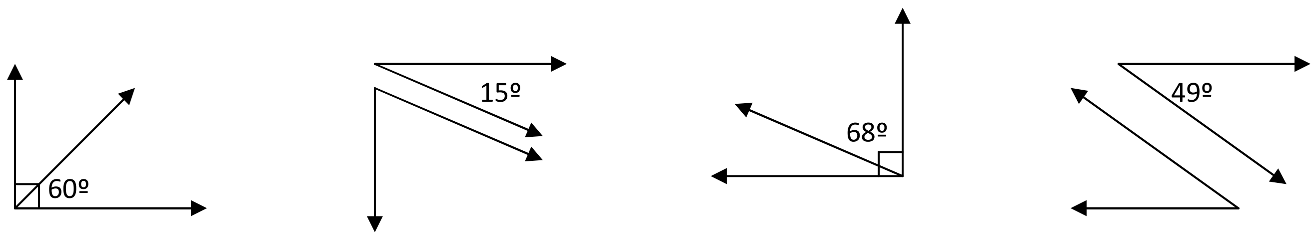


m∠B = __________º

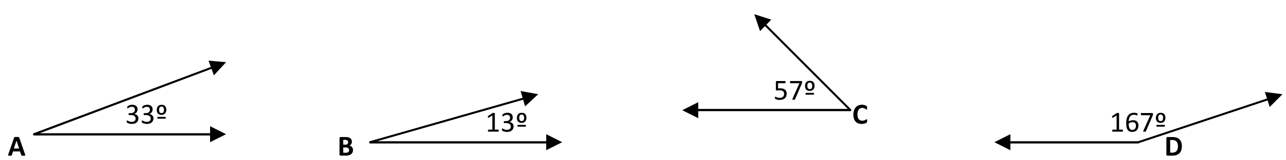
III. Complementary Angles

- To find the complement of an angle, subtract from _______.

The following angle pairs are complementary. Fill in the missing angle.



Use the angles below to answer the following questions.



Which two angles are **complementary**? _____ and _____

Explain why:

____

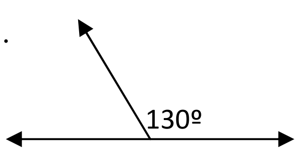
Which two angles are **supplementary?** _____ and _____

Explain why:

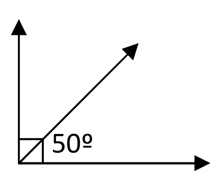
____

Practice—Say whether each angle pair is **complementary** or **supplementary.** Then find the measure of the missing angle.

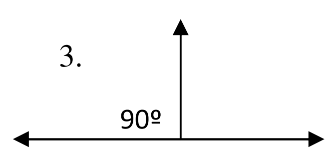
1.



2.

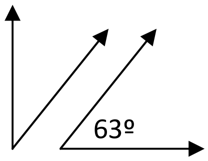


3.



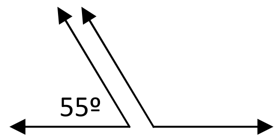
Type: _____________ Type: ___________ Type: ___________

4.



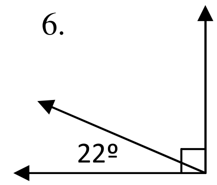
Type: _______________

5.



Type: ______________

6.



Type: __________

Appendix C Unit 3 Quiz 1

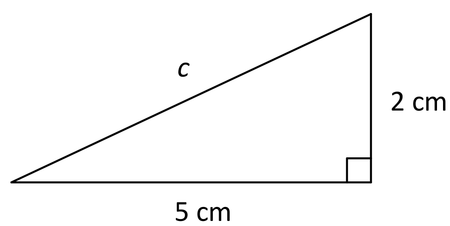
Multiple Choice—**Choose the best answer. Use pencil only. (1 point each)**

1.____ The relationship between the lengths of the legs and hypotenuse of a right triangle is known as the

A. Pythagoras Principal **B.** Side Theory

C. Pythagorean Theorem **D.** Triangle Side Formula

2.____ Find the length of the hypotenuse.



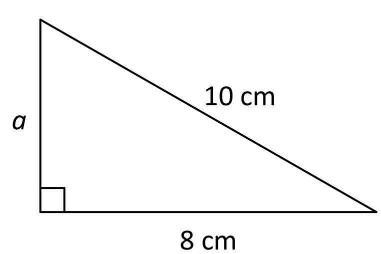
A. 14 cm

B. $\sqrt{14}$ cm

C. 29 cm

D. $\sqrt{29}$ cm

3.____ Find the length of the missing leg.



\

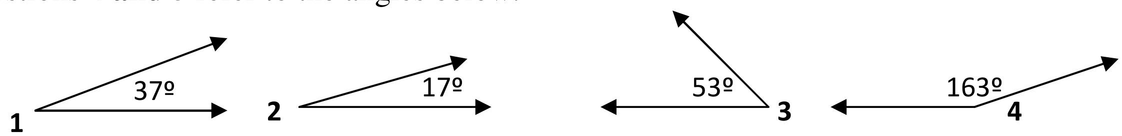
A. 36 cm

B. $\sqrt{164}$ cm

C. 6 cm

D. $\sqrt{84}$ cm

Questions **4 and 5** refer to the angles below.



4.____ Which pair of angles is **complementary**?

A. ∠1 and ∠4 **B.** ∠1 and ∠3

C. ∠2 and ∠4 **D.** ∠2 and ∠3

5.____ Which pair of angles is **supplementary**?

A. ∠1 and ∠4 **B.** ∠1 and ∠3

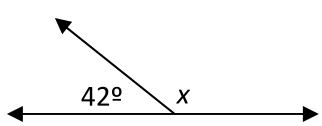
C. ∠2 and ∠4 **D.** ∠2 and ∠3

6.____ Which of the following lengths are the sides of a right triangle?

A. 1 cm, 2 cm, 3 cm **B.** 3 cm, 4 cm, 5 cm

C. 2 cm, 3 cm, 4 cm **D.** 4 cm, 5 cm, 6 cm

7.___ Below is a linear pair. What is the measure of the missing angle *x*?



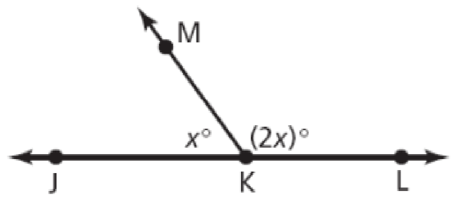
A. 48°

B. 58°

C. 148°

D. 138°

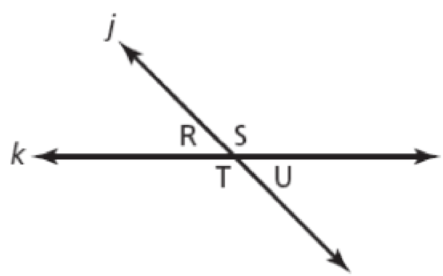
8.____In the diagram below, line JL intersects KM at point K.



What is the measure of ∠JKM?

A. 30° **B.** 60° **C.** 120° **D.** 180°

Questions 9-10 refer to the diagram below, where line *j* and line *k* intersect.



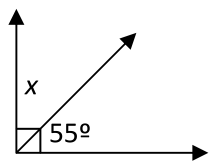
9.____Which angles form a **linear pair**?

A. ∠R and ∠S **B.** ∠S and ∠T **C.** ∠R and ∠U

10.____If m∠S = 110°, what is m∠U?

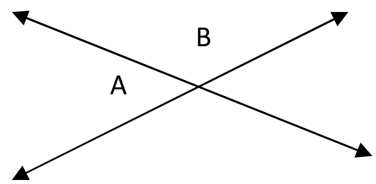
A. 110° **B.** 70° **C.** 180° **D.** 250°

11.___ What is the measure of the missing angle *x*?



A. 35° **B.** 45° **C.** 125° **D.** 135°

12.____What is the relationship between angles A and B?



A. A + B = 180 **B.** A = B

C. A · B = 360 **D.** A + B = 90

True or False—Write "T" for true or "F" for false. (1 point each)

13.____Complementary angles add up to 180 degrees.

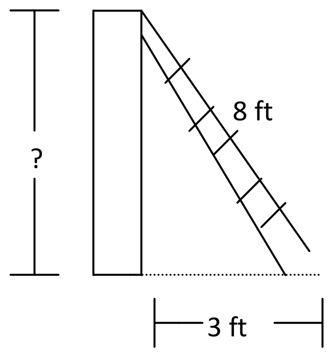
14.____Angles in a linear pair are supplementary.

15.____Supplementary angles add up to 180 degrees.

16.____The hypotenuse of a right triangle is always the longest side.

Short Answer—Be sure to **show your work** for each problem. Use pencil only. (3 points each)

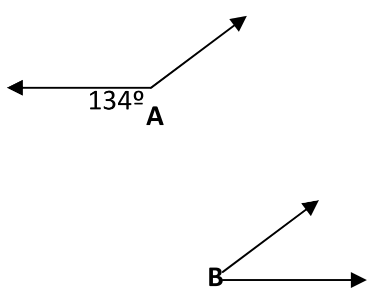
17. A ladder that is 8 feet long is leaned against a wall. It is 3 feet out from the wall at the bottom. How tall is the wall? **Round your answer to the nearest tenth.**



SHOW YOUR WORK

Answer ___________ feet

18. Angles A and B below are **supplementary**. What is m∠B?

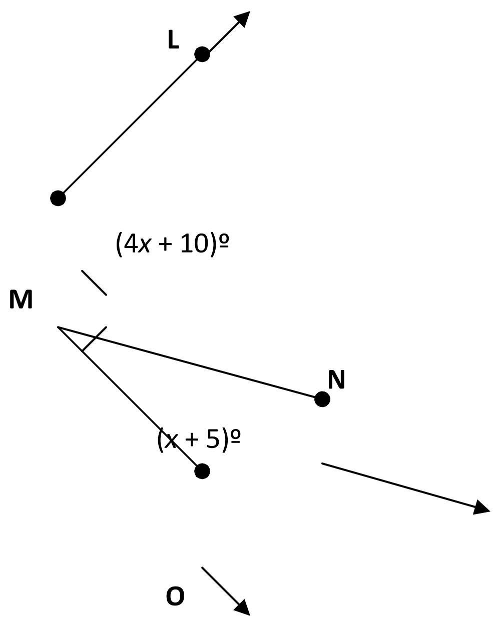


SHOW YOUR WORK

m∠B = _________º

19. Find the measure of angle LMN.

SHOW YOUR WORK



x = ________° m ∠LMN = ________

Explain how you determined your answer.

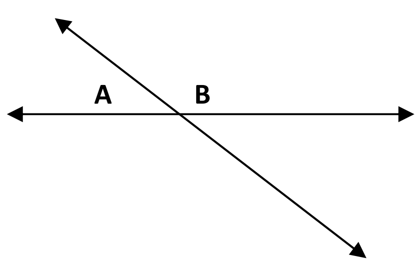
____

____

____

20. In the diagram below, m∠A = $(x + 25)°$ and m∠B = $(3x + 15)°$. Find the measure of angle A.

SHOW YOUR WORK



m ∠A = ________°

Resources

Al-Yaseen, W. S. (2011). Expectations of a Group of Primary School Teachers Trained on Cooperative Learning on the Possibility of Successful Implementations. *Education*, *132*(2), 273-284.

Farivar, S., & Webb, N. M. (1994). Helping and getting help--essential skills for effective group problem solving. *Arithmetic Teacher*, *41*(9), 521.

Kroeger, S. D., & Kouche, B. (2006). Using Peer-Assisted Learning Strategies to Increase Response to Intervention in Inclusive Middle Math Settings. (Cover story). *Teaching Exceptional Children*, *38*(5), 6-13.

Köse, S., Şahin, A., Ergü, A., & Gezer, K. (2010). The Effects of Cooperative Learning Experience on Eighth Grade Students' Achievement and Attitude Toward Science. *Education*, *131*(1), 169-180.

Lopata, C., Miller, K. A., & Miller, R. H. (2003). Survey of Actual and Preferred Use of Cooperative Learning Among Exemplar Teachers. *Journal Of Educational Research*, *96*(4), 232.

Parveen, Q., Mahmood, S., Mahmood, A., & Arif, M. (2011). Effect of Cooperative Learning on Academic Achievement of 8th Grade Students in the Subject of Social Studies. *International Journal Of Academic Research*, *3*(1), 950-954.

Schul, J. E. (2011). Revisiting an Old Friend: The Practice and Promise of Cooperative Learning for the Twenty-First Century. *Social Studies*, *102*(2), 88-93. doi:10.1080/00377996.2010.509370

Servetti, S. (2010). Cooperative Learning Groups Involved in a Written Error-Correction Task. *European Education*, *42*(3), 7-25. doi:10.2753/EUE1056-4934420301

Sherman, L. W., & Thomas, M. (1986). Mathematics Achievement in Cooperative Versus Individualistic Goal-Structured High School Classrooms. *Journal Of Educational Research*, *79*(3),

Siegel, C. (2005). An ethnographic inquiry of cooperative learning implementation. *Journal Of School Psychology*, *43*(3), 219-239. doi:10.1016/j.jsp.2005.04.005

Stearns, C. (1999). A Middle School Venture Into Cooperative Learning: Successes and Dilemmas. *Theory Into Practice*, *38*(2), 100.

Webb, N.M., Farivar, S.H., & Mastergeorge, A.M. (2002). Productive Helping in Cooperative Groups. *Theory Into Practice,* 41(1), 13.

Webb, N. M., Nemer, K., & Ing, M. (2006). Small-Group Reflections: Parallels Between Teacher Discourse and Student Behavior in Peer-Directed Groups. *Journal Of The Learning Sciences*, *15*(1), 63-119. doi:10.1207/s15327809jls1501_8

Zakaria, E., Lu Chung, C., & Daud, M. (2010). The Effects of Cooperative Learning on Students' Mathematics Achievement and Attitude towards Mathematics. *Journal of Social Sciences (15493652)*, *6*(2), 272-275.