

INCREASING STUDENT LEARNING IN MATHEMATICS WITH THE USE OF  
COLLABORATIVE TEACHING STRATEGIES

Jenna Di Fatta, B.A.

Sarah Garcia, B. S.

Stephanie Gorman, B. S.

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## ABSTRACT

Three teacher researchers conducted this action research project to increase their 54 high school students' achievements in mathematics. The teacher researchers had noticed a trend of low scores on teacher-made chapter tests and non-completion of daily homework. Standardized tests showed that most students scored below average on the mathematics portion, and the number of students having to repeat mathematics courses had increased. The students' overall grades in mathematics have dropped, along with their attitudes towards mathematics learning.

The project included 40 high school students enrolled in either Algebra 1-2 or Geometry classes, from August 27, 2008 through January 17, 2009. In each mathematics classes, there is a mixture of both freshmen and sophomores containing ten boys and ten girls. Both mathematics classes are collaborative classes where a regular education mathematics teacher and a special education teacher teach collaboratively.

The teacher researchers planned three different interventions including incorporating multiple intelligence based lessons, offering positive reinforcement for homework, and involving the students in more regular group work. The teacher researchers started by having their students participate in a multiple intelligence survey and based their lessons on intelligences most prominent in their classes. To increase homework completion, the teacher researchers rewarded students who completed five consecutive assignments with a free homework pass. The group work took place during homework time in class. Students were divided into groups of four or five based on their ability level and worked as a team on homework and other activities.

The teacher researchers gathered data using three different tools which included obtaining average test scores, average homework completion, and student surveys to understand how the collaborative setting affected their learning.

They found that some of the interventions did not work as planned. For example, offering positive reinforcement to increase homework completion had a negative effect on the students. The decline in the average homework completion was 0.68% in one class and 6.22% in the other mathematics class. There were mixed results from both classes regarding the average test scores. Overall, the majority of the students felt that being in a collaborative setting helped to improve their learning in mathematics.

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## CHAPTER 1 PROBLEM STATEMENT AND CONTEXT

### General Statement of the Problem

Three high school teacher researchers observed that within their high school there had been a recent increase of academic failure within mathematics, and they questioned whether a collaborative setting would help increase their students' success in these areas. Initial evidence of this problem included low standardized test scores and an increase in the number of students who had to repeat a mathematics course in order to receive sufficient credits for graduation. The teacher researchers believed that this was evidenced in the classroom setting by the lack of daily homework completion and by the students' poor motivation succeed.

### Immediate Problem Context

The three high school teacher researchers conducted this research in their classrooms in the same high school building. Their high school is described in detail in the following section. All the data was drawn from the 2007 State School Report Card.

#### High School

The High School is a public school located in a suburban community that was established in 1962. It is a large brick building that houses a total of 2,289 students and 157 full-time faculty members. This high school has five computer labs as well as at least one computer in each classroom. It also houses a fine arts academy where students can study drama, dance, band/orchestra, or chorus, for students that have applied and been accepted. The breakdown of student ethnicity is 41.5% Caucasian, 9.6% African American, 44.8% Hispanic, 3.5% Asian/Pacific Islander, 0.1% Native American, and 0.5% Multiracial. Among these students 45.3% of them came from low income families.

The limited English proficiency rate of the students was at 16%. The high school dropout rate in 2006 was 6.3% while the chronic truancy rate was at 7.4%.

The financial earnings of the teachers and administrators at this district average at \$62, 452 per year. The teachers in this district have been working for an average for 12.5 years. The number of teachers with a bachelor's degree is 41.1%. The number of teachers with a master's degree and or higher degree is 58.7%. The ethnic background of teachers in this district is 84.7% Caucasian, 2% African American, 12.6% Hispanic, 0.6% Asian/Pacific Islander, and 0.1% Native American. In this district 22.4% of the students are male, and 77.6% are female. The average class size at this high school as of the first school day in May 2006 was recorded at 18.9. The ratio of students to teachers is 20.9 students to one teacher.

The graduation requirements and curriculum are described in the Table 1.

*Table 1: High School Graduation Requirements*

<b>Academic Area</b>	<b>Duration</b>	<b>Semester(s)/Credit(s)</b>
<b>English</b> Freshman English, Sophomore English (Writing intensive), Junior English (Writing intensive) Senior English	4 years	8
<b>Mathematics</b> Algebra 1-2, Geometry 1-2, Algebra 3-4	3 years	6
<b>Science</b> Biology, Physical Science either Chemistry, Geology Intro to Physical Science or Physics	2 years	4
<b>Social Studies</b> U.S. History: Civics (Pass the U.S. and Illinois Constitution Tests), Economics (Includes consumer education as required by law)	1 year 1 semester 1 semester	2 1 1
Physical Education	3.5 years	7
Health Education	1 semester	1
Art <b>or</b> Music <b>or</b> Career & Technical Education Family and Consumer Science, Health Occupations, Business Education, Industrial Technology <b>or</b> World Language	1 year	2
Electives	8	
<b>Total Required for Graduation</b>	<b>40</b>	

Source: School District Website

The graduation rate for all students in this high school is 80.1 %. The graduation rates by category are as follows: 72.4% male, 87.1% female, 88.7% Caucasian, 70.1% African American, 70.5% Hispanic, and 82.2% Asian/Pacific Islander.

The American College Testing (ACT) composite score for the 2007 graduating class was 18.7 out of a total of 36. Broken down by sections, the class scored 17.9 on the English portion, 18.9 on the mathematics, 18.6 on the reading, and 18.8 on the science. The overall Prairie State Achievement Examination performance for the 2006-2007 school years was 44.1%. This score represents those who met or exceeded the Illinois Learning Standards.

The High School has one principal and two assistant principals, one of which acts as a dean. In addition, there are four other deans who handle discipline issues in the school. Every department is assigned a department head who deals with scheduling, and curriculum structure. The department head is also responsible for conducting teacher evaluations.

The High School is known for its fine arts academy. In this fine arts academy, students audition to be accepted, and are allowed to attend even if it is outside of their geographical school boundaries. In the academic setting, students who score below the average on the Explore Test (the high school placement test) are placed into a program with extended meeting times, such as 75-minute periods for mathematics and science. A normal period at this high school lasts for 50 minutes. The extra time allotted in this program allows teachers to incorporate additional reading strategies and basic mathematics skills, which can bring the students up to sophomore standards. Additionally, new in the 2007-2008 school year, this high school has incorporated a

mathematics resource room that also serves as a test make-up center. This center enables students to receive additional help provided by mathematics teachers.

When approaching this high school, one notices a baseball field, an outside track, tennis court, a soccer field, but no football field. All football games are conducted at a different high school within the district. There are five computer labs accessible to students and staff, including twenty five computers in the library. The High School is forty-five years old that had three additions during that timeframe. The teacher researchers believe that the poor morale of the High School is directly related to the building's poor physical condition. This includes leaking ceilings, falling chalkboards, bathrooms with overflowing toilets, desks covered in graffiti and broken chairs. These conditions may also affect the students' lack of motivation and attention during class.

The teacher researchers have noted that the students tend not to take daily notes in class and that the students do not see the relevance in doing homework for practice. Students are also performing poorly on tests in their mathematics classrooms. There is little access to new technology and other tools for learning. A class size of 30 students for this school seems large for one teacher. Most students come from a lower economic status and many parents are preoccupied with more than one job and are often hard to reach.

#### Local Context of the Problem

This high school is located north west of a major midwestern city. In 2000 the city had a population of 94,487. There are 3,118 people per square mile with a population growth rate of 11%. To separate the population by age groups, 38.03% are residents between the ages of 1 and 24, 54.01% are between 25 to 64, and 7.98% are of ages 65



and up. Caucasians make up 69.75% of the population, while African-Americans are at 5.66%, Asians at 4.97%, American Indian at 0.41%, Hispanics at 36.22%, and others at 19.09%. A total of 59.99% of the population claim to be religious. Several religions are represented: 34.39% of the population is Catholic, 15.74% Protestant, 0.39% Latter Day Saint, 5.05% other Christian faith, 0.25% Jewish, 0.04% of eastern faith, and 0.12% Islamic. The number of people with a two-year college degree is 7.1% of the population, 15.01% have obtained a four year college degree, while 5.76% hold a graduate degree and 76.36% have a high school degree.

The average household income is \$24,278, while the average number of people in a household is 2.95. The unemployment rate in this community is 4.30%. The job growth is 1.14%. The prediction for job growth within the next ten years is 21.38%. The majority of the population works in sales or an office position.

The city was founded in 1835 by two men who settled on a nearby river. Over the next 165 years, this city would include the world's largest watch making factory, and the largest producer of dairy products in the Midwest. This city also houses a number of facilities, including a recreational and fitness center, a cultural center which houses their own world-renowned orchestra, golf courses, and a riverboat casino.

This high school is the product of 10 elementary schools and 2 middle schools. The mission of this High School is “...to provide all students with quality curricula and programs to meet intellectual, emotional, physical and moral potential in a safe environment which respects the dignity and value of the individual.”

The district consists of 64 schools and one superintendent. The High School's tax base is \$293,111,241.

## National Context of the Problem

Catherine Gewertz of The Civic Enterprises for the Bill and Melinda Gates Foundation recently studied the reasons why students drop out of high school (Gewertz, 2006). Catherine Gerwerz obtained the viewpoints of diverse high school dropouts between the ages of 16 and 25. According to her findings, the major reasons why students leave school are that they are bored with school, could not keep up with the work due to frequent absenteeism, influence from their peers, lack of rules with too much freedom, and they were failing classes, along with personal reasons of parenthood or the need to provide for their family. The majority of the dropouts in her research commented on becoming uninterested in school starting within the first two years of high school. The author, Gewertz, conducted interviews of 467 drop-out students in Philadelphia and Baltimore. Results from the interviews confirmed that students were dropping out of school because they were unmotivated to attend classes the classes were uninteresting to them and unchallenging.

In 1999, the College Board reported on the trend for lower academic achievement by students (mainly minority). In response, the Mid-Continent Research for Education and Learning combined seven papers from known experts on diverse issues to generate a list of causes for this low achievement along with offering suggestions for district and state policy makers to help teachers improve students' academic success.

## Reflection

Students are showing a steady decline in achievement in mathematics and we would like to identify methods that will increase this area of decline. Looking at the demographics of the community that holds this high school, we suspect that some of the

student behaviors and problems stem from a low average household income and a lack of educational background. We intend to increase our knowledge of collaboration and cooperation with our students and other teachers in this process. By looking at our students tests scores, homework completion, and their opinions on collaborative teaching, we will be able to tell if our efforts are successful and in turn will be growing in our profession.

## CHAPTER 2 PROBLEM DOCUMENTATION

### Problem Evidence

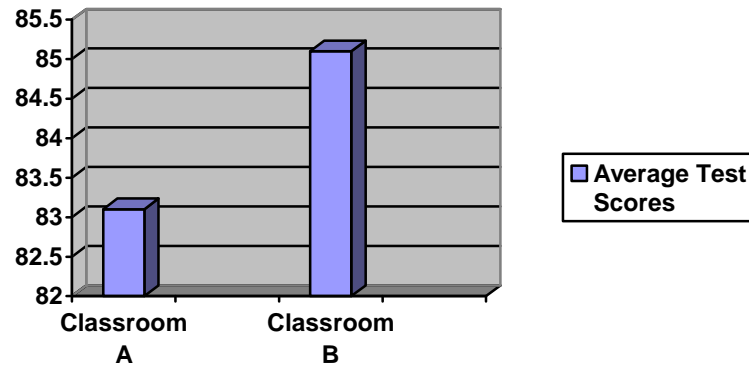
The three teacher researchers involved in this action research project include two general education teachers who teach mathematics and one special education teacher. The teachers had a common goal of increasing overall student learning within their mathematics classes. The teacher researchers noticed a common trend of students scoring low on tests, not completing homework, and having overall poor motivation to learn and do well in their mathematics class.

To fully understand the current situation of their students, the teacher researchers gathered baseline data from test scores, homework completion and surveys.

#### Test Scores

Teacher researchers calculated average test scores from both the mathematics classes from the first quarter, which consisted of 9 weeks. Teacher-made tests were worth 25% of the student's grade. This data was gathered using a computer program, called Grade Machine, which calculated class averages when individual grades were entered into the program.

*Table 2: Average Test Scores Pre-Intervention*

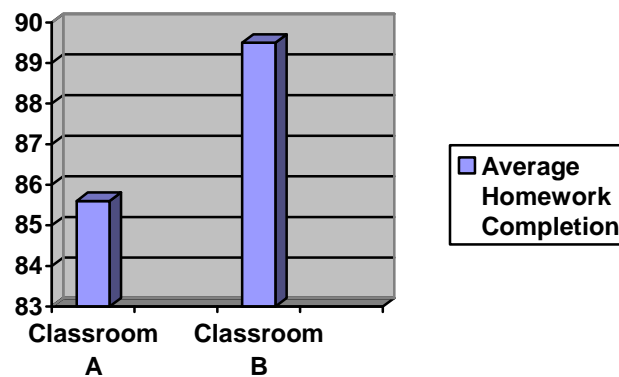


The average tests scores for both classroom A and B are shown in Table 2. The data shows that in classroom A, the average was 83.1%, and the average for classroom B was 85.1%.

#### Average Grades for Homework

The teacher researchers calculated average homework scores within all the classes from the first quarter. Homework was worth 15% of the student's grade. This data was also gathered using Grade Machine.

*Table 3: Average Homework Completion Pre-Intervention*



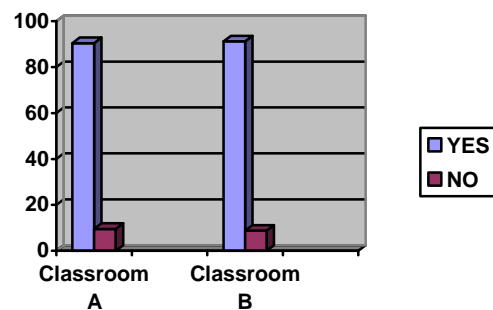
The average homework completion for both classrooms A and B are shown in Table 3.

The data shows that in Classroom A, the average was 85.6% and in Classroom B, the average was 89.5%.

### Student Survey

Students were given the Collaborative Teaching Survey (see Appendix A) to gather their thoughts about being in a collaborative setting. The pre-surveys took approximately 15 minutes during regular class time, and was given during the first week of school. Students were asked questions such as how much help they received the first quarter and what they thought about having two teachers in the classroom. The student survey was intended to gather more qualitative data as opposed to the quantitative data gathered from the average test and homework scores.

*Table 4: Percentage for Question #1: Do you feel that you are getting more help by having two teachers?*



*Table 5: Percentage for Question #2: Do you feel that having two teachers have helped you learn the mathematics concepts better?*

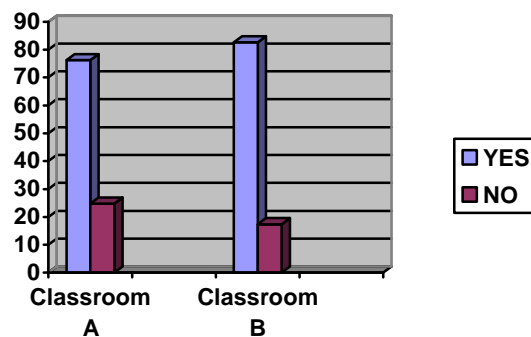


Table 6: Percentage for Question #3: Do you feel that having two teachers has helped you to perform better on tests?

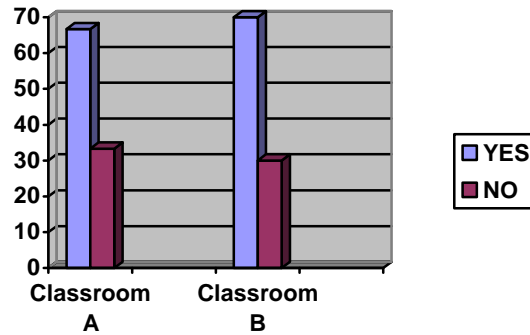
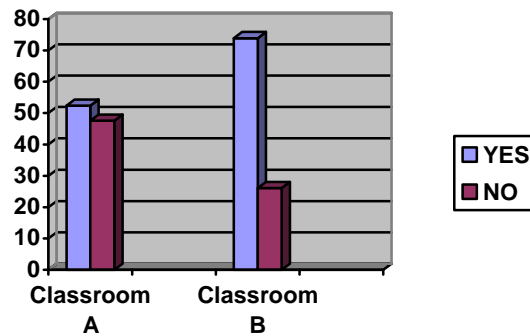


Table 7: Percentage for Question #4: Do you feel that having two teachers has helped you to complete more homework assignments?



Tables 4-7 show the percentages of the responses for the four questions asked on the Collaborative Teaching Survey. Overall, more than 50% of the students felt that being in a collaborative setting would be beneficial to them.

As the baseline data shows, student achievement, as far as homework completion, test scores, and attitude towards mathematics was in the average range. The students were on the low end of the average range of performance on standardized tests. The teacher researchers believed that if homework completion increased, combined with an increase in classroom test scores and an improvement in attitude, this would affect students' standardized test scores and overall success. With this goal in mind, the teacher

researchers gathered information concerning why their students are under-performing, and narrowed it down to three probable causes.

### Probable Causes

As the demographics in Chapter One showed, the High School at which the research project took place has a diverse population. In addition there are other issues that may impact student achievement in high school mathematics. These include socio-economic status, parental involvement, and both students' and parents' attitudes on mathematics education.

#### Socio-Economic Status

“To reach the goal of mathematics achievement for all, we must understand and address the obstacles faced by economically disadvantaged students” (Lubienski, 2007, p. 55). Socio-economic status (SES) has become more of an issue recently in the United States. Disparities between low and high socio-economic statuses have been researched and have become more prevalent, as Lubienski found. Lubienski further discovered that in low-SES students, their willingness to learn mathematics is not as high as their higher-SES peers. Lubienski (2007) states, “Their higher-SES students have the confidence to make sense of mathematics for themselves; in contrast, more lower-SES students would often ask me to just ‘explain how to do it’ or ‘tell the answer’” (p. 56). He also said that as far as being interested and engaged, the higher-SES students enjoyed discussions on certain conflicting mathematics topics; the lower-SES students often complained that they would get confused about which mathematics ideas were right and which were wrong (2007).

Lower-SES students view mathematics has merely memorizing facts. Lubienski



(2007) has found that this belief in the lower-SES students is negatively correlated with achievement. Therefore, they are more likely to forget what they have learned. These students are less likely to retain mathematics information as opposed to those students who have a deeper understanding of mathematics concepts and relationships.

When the students are not at school, Lubienski (2007) found that “working class parents tend to be more overtly directive with their children, often showing or telling the children how to do things” (page 54). In contrast, he says, middle class parents find playful ways to help their children through certain mathematics problems, guiding them through the problem solving process through questioning and focusing on the general structure of the problems.

Furthermore, according to a study by the faculty in education at the Chinese University of Hong Kong, students in richer or more egalitarian countries and with higher SES were more interested in mathematics. These students put forth more effort and had higher self-concepts and self-efficacy. The study involved questioning and testing, using the Programme for International Student Assessment (PISA) mathematics test, of 107,975 15-year old students (Chiu and Xihua, 2008).

In another study that focused on patterns of Hispanic students’ mathematics skills, mainly lower-SES groups, the results confirmed that these students displayed the lowest level of mathematics skills throughout elementary school (Reardon and Galindo, 2007). This study included a nationally representative sample of Hispanic students who were assessed in their mathematics skills from kindergarten through 5<sup>th</sup> grade. Data from these tests were gathered and patterns revealed lower mathematics skills for lower-SES students.

### Parental Involvement

The teacher researchers have noticed a trend of parents of the high school students being so busy that they cannot be involved in their child's education, as exhibited through their poor attendance at open houses and parent-teacher conferences. Hoover (2001) investigated the relationship of parental involvement with student achievement in the classroom. He found that parental involvement correlates with student success and performance in school through modeling and reinforcement. A major concern amongst teachers is homework completion. Teachers complain that students do not attempt to complete homework or give up easily on homework assignments. It was found that students are most attentive on homework assignments when they had a parent working with them or overseeing them while doing their homework (Xu, 2005). Moreover, the environment created by the parents was found to be linked with a student's own self-regulation of homework completion.

Data gathered from the National Education Longitudinal Study was used in a study conducted by Andrew Houtenville and Karen Smith Conway to investigate parental effort and student achievement. Their results confirmed that parental effort had a strong, positive effect on student achievement (Houtenville and Conway, 2008).

### Attitudes of Students and Parents on Mathematics Education

“According to a 2007 Public Agenda report called *Important, But Not for Me*, the majority of students and their parents polled believed that studying higher level mathematics is not essential for life in the ‘real world’ “(Scherer, 2007, p.7). Scherer also discovered that students are only studying higher level mathematics courses to ensure graduation requirements.

Colin Foster (2007) found that students dislike mathematics due to not knowing the acceptable mathematic behavior; they fail to distinguish which behavior is appropriate and which is not. He explains that sometimes in mathematics there are problems that require a lot of work while other problems require little to no work (mathematic behavior). Students often get confused about what problem requires what amount of work and thus hesitate to answer, or even ask, questions. When they do feel that they need to answer a question, they will do so with sarcasm which provokes the teacher and leads to punishment. For example, Foster (2007) had students that always responded with “pi,” no matter what the context of the problem was.

In the article, *Important, But Not for Me*, researchers found that local parents in Kansas and Missouri realized that mathematics is important in education, but not vital in the need for personal growth or opportunities. This resulted in the lack of parental encouragement for their children to better their test scores within mathematics. Moreover, the parents do not see the need to improve mathematics education in their local schools, as their children lack interest and motivation when entering mathematics classes. These same parents claim that understanding higher level mathematics like calculus is not absolutely essential while in high school. In fact only 23% of the parents polled say that higher level mathematics classes are absolutely essential to be studied during high school (Public Agenda, 2007).

### Classroom Possibilities

Many factors can cause a student’s lack of achievement or learning. However, not all of these causes can be addressed in our research project. For example, the teacher researchers are not able to change their students’ parent’s attitude or thoughts on

mathematics education. They can not change their student's families' socio-economic status, nor can they easily change how much the parents are involved in their student's educational experience. However, they can influence their student's attitudes on mathematics through various instructional strategies. The teacher researchers wanted to be able to help their students perceive their math education as beneficial and valuable to their future.

## CHAPTER 3 SOLUTION STRATEGY

### Literature Review

The literature on helping students retain and develop higher level thinking skills focuses mainly on creating lessons based on different multiple intelligences, incorporating more group work, and the use of positive reinforcements in the classroom. Three instructional strategies drawn from the articles provided the processes and uncovered the advantages of using these strategies in mathematics courses.

#### Use of Multiple Intelligences

The use of multiple intelligences in the classroom lessons is a widely popular technique to help students retain and develop higher level thinking skills. The potential of students is no longer just based on a student's IQ. Research has shown that a student's IQ accounts for only 20% of the student's potential. The use of multiple intelligences has been described as "a framework allowing teachers to explore their teaching styles and to assist them in making decisions about ways to structure teaching and learning experiences for students" (Ozdemir & Tekkaya, 2006). The approach has been described as serving three main purposes: 1) matches teaching to the way students learn, 2) encourages students' development, and 3) encourages diversity (Ozdemir & Tekkaya, 2006). A research study done by Teele Inventory for Multiple Intelligence (as cited in Ozdemir & Tekkaya, 2006) has shown that out of seven of the multiple intelligences, students are strongest in both linguistic and logical-mathematical when entering elementary school and are the weakest in these two by the end of high school. After conducting a study on students in a science classroom incorporating a pre- and post- test along with activities that addressed all intelligences, Teele reportedly found that the

multiple intelligence instruction allowed students to retain more information and started using the other intelligences besides linguistic and logical-mathematical (Ozdemir & Tekkaya, 2006).

Another teacher in Pennsylvania also found benefits of using multiple intelligences within her classroom (Emig, 1997). She gave two examples of lessons that incorporated activities that addressed each of the multiple intelligences. When she would finish an activity she would then evaluate her work using a chart that she developed and determine the students' content knowledge. By doing several lessons that spanned throughout a year, she concluded that within each unit she was able to address all intelligences and that students felt more competent and confident in their work and found enjoyment in learning new information (Emig, 1997). By using all of the multiple intelligences it has been shown that lessons can be presented in more interesting ways and leads to students' having a confidence in themselves and more of a desire to learn the material.

“Multiple intelligences have been praised as one of the most important new ideas on the educational horizon” (Gardner, 1997, p. 20). It does take time to develop implications of these intelligences but, according to Gardner, “it can be a partner in the process of creating an excellent school” (p.20). He has discovered that it allows students to be engaged with what they are learning and better prepares them for work after school. Teachers who have experience in the use of multiple intelligences have expressed its strength in “conveying interdisciplinary content and concepts” (p.21). Gardner refers to a teacher who has a decade's worth of experience who has determined that these ideas have greatly improved student progress, parental communication, and growth amongst his

colleagues. Gardner concludes that the use of multiple intelligences within the classroom is an ongoing process, but research shows that it can be highly beneficial.

### Grouping students

Grouping students in the mathematics setting is very substantial and effective according to many sources (Lee, 2006). For example, the author of *The Power of Groupthink*, Lee, states that when people pull together their knowledge, they can outperform the brightestest of individuals. In this article, researchers at the University of Illinois conducted a study that included 760 college students. They asked these students to crack a code that tested mathematics and logic skills, some worked alone while others worked in small groups. Partners who teamed up outshone even the top-scoring solo individuals at this school. One of the researchers explained that groups have an edge because they build on each other's insights, making it easier to recognize correct answers.

According to Theodore Panitz (2000), the author of *Using Cooperative Learning in the Mathematics Classroom*, there are many benefits to cooperative learning. It not only benefits the students and their learning, but it also benefits the teachers. As she interviewed her students after they had worked in groups, one of her students responded to her question by saying, "Before your class, I disliked math. I was always getting aggravated and scared by it. Working together with those around me in a group was a great help in understanding the material and the many different ways in which a problem can be tackled and solved" (Panitz, 2000, p.8). Grouping students motivates them and their critical thinking skills are enhanced, as well, students becoming more familiar with their peers while still enjoying mathematics.

"I felt so isolated and frustrated when I was asked to work by myself; I had no

one to bounce ideas off of!”(Williamson, 2006, p.195). This was a statement made by a 12-year-old student in a mathematics class. Their teacher, Williamson, who is the author of *Group and Individual Work* (2006), concluded that group work increased the opportunities for communication and made problem solving a richer experience for students. Her research process was to have half of her class work as a team for the lesson, and the other half work individually. She found that the teams that worked together were very confident and felt less frustrated with the material. The groups that worked together also had no problem with reporting to the class on something they had produced as a group (Williamson, 2006).

### Positive Reinforcement

There have been many debates about whether teachers should incorporate positive reinforcements to their students. Some argue that students should not be rewarded for things that they should be doing anyway, while other teachers believe that student demographics are changing and that education and pedagogical practices need to follow that change in order to better help our students (Lysakowski & Walberg, 2001). Despite both of these views, there have been many studies that have shown the benefits of giving positive reinforcements to students with an increase in student learning.

Patzelt (1992) reported one case where a 9-year-old student was failing to complete daily homework assignments. In response, the teacher with the student created a three-week contract that required the student to complete homework assignments neatly, check homework with the teacher, and complete a homework recording chart with the teacher. As a reward for the student complying with the contract, the teacher gave positive reinforcements, such as certificates of accomplishment, food, verbal praise and



encouragement, and being able to function as the teacher's helper. At the end of this study, this student took responsibility for checking and correcting homework, and completing the homework chart individually (Patzelt, 1992).

In a study conducted by Lysakowski and Walberg at the University of Illinois at Chicago Circle in 2001, the effects of reinforcement had an impact on students' percentile ranges. A sample of students was split into two groups, one group receiving positive reinforcement while the other group did not. The researchers found that the group which received positive reinforcement averaged at about the 88<sup>th</sup> percentile compared to the group which did not receive reinforcements which averaged at the 50<sup>th</sup> percentile (Lysakowski & Walberg, 2001).

Awarding points has been discovered to be a way to help students stay on task and as a way to implement positive reinforcement. Cruz and Cullinan (2001) described a mathematics class of students with social-emotional disabilities, learning disabilities, and other health impairments where the teacher created a definite on-task behavior plan and recorded the results each day. The students were on a token-reward system based on points. Within this system, there are three different types of behaviors that students could receive points for. These included behaviors such as following general classroom rules, achieving goals set by an individualized learning plan, and for going "above and beyond" interactions with other students. As a result, the teacher noticed that the classroom on-task behavior had improved, and eventually most, if not all of these students exhibited on-task behavior (Cruz & Cullinan, 2001).

## Conclusion

The literature supports using multiple intelligences, incorporating more group work, and using positive reinforcement to increase student achievement in mathematics. The articles provided the processes and uncovered the advantages of using these strategies. Through the use of lessons driven by the multiple intelligences, it has been found that teachers have reached more of the students' needs. Grouping students together in the classroom not only supports their learning of mathematics, but improves their confidence as well. Positive reinforcement gives the students the extra incentive needed for them to do well in mathematics. It also becomes a way for students to take responsibility for their choices. All three of these strategies together would contribute to student success in mathematics.

## Project Objective

The objective of this research project is to increase student learning in mathematics classes. As a result of using multiple intelligences in lessons, assigning more group work, and using positive reinforcement for homework during the time period of September 1, 2008 through January 17, 2009, the students of teacher researchers A, B, and C aimed at improving homework completion, increasing students' performance on tests, and affect students' thoughts and feelings about collaborative teaching in a positive way.

## Processing Statements

To complete this research, the teacher researchers had to complete certain tasks that included creating surveys, lessons, and deciding the types of positive reinforcement. Students' opinions on collaborative teaching were gathered through surveys. The lessons

needed to be developed so that they touched upon the different multiple intelligences of the students. The teacher researchers needed to devise an action plan to give positive reinforcement to the students to address the lack of homework completion.

### Project Action Plan

#### **Week 1** (August 27 – August 29)

- Pass out consent forms for students and parent/guardian. These will be collected by the end of the week.

#### **Week 2** (September 1 – September 5)

- Conduct Pre-Collaborative Teaching Survey asking students how they feel about their classroom environment..

#### **Week 3 – Week 8** (September 8 – October 24)

- Traditional co-teaching styles. The general education teacher teaches the lesson, while the special education teacher keep students on task.

#### **Week 9** (October 27 – 31)

- Teacher researchers will gather data on the following from the first quarter:
  - Average homework completion in each class
  - Average test scores for each class

#### **Week 10 – Week 18** (November 3 – December 19)

- Have students participate in the multiple intelligence online survey in class.
- Implement different multiple intelligences lessons into the classroom.
- Distribute strategy survey to students after each multiple intelligence lesson or group work activity.
- Incorporate more cooperative learning groups.
- Give positive reinforcement for homework completion.

#### **Week 19 – Week 20** (December 22 – January 4)

- Winter break

#### **Week 21** (January 5 – January 9)

- Teacher researchers will gather data on the following from the second quarter:
  - Average homework completion in each class
  - Average test scores for each class
- Distribute post collaborative teaching survey.

#### **Week 22** (January 12 – January 17)

- Teacher researchers will collect and analyze data and compare results from the first quarter to the second quarter.
- Teacher researchers will meet as a group to compare and evaluate results.

### Methods of Assessment

The teacher researchers created two different surveys to gather data on their

students' views on collaborative teaching as a whole. One was a Collaborative Survey and the other was a Strategy Survey (see Appendix B).

### Student Surveys

#### *Collaborative Teaching Survey*

The Collaborative Teaching Survey was given before and after the interventions in this research process. The survey asked students for their thoughts and feelings about collaborative teaching. The purpose was to determine if students see collaborative teaching as beneficial to their learning, homework completion and performance on tests. This survey was given during the week of September 1, 2008 and again during the week of January 5, 2009 to see if there was a change in the students' attitude towards having two teachers. All three teacher researchers administered the survey in their classes to gather data about how the students perceived their collaborative class.

#### *Strategy Survey*

The Strategy Survey was given after each multiple intelligence-based lesson was taught. This survey was an open-ended question that asked students for their comments about how the lesson did or did not help improve their understanding in mathematics.

### Homework Completion

Another assessment tool used was the Quarterly Average Homework Assessment. The teacher researchers kept a daily record book of homework completion and then calculated the homework average on a quarterly basis. This data gathering tool was used starting in the week of September 1, 2008 and ending in the week of January 5, 2009. The teacher researchers calculated averages from the first quarter and then compared the averages from the second quarter after the interventions took place. The first quarter was done the week of October 27, 2008 and the last quarter was done in the week of January 5, 2009. This data was then graphed to show changes in homework completion as a result of the interventions.

### Test Scores

Test scores were gathered from all the students and were used as the last data tool. The tests in the teacher researchers' classrooms were teacher-designed. The teacher researchers calculated their averages at the end of each grading quarter. The first was done the week of October 27, 2008 and the last was the week of January 5, 2009. This data compared the two time periods to assess any changes in students' test scores after the intervention strategies were implemented.

## CHAPTER 4

### Historical Descriptions of the Interventions

The three teacher researchers had a common goal of increasing overall student learning in their mathematics classes. In particular, they wanted to increase homework completion, increase test scores, and improve students' attitude toward being in a collaborative setting.

In the first week of this action research project, the teacher researchers distributed and collected student consent forms to be signed by their parent/guardian. During that same week, the students themselves signed consent forms allowing the teacher researchers to collect data. After consent forms were signed and turned in, the teacher researchers had students participate in the Collaborative Teaching Survey. This survey gathered information concerning the students' attitude towards the collaborative setting. The rest of the first quarter, which was the third through the eighth weeks of the research project, the teacher researchers taught in a traditional collaborative setting. During this time period, there were no interventions implemented and students, for the most part, worked individually. At the end of the first quarter, Week 9, the teacher researchers gathered data from test scores and homework completion, and found the average for each classroom.

Soon after, during Week 10, the teacher researchers conducted the Multiple Intelligence Online Survey (see Appendix C) to find what multiple intelligences were prominent in each classroom. The teacher researchers used the statistics from the surveys to design lessons that appeal to those types of intelligences (see Appendices D-G). Throughout the second quarter, weeks ten through eighteen, these lessons were

implemented and the Strategy Surveys were given to gather information about students' attitudes toward how that lesson improved their understanding of that particular topic. During this time, the teacher researchers also rewarded students with a homework pass for every five consecutive homework assignments completed. Lastly, the teacher researchers divided their classes into groups of four or five, according to their ability level, and had them work together within their group on homework assignments and other activities.

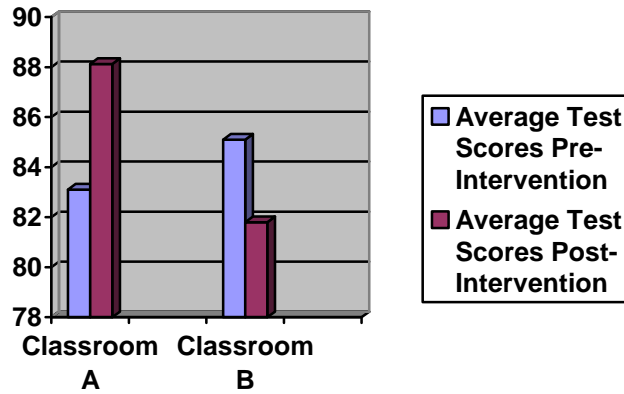
During Weeks 20 and 21, data from test scores, homework completion, and the Collaborative Teaching Surveys from the second quarter were gathered and tabulated. Then, as a group, the teacher researchers compared their data between both quarters.

### Presentation and Analysis of the Results

#### Test Scores

After the second quarter was completed, the teacher researchers gathered the average percentage of test scores from their classes. The data was gathered using the GradeMachine program, which was the same program used to gather the data before interventions were implemented.

*Table 8: Average Percentage of Test Scores Pre- and Post-Intervention*



In Table 8, the data displays the average test scores before and after the intervention strategies were implemented. Within Classroom A, the average test score increased by 5.03%, while Classroom B decreased by 3.3%.

#### Average Grades for Homework

The program GradeMachine was also used to gather the average percentages for homework completion.

*Table 9: Average Homework Completion Pre-Intervention and Post-intervention*

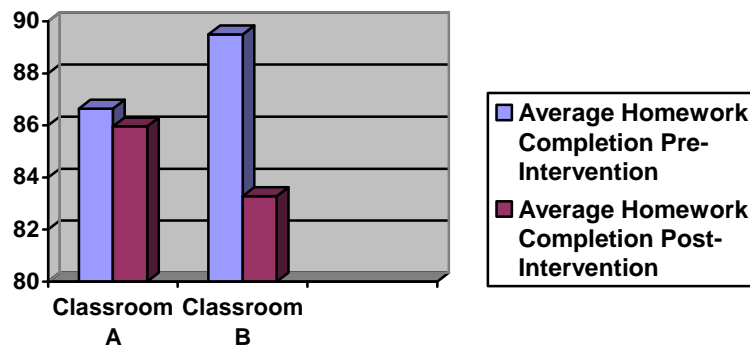
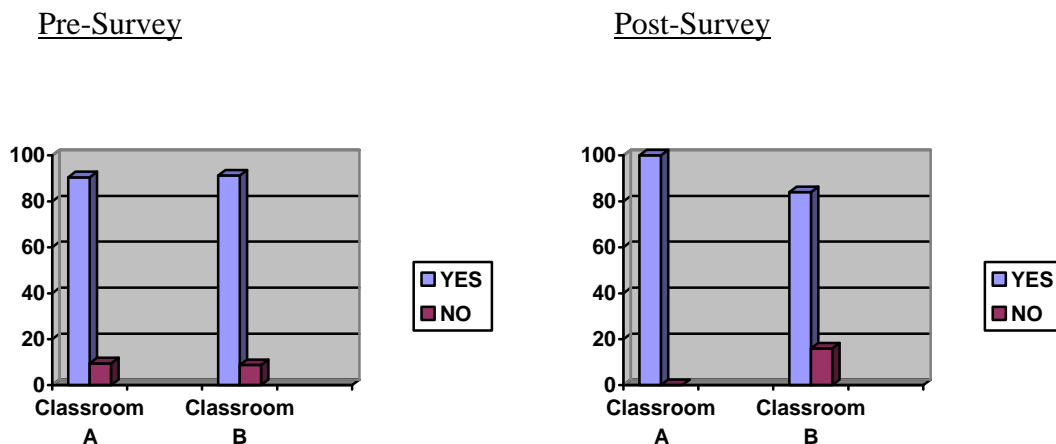




Table 9 illustrates the average homework completion scores pre- and post-intervention strategies. Classrooms A and B both experienced a decrease in their average homework completion, 0.68% and 6.22% respectively.

Student Survey

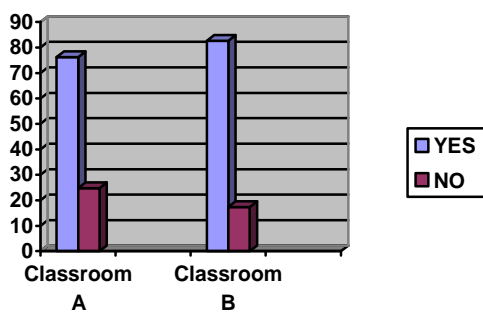
*Table 10: Percentage for Question #1-Do you feel that you are getting more help by having two teachers?*



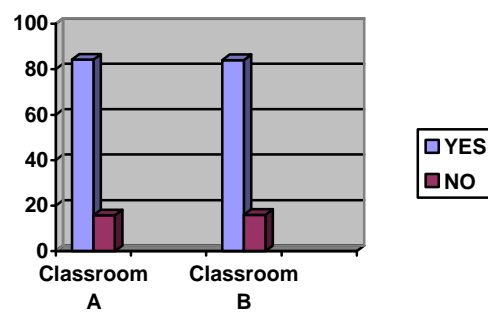
In Classroom A, there was an increase by 9.5% in students' attitudes about having two teachers within the classroom, while Classroom B experienced a decrease of 7.3%.

*Table 11: Percentage for Question #2 – Do you feel that having two teachers have helped you learn the mathematics concepts better?*

Pre-Survey



Post-Survey



Both Classroom A and B saw an increase in the students' attitudes concerning having a better understanding of mathematical concepts. Classroom A increased by 8% and Classroom B increased by 1.4%.

*Table 12: Percentage for Question #3: Do you feel that having two teachers has helped you to perform better on tests?*

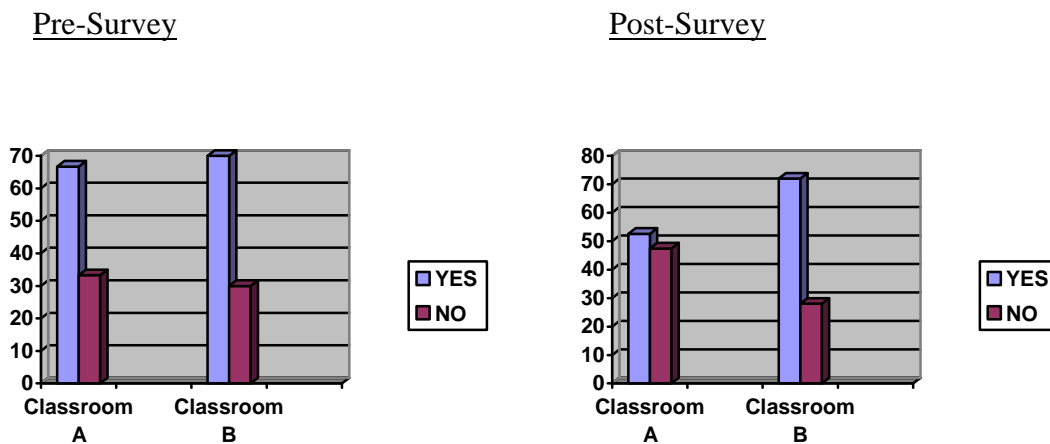
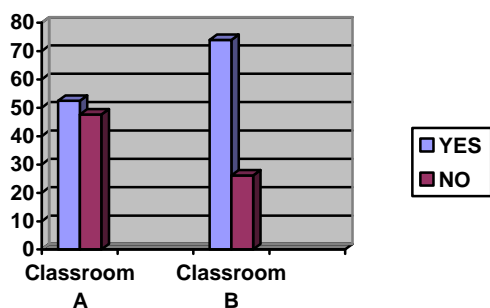


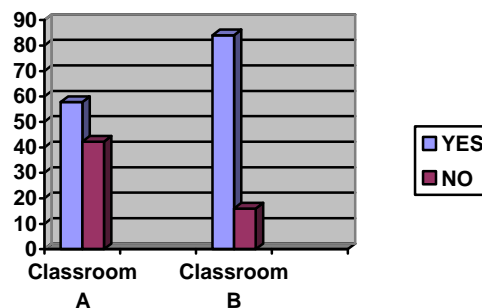
Table 12 shows that for Classroom A, the number of student responses for feeling that having two teachers helped improve test performance decreased by 14.1%. On the other hand, the students' feeling for having two teachers helping to improve their test scores in Classroom B increased by 2%.

*Table 13: Percentage for Question #4 – Do you feel that having two teachers has helped you to complete more homework assignments?*

Pre-Survey



Post-Survey



In Classroom A, there was a slight increase of 0.2% of students responding “Yes” to the question regarding the students’ attitudes towards completing more homework assignments due to having two teachers. Classroom B had a more significant increase of 10.1% in response to the same question.

### Conclusion and Recommendation

Through analyzing the data, the teacher researchers have concluded that the strategies that were implemented had a positive affect on the students’ attitude towards being in a collaborative setting. With an increase of group work and incorporating more multiple intelligence based lessons into the classroom, the data showed, through Tables 10-13, that the majority of the students either had similar thoughts or had changed their thinking for the better. On the other hand, within Classroom B, after the interventions, more students felt that they were not getting more help by having two teachers, considering the data decreased by 7.3% as shown in Table 10. Also, Classroom A saw a

decrease in the number of positive responses in regards to performing better on tests while having two teachers in the classroom.

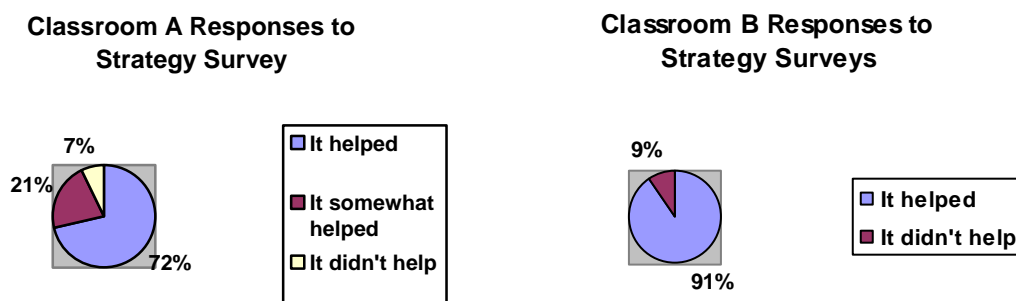
Another area where difference within classrooms was shown was in the average classroom test scores. Classroom A experienced an increase of 5.03%, whereas Classroom B experienced a decrease of 3.3%. Interestingly, this does not correlate with the student responses from the Collaborative Teaching Survey concerning collaborate teaching. Even though there was an increase in the average test scores in Classroom A, fewer students felt they performed better on tests due to having two teachers in their classroom. In Classroom B, after the interventions, more students felt they performed better on tests, even while their average test scores were lower after the interventions.

Another interesting finding was concerning the students' feelings of having two teachers to better learn mathematics concepts. As shown in Table 11, both classes felt that by having two teachers their mathematics learning improved. This data supports the increase in the average test scores in Classroom A, but contradicts the actual data for Classroom B. In Classroom B, the students felt that by having two teachers helped improve their test scores, but in actuality their scores decreased.

In addition to the discrepancies in the test scores and student perceptions, there were also inconsistencies amongst average homework scores. The intervention that aimed to increase homework completion was the awarding of a free homework pass to students who completed five consecutive homework assignments. Within both classrooms, the average homework completion percentage decreased (see Table 9). However, the students, in the Collaborative Teaching Survey, expressed their thinking that having two teachers helped them to complete more homework assignments (see Table 13).

In an effort to improve mathematical knowledge, test scores, and homework completion, the teacher researchers created and implemented lessons based on Gardner's multiple intelligences that were most prominent in the classrooms. Those prominent intelligences that were in Classrooms A and B were visual/spatial and bodily/kinesthetic. After each lesson, the students were given the Strategy Survey to collect their thoughts and feelings as to whether they thought the lesson improved their understanding of the content at hand. The results were grouped into three different categories: It helped, It somewhat helped, It didn't help. The results are shown in Table 14.

*Table 14: Explain in complete sentences how you felt the activity done in class today did or did not help you to better understand the mathematics concept we have been studying.*



In both classrooms, the majority of the students felt that the multiple intelligence lessons helped with their understanding of the mathematical concepts.

After reviewing and analyzing the data results, the teacher researchers recommend that there be further study of the use of incentives to increase homework completion as their students did not increase completion of their homework assignments after they gave incentives. The teacher researchers believe that this strategy either needs to be modified or eliminated. For example, a possible modification of this intervention would be to award the students with a free homework pass for every five cumulative

homework assignments completed, instead of every five consecutive. The teacher researchers felt perhaps their students felt discouraged after completing only five consecutive homework assignments as opposed to having longer opportunities to succeed.

On the other hand, the teacher researchers feel that the group work and using multiple intelligence-based lessons helped their students improve their understand and retain mathematical content knowledge. The teacher researchers recommend adding multiple intelligence lessons more frequently in mathematics classes. They also feel that their students need to be transitioned into different teaching methods as the students are accustomed to lectures and taking notes when introduced to new lessons. Possibly, they were uncomfortable with the new approaches. Although the students said they felt that the multiple intelligence lessons were beneficial to them, as indicated in the strategy surveys, the teacher researchers felt that the average test score data did not reflect any benefits from the MI lessons. Again, if more multiple intelligence lessons were implemented, perhaps their average test scores would have been higher.

Overall, the teacher researchers felt that with modifications to this research project, student learning within the mathematical content area would increase. In addition to the modifications above, if the time of the study were lengthened, the results could be more complete and thorough.

### Reflection

As we complete this research project, we decided to pull together as a group and reflect together; since we have been communicating together throughout this process and

share the same opinions on the results. Being together at the same site and all being in a collaborative setting was helpful and made the process go more smoothly. We saw each other on a daily basis and were able to discuss what we were doing in our classrooms; therefore, we were more motivated throughout the development of our research project. Even though we were advised not to work with friends, we felt it comforting to be able to express our thoughts, feelings, and frustrations freely with each other.

Although it was convenient to be in the same school, it would have been more beneficial to be teaching the same content. The two teachers that taught in Classroom A taught Algebra 1-2 and the other teacher that taught in Classroom B taught Geometry. We felt this to be challenging due to the fact that we were using the same interventions and strategies for each of our classes, yet it was difficult to determine the effectiveness of these interventions because the content was different. If the research project was repeated by other individuals we would be curious to see if the data would result differently having the same exact content throughout the classes.

We feel there could have been many other factors that influenced the students during this research process. In mathematics, having a solid foundation is very important and each lesson is a building block for the next lesson. If the foundation is not concrete and mastered, students will struggle on a daily basis in their mathematics class. We feel that today, students do not have specific prerequisites met before they enter into our classroom. We are constantly spending more time reviewing the basics than concentrating on the new content at hand. We think this has hindered our results because as content is increasing in difficulty, students are still struggling with basic mathematical knowledge.



Motivation also has a considerable effect on our students' performance. From the years of service within this high school, we have noticed that within our school as a whole, students are facing many challenges including single family homes, gangs, pregnancy, low socio-economic status and the overall failing economy. For the majority of the families facing these challenges, their children's education is not their main priority. Most of our students come to school and work an after school job to help support their family, and therefore do not have the extra time to be working on homework assignments. When in class, it seems that students are not attentive and have other issues that are occupying their thoughts. At this time it seems that the motivation to do well in school is not apparent or important.

We feel that we were able to do this research project more effectively because we were in a collaborative setting. Having two teachers in each classroom aided the lessons, the group work, and the collection of data. We would be interested to see if this research project would be feasible if implemented in a non-collaborative setting.

Through this research project we have learned a great deal about each other and ourselves. We have learned that even though we have all been teaching for years, in a sense we are still novice teachers. We believe that as teachers we are life long learners ourselves, and that there is always new strategies to use in our classrooms. However, those new strategies can not be blindly brought into our classrooms without carefully reviewing the process and the data that supports its effectiveness. In order to be effective teachers we need to be able to adapt to our students and find new ways to reach them year after year. While doing this research we realized that there is isn't necessarily a right or wrong technique that can be applied to all of our students and that it is a trial and error

process. With these realizations we do feel that we have grown as teachers and are better prepared to effectively teach our population of students.

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## APPENDICES

## APPENDIX A

PRE

CODE NAME \_\_\_\_\_  
DATE \_\_\_\_\_***Collaborative Teaching Survey****Directions: Please check the appropriate box for each question.*

	<b>YES</b>	<b>NO</b>
1. Do you feel that you are getting more help by having two teachers?		
2. Do you feel that having two teachers has helped you learn the mathematics concepts better?		
3. Do you feel that having two teachers has helped you to perform better on tests?		
4. Do you feel that having two teachers has helped you to complete more homework assignments?		

Comments:

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POST

CODE NAME \_\_\_\_\_  
DATE \_\_\_\_\_***Collaborative Teaching Survey****Directions: Please check the appropriate box for each question.*

	<b>YES</b>	<b>NO</b>
1. Do you feel that you are getting more help by having two teachers?		
2. Do you feel that having two teachers has helped you learn the mathematics concepts better?		
3. Do you feel that having two teachers has helped you to perform better on tests?		
4. Do you feel that having two teachers has helped you to complete more homework assignments?		

Comments:

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## APPENDIX B

CODE NAME \_\_\_\_\_

DATE \_\_\_\_\_

***Strategy Survey***

*Explain in complete sentences how you felt the activity done in class today did or did not help you to better understand the mathematics concept we have been studying.*

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## APPENDIX C

### **Multiple Intelligence Online Survey**

[http://www.bgfl.org/bgfl/custom/resources\\_ftp/client\\_ftp/ks3/ict/multiple\\_int/questions/questions.cfm](http://www.bgfl.org/bgfl/custom/resources_ftp/client_ftp/ks3/ict/multiple_int/questions/questions.cfm)

This survey will be given to the students as a means to determine their method of learning through the use of multiple intelligences. The teacher researchers will only be using this as information to help better group students in activities and guide their lesson planning process.

## APPENDIX D

**Multiple Intelligence Lesson #1*****Mathematics Instructional Planning Guide for Algebra 1-2***Chapter: Chapter 5 – Analyzing Linear EquationsTopic/lesson: Section 5.6 (*Parallel and Perpendicular Lines*)**PART ONE: GOALS AND OBJECTIVES**

Objectives –

- To see the relationship between the slopes of parallel lines and perpendicular lines.

State – (8.D.3a)

- Formulate and solve linear and quadratic equations and linear inequalities algebraically and investigate nonlinear inequalities using graphs, tables, calculators and computers.

National –

- Problem Solving: apply and adapt a variety of appropriate strategies to solve problems
- Communication: communicate their mathematical thinking coherently and clearly to peers, teachers, and others
- Representation: create and use representations to organize, record, and communicate mathematical ideas

**PRE-REQUISITE KNOWLEDGE:**

Know how to find the slopes of lines that are in slope-intercept form and be able to write equations in slope-intercept form when given the slope and a point that passes through the line.

**PART TWO: TEACHING MODEL****Opening Activity/Beginning of class –**

- Bell Ringer – questions that go over the previous day’s lesson
- Go over questions from homework.

**Developmental Activity –**

- Students will be divided into groups of 3.
- Each group will be given an answer sheet (see Appendix D.1)

## APPENDIX D (cont.)

- Two sets of six different cards were created; one set had a purple background while the other had an orange background (see Appendix D.2). There were two lines graphed on a coordinate plane on each card. The purple cards had two parallel lines (one blue line and a red line) and the orange cards are two perpendicular lines (also one blue and the other red).
- Each group received one card (first start with the purple set of cards, then move to the orange once all the purple cards had been analyzed). Their assignment is to visually determine the slope of each line and write it on their answer sheet. After sufficient amount of time, each group passed their card to the next group. Again, each group needs to determine the slope of each line.
- After all cards have been evaluated (purple and orange), each groups needs to analyze and generalize their findings.
- Each group will report their findings to the whole class.
- Teacher will go over the relationship between the slopes of parallel lines and perpendicular lines.
- Teacher will go over examples that will be on their homework.

**Closing Activity -**

If time left over, have students start working on their homework.

## APPENDIX D.1

**Parallel and Perpendicular Lines Card Activity Worksheet***Purple Cards***Find the slope for each line:**

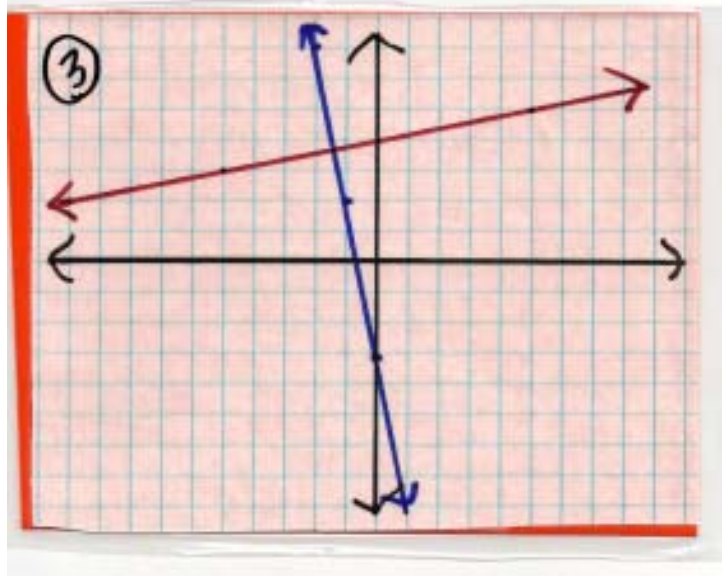
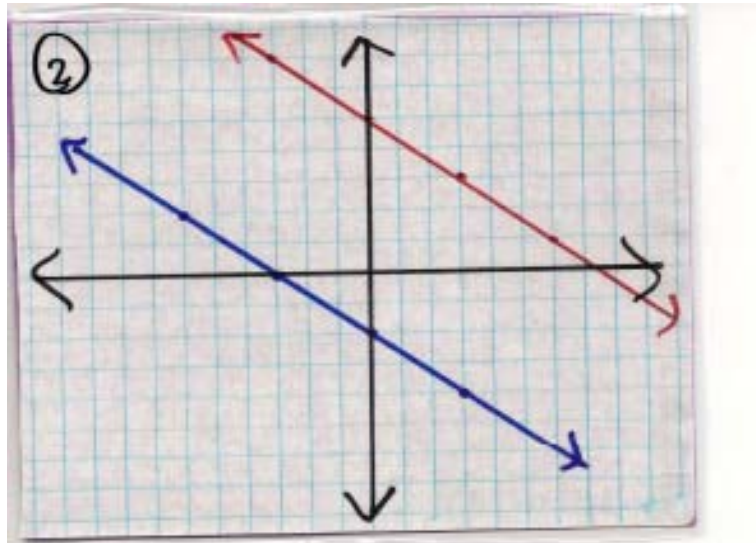
- 1) Blue \_\_\_\_\_ Red \_\_\_\_\_
- 2) Blue \_\_\_\_\_ Red \_\_\_\_\_
- 3) Blue \_\_\_\_\_ Red \_\_\_\_\_
- 4) Blue \_\_\_\_\_ Red \_\_\_\_\_
- 5) Blue \_\_\_\_\_ Red \_\_\_\_\_
- 6) Blue \_\_\_\_\_ Red \_\_\_\_\_
- 7) Blue \_\_\_\_\_ Red \_\_\_\_\_
- 8) Blue \_\_\_\_\_ Red \_\_\_\_\_

*Orange Cards***Find the slope for each line:**

- 1) Blue \_\_\_\_\_ Red \_\_\_\_\_
- 2) Blue \_\_\_\_\_ Red \_\_\_\_\_
- 3) Blue \_\_\_\_\_ Red \_\_\_\_\_
- 4) Blue \_\_\_\_\_ Red \_\_\_\_\_
- 5) Blue \_\_\_\_\_ Red \_\_\_\_\_
- 6) Blue \_\_\_\_\_ Red \_\_\_\_\_
- 7) Blue \_\_\_\_\_ Red \_\_\_\_\_
- 8) Blue \_\_\_\_\_ Red \_\_\_\_\_

## APPENDIX D.2

## Examples of Parallel and Perpendicular Lines Cards



## APPENDIX E

**Multiple Intelligence Lesson #2*****Mathematics Instructional Planning Guide for Algebra 1-2***

Chapter: Chapter 5- Analyzing Linear Equations

Topic/lesson: Covering Sections 5-7 (Line of Best Fit and Data Analysis)

**PART ONE: GOALS AND OBJECTIVES**

Objectives –

- By the end of this lesson students should be able to:
  - Find the equation of the line of best fit.
  - Find the equation of a line given two points or a point and the slope information.
  - Predict using a mathematical model.

State Goal – (8.B.4a)

- Represent algebraic concepts with physical materials, words, diagrams, tables, graphs, equations, and inequalities and use appropriate technology.

State Goal – (10.A.4a)

- Represent and organize by creating lists, charts, tables, frequency distributions, graphs, scatter plots and box plots.

National Goals -

- Problem Solving: apply and adapt a variety of appropriate strategies to solve problems
- Communication: communicate their mathematical thinking coherently and clearly to peers, teachers, and others
- Representation: create and use representations to organize, record, and communicate mathematical ideas

**Pre-requisite knowledge:**

Students need to know how to how to calculate slope, plot coordinates on a coordinate plane, and plug in an x value to get a linear equation.

## APPENDIX E (cont.)

**PART TWO: TEACHING MODEL****Opening Activity/Beginning of class –**

- Bell ringer- review of concepts learned the day before.
- Go over questions from homework.

**Developmental Activity –**

- Explain to the whole class the activity that is going to take place (see Appendix E.1)
- Three students will first make “The Wave” by standing and sitting down in their seats.
- When the wave is happening a student will be keeping a record of how long it takes for students to complete this with a stopwatch.
- The same process is repeated for 6, 9 and 12 students.
- Then students will record their data in a data table.
- After the previous steps were completed students then had to graph and analyze the data.
- The information they had to find was:
  - The slope given two points
  - Students had to use the slope and a point from their data table to find an equation for the line of fit.
- When the students were completed with analyzing and graphing the data, they had to predict the time it would take for 20 people to do “The Wave,” using their equation.

**CLOSING ACTIVITY:**

Students will reflect with each and discuss their findings.



APPENDIX E.1  
The Wave Activity



\_\_\_\_\_  
**Name**

**Math Objectives:**

- Finding the equation of the line of best fit.
- Finding the equation of a line given two points or point and slope information
- Predicting using a mathematical model.

**Materials:**

- About 12 people
- Stopwatch or (watch with second hand)
- Graph paper

Have you ever seen the **WAVE** done by sports fans? In this activity we will let "x" represent the number of students doing the wave. The elapsed time to do the wave will be represented by "y" measured in seconds.

**Now the action of the activity:**

Have three students sit in a row at desks.

- The first student says "**Go**" to chain react the Wave.
- The designated timer begins the stopwatch.
- The first student raises from the desk, places arms above head, then sits down.
- The second student responds by rising from the desk and completes the same action.
- The third student follows suit.
- Upon the sitting down the third student says **Stop!**
- The stopwatch keeper stops the watch and records the time to the nearest second.

Now repeat this same process for 6, 9, and 12 students. Record results in the data table.

No. Students <b>x</b>	Amount Time (seconds) <b>y</b>
3	
6	
9	
12	

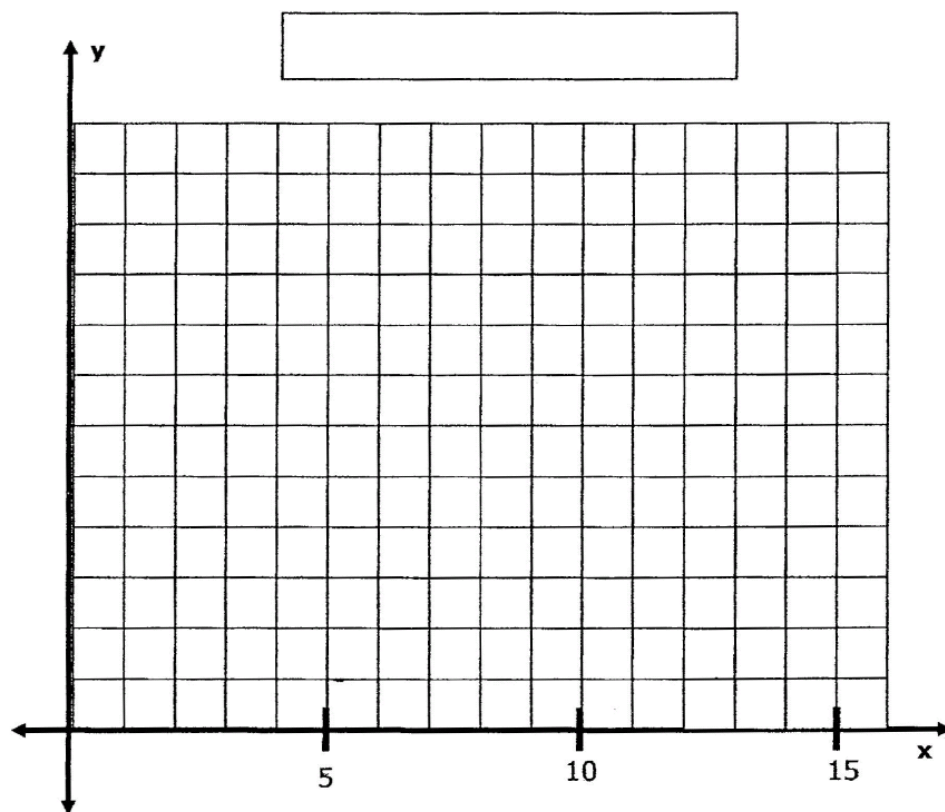
## APPENDIX E.1 (cont.)

**Preparing a Graph of the Data**

Use the data from the table found on page 1, prepare a graph of the data. Place the number of people ( $x$ ) on the horizontal axis and the time in seconds ( $y$ ) on the vertical axis.

Be sure to include these items on the graph:

- Title
- Label on Horizontal Axis (students)
- Finish the scale on the Horizontal Axis
- Label on Vertical Axis (time in seconds)
- Scale the Vertical Axis



**Draw a line of best fit through the four plotted points.**

## APPENDIX E.1 (cont.)

**Analyzing the Graphed Data:**

1. Pick any two points on the graph. Record the coordinates below.

(     ,     ) and (     ,     )

2. Find the slope of the line passing through those two points.

Use this slope formula:  $m = \frac{y_2 - y_1}{x_2 - x_1}$

*Show Work!*

$m =$  \_\_\_\_\_

3. Now use the slope **m** found above along with a point from the table to find the equation of your line of best fit. Express the time to do the wave in seconds "**y**" in terms of the number of people "**x**".

*Show Work!*

Answer:  $y =$  \_\_\_\_\_

4. Test your equation from #3 above. Predict the time it will take to do the Wave using 20 people. \_\_\_\_\_seconds
5. Now actually do the Wave with 20 people. \_\_\_\_\_seconds  
How close was your prediction? \_\_\_\_\_
-

## APPENDIX F

**Multiple Intelligence Lesson #3*****Mathematics Instructional Planning Guide for Geometry***Chapter: Chapter 5 – Relationships in TrianglesTopic/lesson: Covering Section 2 (*Inequalities and Triangles*)**PART ONE: GOALS AND OBJECTIVES**

Objectives –

- To determine if a triangle can be formed using specific measured straws.

State –

(9.B.3)

- Identify, describe, classify and compare two- and three- dimensional geometric figures and models according to their properties.

(9.B.4)

- Recognize and apply relationships within and among geometric figures.

National –

- Communication: communicate their mathematical thinking coherently and clearly to peers, teachers, and others

**PRE-REQUISITE KNOWLEDGE:**

Recall properties of triangles.

**PART TWO: TEACHING MODEL****Opening Activity/Beginning of class –**

- Check and go over questions from homework.

**Developmental Activity –**

- Explain to the whole class the activity that is going to take place (the activity is briefly explained below).
- Divide the class into groups of three to four students. Pass out the instruction sheet (see Appendix F.1) that has the steps and instructions for the activity along with a table to write down the data found for everyone in the group.
- Pass out a bag of straws and dice to all groups.

## APPENDIX F (cont.)

- Each student will have the opportunity to roll the three dice to determine what lengths of straws they must use. They will then try to use those straws to form a triangle. If the straws make a triangle they will receive a point.
- Each student gets ten turns total. At the end of all turns the student that was able to form the most triangles wins.
- Both during and at the end of the activity students will have to discuss and analyze why triangles were formed or not formed based on the lengths of straws that they had.

**CLOSING ACTIVITY:**

- Answer the questions at the end of the sheet to prepare them for the upcoming section tomorrow.

## APPENDIX F.1

## The Carousel Activity

Geometry 1-2

Name \_\_\_\_\_

Per. \_\_\_\_\_ Date \_\_\_\_\_

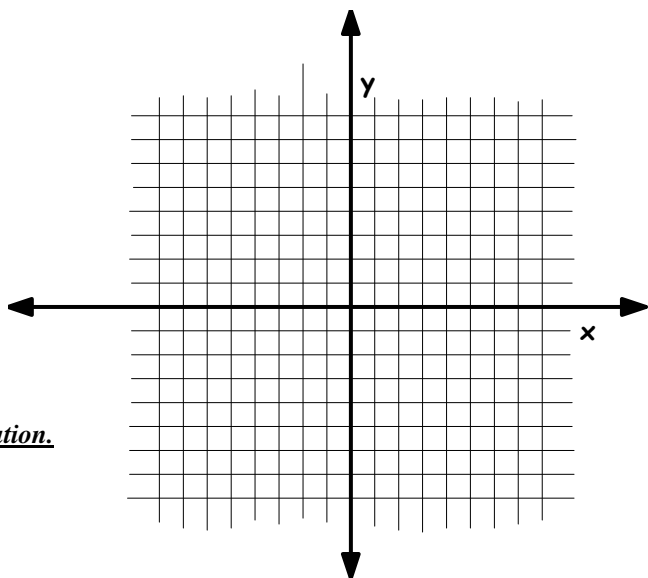
**CAROUSEL REVIEW**

Station # \_\_\_\_\_

List the ordered pairs given and graph them on the coordinate plane.

A \_\_\_\_\_ B \_\_\_\_\_

C \_\_\_\_\_ D \_\_\_\_\_



Station # \_\_\_\_\_

Find the **slope** for the following sides given the coordinates of this station.  
*You must show your work!!!*

AB = \_\_\_\_\_ BC = \_\_\_\_\_

AD = \_\_\_\_\_ CD = \_\_\_\_\_

Station # \_\_\_\_\_

Find the length of each side using the **distance formula** for the given coordinates of this station. *You must show your work!!!*

AB = \_\_\_\_\_ BC = \_\_\_\_\_

AD = \_\_\_\_\_ CD = \_\_\_\_\_

Station # \_\_\_\_\_

What is the most precise name for this figure (at this station) and why? (Explain in a complete sentence!!!)

Name \_\_\_\_\_ Why? \_\_\_\_\_

## APPENDIX G

**Multiple Intelligence Lesson #4*****Mathematics Instructional Planning Guide for Geometry***Chapter: Chapter 6 – QuadrilateralsTopic/lesson: Covering Sections 1-7 (*Properties of Quadrilaterals*)**PART ONE: GOALS AND OBJECTIVES**

Objectives –

- To determine what kind of quadrilateral is formed based on its coordinates on the coordinate plane and using other formulas to find measures of parts of the quadrilaterals.

State –

(9.B.1a)

- Identify, and describe characteristics, similarities and differences of geometric shapes.

(10.B.1c)

- Analyze data, draw conclusions and communicate the results.

National –

- Problem Solving: apply and adapt a variety of appropriate strategies to solve problems
- Communication: communicate their mathematical thinking coherently and clearly to peers, teachers, and others
- Representation: create and use representations to organize, record, and communicate mathematical ideas

**PRE-REQUISITE KNOWLEDGE:**

Recall properties of quadrilaterals, distance and midpoint formulas, and graphing points on the coordinate plane.

**PART TWO: TEACHING MODEL****Opening Activity/Beginning of class –**

- Check and go over questions from homework.

**Developmental Activity –**

▪ APPENDIX G (cont.)

- Explain to the whole class the activity that is going to take place (the activity is briefly explained below).
- Divide the class into groups of three to four students. Pass out the activity sheet (see Appendix G.1) that has the steps and instructions for the activity along with a table to write down the data found for everyone in the group.
- There are four stations set up with posters around the room. Each one has a different set of coordinates that will form a particular quadrilateral.
- Each group will have to travel to each station doing a particular step of the problem having to use information from the previous group.
- After the groups have traveled to all stations and filled in the data on their sheet, the groups must come to a conclusion as to what the quadrilateral is at the last station they are at.
- Both during and at the end of the activity, students will have to discuss and analyze the data collected and make sure that it is correct and how it can be useful for them.
- Each group will then have to present the poster for the last station they were at and discuss the findings.

**CLOSING ACTIVITY:**

Discuss with their group the similarities and differences between all the types of quadrilaterals and where they found certain formulas useful.



## APPENDIX G.1

## Triangle Inequality Game

*△ inequality*

5.

**Trying for Triangles****Materials Needed:**

- Student Groups of 3 or 4
- Soda straws cut to the following lengths: 1 in., 2 in., 3 in., 4 in., 5 in., and 6 in., three each per group of students
- Three number cubes per group of students
- One recording sheet per student

**Rules for Play:**

- Each student takes a turn rolling the three number cubes.
- The three numbers rolled indicate the three lengths of straws that must be used.
- The three straws should be arranged to form a triangle, if possible.
- If a triangle is formed, the student receives a point, which is recorded in the appropriate column. All students should record scores for the entire group.
- The three numbers rolled should also be recorded in the appropriate “Yes” or “No” column indicating whether or not those three lengths formed a triangle. Every student in the group should record each outcome.
- At the end of ten rounds, the winner is the student who has the highest score.

**Reviewing the Outcomes:**

- Can you determine whether or not a triangle is possible on a given roll before building it?
- Classify the triangles in your “Yes” columns. How many are equilateral? isosceles? scalene? Are there patterns in these groups of triangles?
- Can you fill in some of the missing triangles that were not “rolled” in your game?
- What are some conclusions we can draw?

