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ABSTRACT

This report examines the problem of a lack of motivation in secondary mathematics students. A large percentage of our students view upper level math courses as only a means to an end. They lack self motivation and are driven by either parental concerns or the desire to score well on college entrance exams. They see very little transfer from the classroom environment to their own career goals. The targeted population consists of a single site in a rural suburban setting. The students will be those who are currently enrolled in Advanced Algebra, Trigonometry, and Calculus. Analysis of the probable cause literature supported this hypothesis that students: 1) do not learn much by just being in class, 2) meaningful activities are more transferable, 3) when everything is the same in a daily structure boredom sets in, 4) secondary schools tend to offer strict methods of instruction rather than the use of exploration, 5) tend to achieve more when they are in control of their own learning, 6) active learning leads to less behavioral problems than passive learning, and 7) success is the most powerful of all motivators. After a review of the possible intervention strategies as presented by educational researchers, the goal was to measure the motivational levels of various levels of classes before, during, and after being exposed to cooperative learning. By tailoring cooperative learning lessons to real life situations, a direct correlation between motivation and active involvement of the learner could be detected. Post intervention data verified the hypothesis that students tend to learn better and enjoy their educational experiences while being exposed to cooperative learning projects as opposed to a strict diet of lecturing. Mathematics on the secondary level still requires some degree of traditional delivery, so that students properly receive the concept in a desired manner. The mastering of the technique is often best obtained in group settings where students can experiment with different methods of procedure. (Contains 18 references.) (Author)

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IMPROVING STUDENT MOTIVATION IN SECONDARY MATHEMATICS BY THE USE OF COOPERATIVE LEARNING

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This report examines the problem of a lack of motivation in secondary mathematics students. A large percentage of our students view upper level math courses as only a means to an end. They lack self motivation and are driven by either parental concerns or the desire to score well on college entrance exams. They see very little transfer from the classroom environment to their own career goals. The targeted population consists of a single site in a rural sururban setting. The students will be those who are currently enrolled in Advanced Algebra, Trigonometry, and Calculus.

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After a review of the possible intervention strategies as presented by educational researchers, the goal was to measure the motivational levels of various levels of classes before, during, and after being exposed to cooperative learning. By tailoring cooperative learning lessons to real life situations, a direct correlation between motivation and active involvement of the learner could be detected.

Post intervention data verified the hypothesis that students tend to learn better and enjoy their educational experiences while being exposed to cooperative learning project as opposed to a strict diet of lecturing. Mathematics on the secondary level still requires some degree of traditional delivery, so that students properly receive the concept in a desired manner. The mastering of the technique is often best obtained in group settings where students can experiment with different methods of procedure.

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CHAPTER 1

PROBLEM STATEMENT AND CONTEXT

General Statement of the Problem

Secondary mathematics students lack motivation, especially in the junior and senior year. This is mainly caused by a perception that there isn't any direct correlation between what is discussed in the classroom and what is used or needed in the workplace. Numerous students have met with failure or at least a limited degree of success in mathematics before entering the secondary arena. This failure is evidenced by teacher observations, student behaviors, parent-teacher conferences and low performance on both teacher-made and standardized tests.

The Immediate Setting

The unit district of which the participating school is a part consists of three elementary schools, one junior high school and one high school. The participating school is the ninth through twelfth grade educational center for the unit district. The participating school is located in a village north of a large midwest city. Students reside in the village, the surrounding rural area as well as the northwest suburbs and city itself. Approximately 50% of the students reside within the limits of the large city.

The participating school is considered medium in size and is representative of the diversity of the approximately 1900 students enrolled in the kindergarten through twelfth grade district. Enrollment as reported in the October 1996 School Report Card was 619 students. Of these students, 96% are White; 1.9% Black; 1.9% Asian/Pacific Islander, and 0.2% Hispanic. Some of the students transfer into the school when the parent is transferred from a foreign country. These students receive the service of the English as a Second Language (ESL) tutor. Students who are limited English proficient make up 1.5% of the student population.

A extremely high percentage of the families are supportive of education and the participating school with 89.9% making contact with the school at least once during the year. The parents also are active in the music boosters club and the parent club.

The attendance rate is 94% with student mobility at 5.2%. This is mostly due to parent professional transfers. Low income students make up 1.1% of the school population and the dropout rate is 0.3%. There are no Chapter 1 statistics for the participating school.

The 1995-96 graduation rate compares the number of students who enrolled in the ninth grade in the fall of 1992 with the number from that group who actually graduated in 1996. Adjustments to the rate have been made for students who transferred in and out of the school. The participating school's graduation rate is 99.3%

The participating school staff consists of the following:

Certified Staff

a. one principal
b. one assistant principal
c. thirty-nine full time teachers
d. one technology specialist
e. one psychologist (part-time)
f. one social worker (part-time)

g. two counselors

h. one library learning center coordinator

i. two part-time instructional tutors

j. three special education teachers

k. two special education aides

Non Certified Staff

a. two secretaries

b. one library learning aide

c. four custodians

d. one part time ESL aide

Of the thirty-nine staff members, 51% are male and 49% female. The entire staff is White. The average teaching experience is 13.9 years with thirteen holding a bachelor's degree; ten at bachelor's plus 15; seven at bachelor's plus 45 / master's; four at master's plus15; one at master's plus 30 and four master's degree or higher. The average teacher salary is based on full-time equivalents. The average teacher salary is $35,323.

The unit district consists of one superintendent, one assistant superintendent, one curriculum director and two and one half secretaries. The average administrator salary is $61,142 and the overall average expenditure per pupil is $4,299.

The three teachers involved in this research are in the field of mathematics and computer science.

The student base makes the school unique in the fact that most of the population comes from families that are generally well educated and supportive of education. The students are well supplied with the necessary tools both from home and school to achieve success in education. Since most are coming from a good support base and possess a lot of worldly goods, motivation is the only thing lacking in most students who are underachievers.

Community Setting

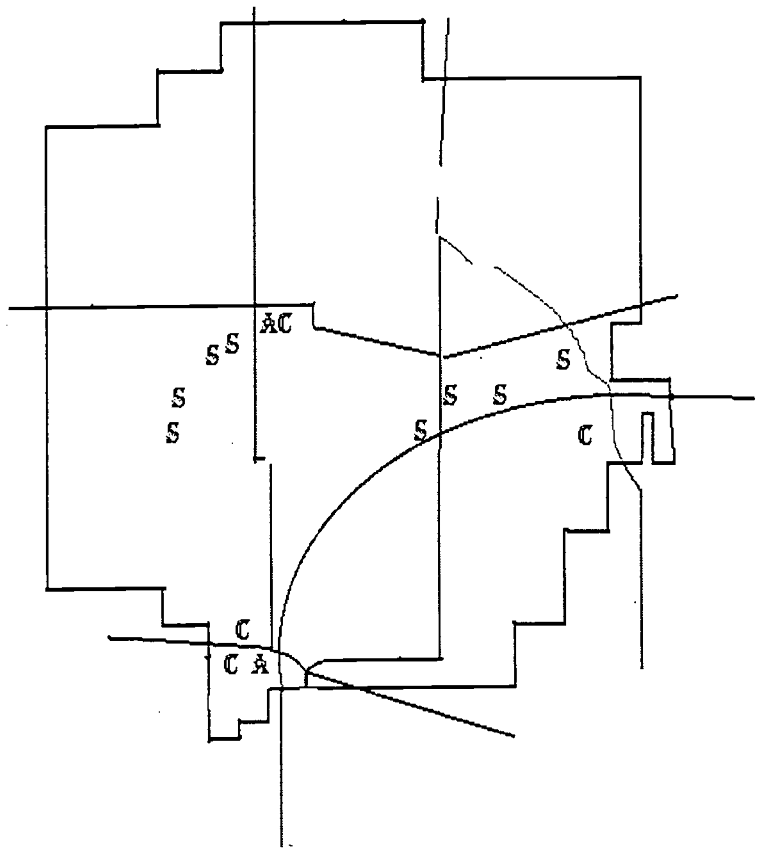
The community that the participating school serves is rural suburban with at least 50% of the students actually living within the city limits of a large Midwest city. *U.S. News and World Report* ranks the city as one of the hottest housing markets in the country. The city is ranked sixth in the country and is the only Illinois city in the top 10 and has been designated the twelfth most affordable housing market in the country by the National Association of Home Builders. This is based on their findings that the August 1995 sales price of a single-family home ($83,516) is within reach of 83% of local families earning a median income.

The economy has been generally stable even thought the area has been hard hit by local labor unrest. The school is supported by a cross section of professionals from a large international corporation, a growing medical community, and a expanding business force. New housing in the district is increasing. There have been eight new subdivisions with a total of 1,000 lots that came onto the market in the past three years. The area is also experiencing numerous commercial developments such as a large, 380 unit apartment complex assessed at $12,000,000; an $8,000,000 local shopping, dining and entertainment area; a $21,000,000 local strip mall and a proposed $ 54,000,000 regional mall anchored by three nationally known retailers. Voters passed a bond referendum in the fall of 1996 to fund a new middle school, additions to the present high school and the modernization of one elementary school. The high school expansion will consist of nine new classrooms, a new library/multimedia center equipped with access to the Internet, athletic locker room improvements, teacher and parent conference space, and improvements to the school's administration area.

The expenditures to finance our school district from the October 1996 School Report Card were :

Fund	District	Percentage
Education	$6,378,081	70.2%
Operations & Maintenance	$931,521	10.1%
Transportation	$488,695	5.4%
Bond & Interest	$1,157,940	12.7%
Rent	$0	0.0%
Municipal Ret/Soc. Security	$151,245	1.7%
Fire & Safety	$0	0.0%
Construction & Improvement	$0	0.0%
TOTAL	$9,089,482	100%

School District Boundary Site Plan



AC Attendance Center

S New Single Family Subdivisions

C New Large Scale Commercial Developments

A New Apartment Complex

National Context of the Problem

Students come to school at an early age with the best that they have; they enter the world of education excited, enthusiastic and expecting to learn numerous things. The interest in learning often begins to change early in their careers as students. Unfortunately, some of the young people are exposed to failure very quickly - either in the education system or in their personal life. Failure is a powerful incentive for them to become discouraged and unmotivated. Lack of achievement in school should be viewed as a fault of the education system, not the student. (Harris study as cited by Costa, Bellanca, and Fogarty 1992). As a result, students poor performance at school perpetuates poor performance. Therefore, any motivation to learn is lost, perhaps, even at an early age.

The problem of student lack of motivation has generated a great deal of concern at the local and national levels. This is evident by the fact that almost every segment of our society is insisting on educational reform. Even our national professional organizations such as the American Federation of Teachers, National Council of Teachers of Mathematics, National Science Teachers and the Association for Supervision and Curriculum Development are calling for major instructional reforms that utilize methods such as cooperative learning (Bellanca & Fogarty, 1991) to help motivate our students. Trying to reach students who seemed to have lost interest in learning is a frustrating and all too common experience for teachers in today's classroom.

What does the research say about children who start out with the desire to learn, the motivation to learn, a natural childlike curiosity and a zest for soaking up all information around them, only to have their motivation and excitement about education derail by the time they reach middle school? Research (including McCombs,1991) continually comes back to address the problem of lack of motivation. First, students are asked too often to learn something that does not particularly interest them. Second, students feel they have little or no control or choice about what and how they learn. Third, they lack the personal skills and abilities necessary to be successful. Finally, the external support of a family unit and or monetary support for supplies may not exist. This, for too many students, describes much of their school experience.

Many topics that a student may need to study will not have a direct impact on their life the minute that they learn the skill or information. Most information provides a background to ensure success later in their life. However, not taking responsibility for one's own learning can cause a student to lack motivation. Teachers, for the most part, rely on lectures as their presentation method of choice. This tends to reinforce a hierarchical relationship between teacher and student. Berliner and Casanova (1993, p55) stated:

> This is a relationship that the teacher holds the knowledge that the student is expected to absorb. The message to students, in this case, is that they are to be passive recipients of knowledge rather than architects of their own learning. This therefore inhibits the student's willingness to take responsibility for their own learning.

This leads to why students are not involved in taking responsibility for their own learning. Traditional classrooms expect students to work independently and to compete for good grades, teacher approval, and personal recognition. Research has long shown that when socially interacting people are placed in individual competition with each other, they discourage each other from working hard. Traditional classrooms treat high school students as young children, rarely giving them authority, responsibility or opportunities for participation. In fact, high school students want responsibility. They do not want to take a passive role in their education (Slavin 1996).

Students not given an active role in their education often feel discouraged and may pose a challenge to their teachers. They may become a discipline problem or display a sense of frustration with the entire situation. An attitude is developing that is not conducive to learning. These students become what are called discouraged learners. The reason they become discouraged is that research states that, in a typical class period, someone is talking approximately two-thirds of the time. Most of the taking is done by the teacher. Teachers spend this time giving directions, lecturing and/or criticizing students. Other research states that teachers talk three times as much as students in their classrooms. This leads to a very uninvolved, passive and unmotivated student. (Bosch and Bowers 1992).

The solutions would result in some drastic educational reform that would include ways of getting students actively involved in their learning process. The answers lie in a more constructivist approach to education, with cooperative learning being a big factor. People with little knowledge of the constructivist pedagogy would see this as a very radical and controversial way to conduct a classroom.

CHAPTER 2

PROBLEM DOCUMENTATION

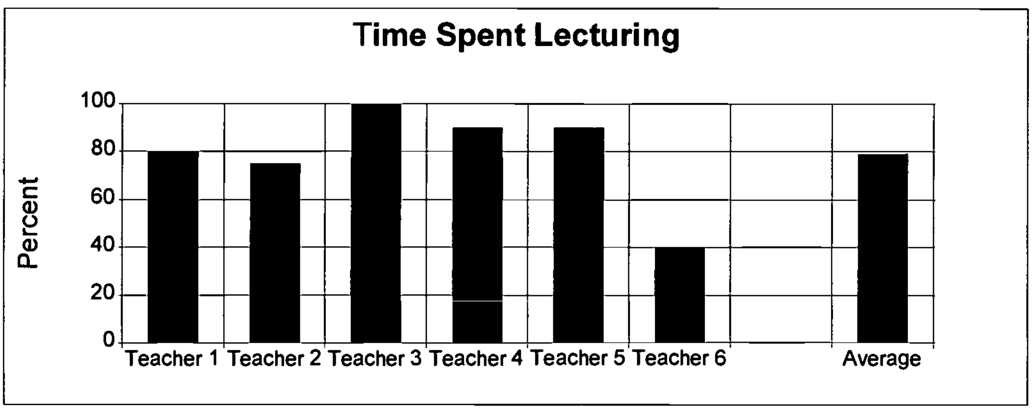
Problem Evidence

In order to establish documentation that there is a lack of motivation in the high school students who study the discipline of mathematics, we first looked at departmental anecdotal notes and interviews. From these conversations, a short list of teacher observations was compiled. Teachers were asked to reflect on the following: 1) in a nine week grading period what percentage of time is spent using the lecture approach to instruction, 2) percentage of students on a daily basis who have incomplete assignments, 3) percentage of students not working to potential, and 4) percentage of students who rarely participate in classroom discussions. The material used from the anecdotal notes formed the beginning of the baseline data. Other tools that will confirm the lack of motivation include: parent survey, student survey and teacher observations of students being instructed by use of the lecture/presentation format.

The participating school traditionally places a large number of its clientele into fields of higher education. For the past decade, approximately 80% of the students seek to further their education. In 1996, graduating seniors who enrolled in two year junior colleges were 38% and those who enrolled in four year colleges were 51%, for a total of 89%. The participating school has a high number of students who further their education. Yet, there appears to be a lack of student motivation to make the most of the mathematics instruction they receive.

The following graphs represent the compilation of teacher observations and discussions. The math department sees on the whole, 510 out of 620 students enrolled in the school. This data was collected through a Math Department Survey (Appendix A) completed during the spring semester of 1997.

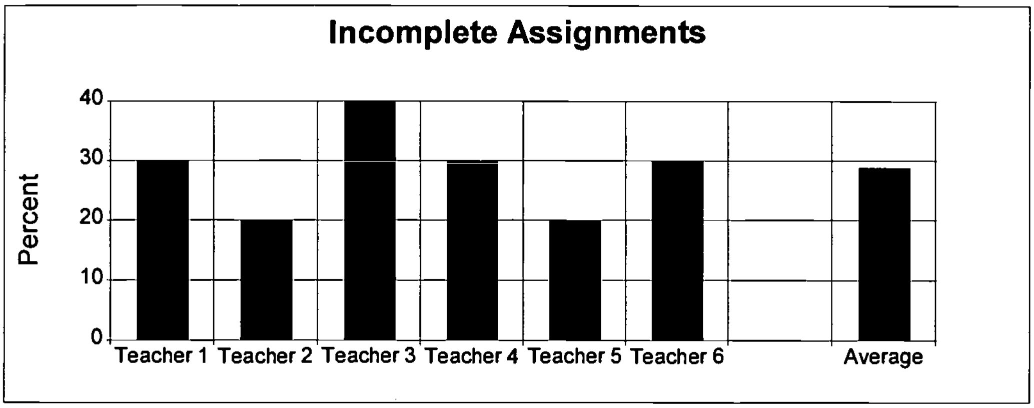
Graph 2.1



Graph 2.1 shows the percent of time each instructor spent lecturing, and then, the average lecture time for the department. In 1996, the entire mathematics staff averaged 80% of the classroom instructional time in the strict lecture phase.

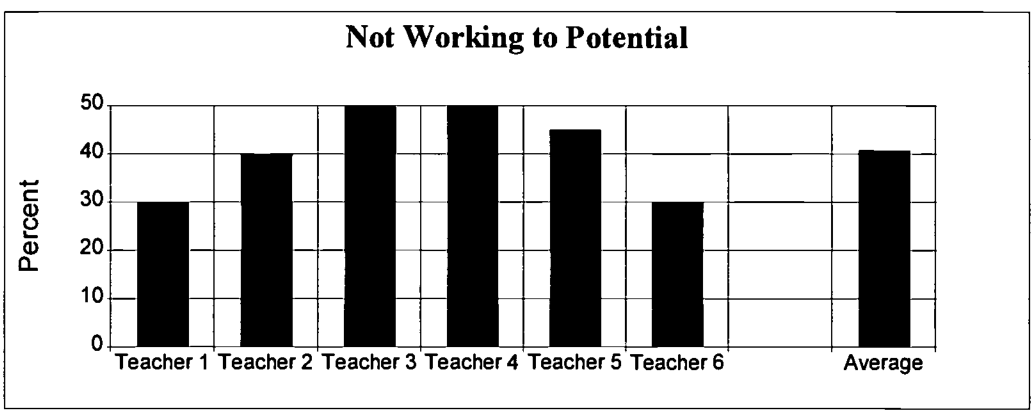
Instructor	Experience	Education	Trained in co-operative learning
Teacher 1	10 years	BS	No
Teacher 2	30 years	MS+45	Yes
Teacher 3	35 years	MS+30	No
Teacher 4	25 years	BS+15	No
Teacher 5	20 years	BS+15	No
Teacher 6	0 years	BS	Yes

Graph 2.2



Graph 2.2 shows the percent of students that either do not complete assignments, forget to bring the assignment to class or simply decide, for what ever reason, not to work on the lesson material. The instructors felt that approximately 28% of the population fell into this category. Students that are not prepared for class seldom do well.

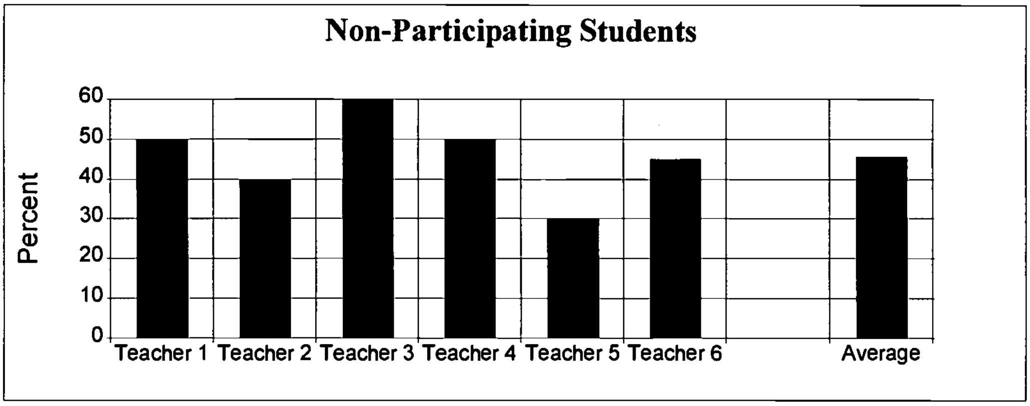
Graph 2.3



Graph 2.3 indicates that 42% of those enrolled in math classes are not working to their potential. These figures are based on the teachers recognition of ability versus grade. Teachers also compare the students' grade to Illinois Goals Assessment Program (IGAP) scores and the results of the national standardized scores. A student who may score well on a standardized test may not be working to potential in class. All students have the ability to succeed.

The teacher could then look for ways to motivate the student to increase their classroom performance.

Graph 2.4



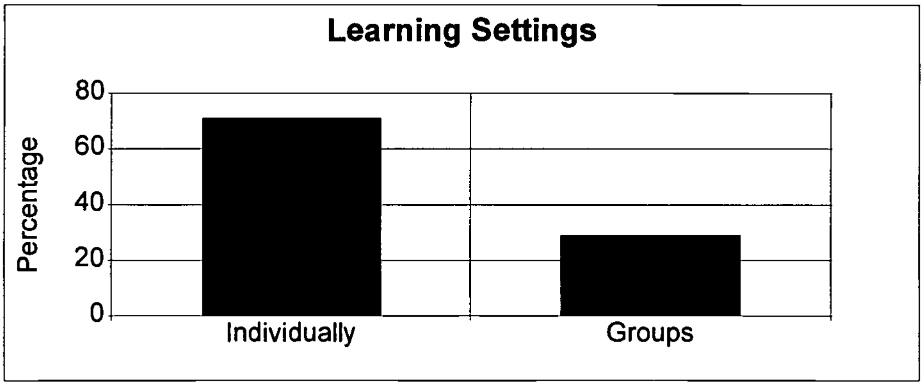
Graph 2.4 depicts the percentage of pupils that the instructors felt rarely or never participated in classroom discussion. Usually, the same individuals tend to answer the questions. The teachers felt that students were hesitant to answer both direct and indirect, or leading questions.

Probable Causes (site based)

After reviewing the information obtained from departmental members, we noted that a large percentage of time (80%) was spent in a lecture format and that very little time was spent on classroom projects, teamwork or inter-disciplinary curriculum content. This passive method of instruction could be a reason for a significant number of students to display incomplete work, to not work up to teacher and student expectations, and to not be willing to demonstrate the cooperative skills involved in team work. Are all our students unmotivated creatures that only seek a satisfactory grade? Absolutely not; however, it is quite plain that several sheep are straying from the flock.

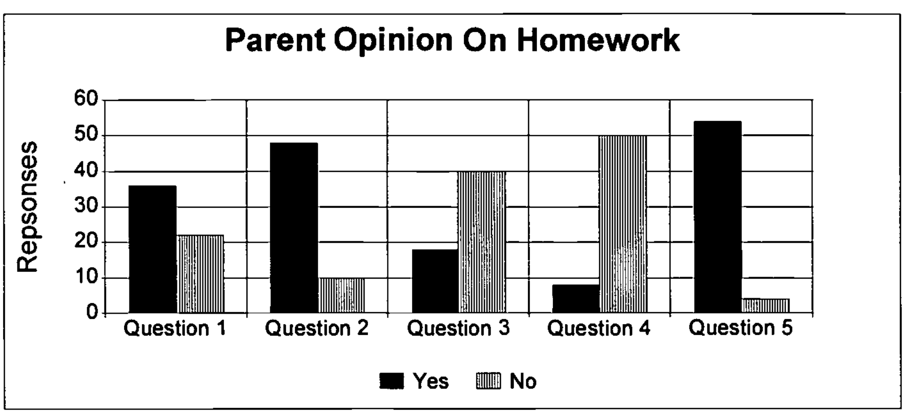
In order to support our perception and to determine baseline data, we constructed and administered three independent surveys of parents, students, and teacher classroom observations. The first four graphs were developed from our Pre-Parent Survey (Appendix B).

Graph 2.5



Graph 2.5 describes data collected on how our parents felt that their child learned better: individually or in a group setting. Out of the 58 parents surveyed, 71% felt that their child learned better individually and 29% felt that their child learned better in a group setting.

Graph 2.6



Graph 2.6 shows data collected from the parents on five different yes/no questions. The data represents the number of yes versus no responses to the following:

Question 1 - Is your child motivated to learn mathematics?

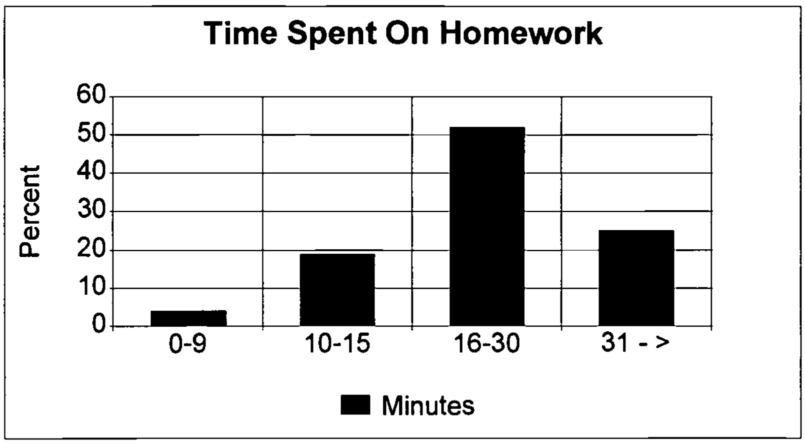
Question 2 - Does your child bring home math assignments to work on?

Question 3 - Do you feel competent in helping your child with math homework?

Question 4 - Do you have a difficult time encouraging your child to do math homework?

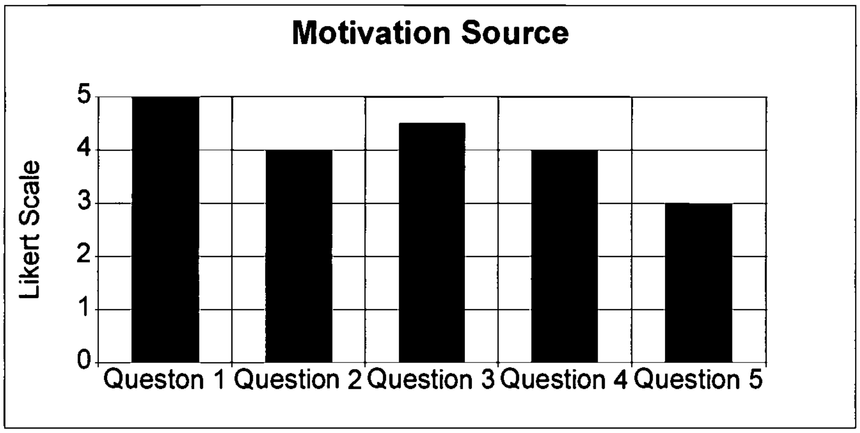
Question 5 - Do you feel math is important?

Graph 2.7



Graph 2.7 describes data collected from parents if yes was the answer to previously asked question 2 'Does your child bring home math assignments to work on?' If so, the parent responded by estimating the length of time spent daily by their student studying and completing math homework.

Graph 2.8



Graph 2.8 describes the parents' opinion of what motivates their student to be successful in math. This chart consists of five different criteria including:

Question 1 - Teaching methods

Question 2 - Parental concerns

Question 3 - Grades

Question 4 - General knowledge

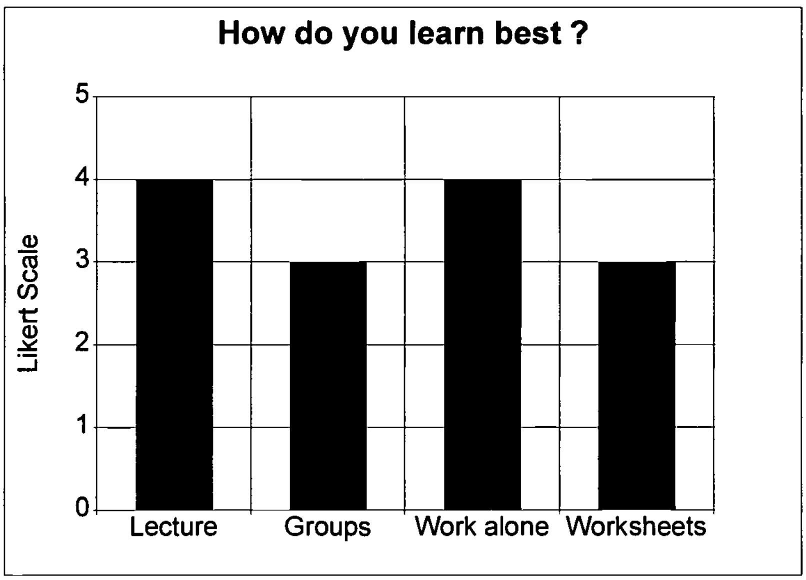
Question 5 - Rewards

These responses were measured with a Likert Scale where 1 is used to indicate that the given criteria is not a highly motivating influence for the student and 5 indicates that the given criteria is a highly motivating influence. The scores shown in this graph, as well as graphs 2.9 through 2.14, reflect the most frequently given response.

The majority of the parents believe that their student learns best in an individual, work alone, environment. This setting would foster the use of direct or traditional lecture style of instruction with individual work being done. The parents felt that a high grade point average and ACT score will help their student be accepted to the college or university of their choice. They are desirous of financial aid as a reward. Most parents believe that their student will spend, on the average, thirty minutes or more a day on math homework. They also believe that this is one of the more important subjects to master.

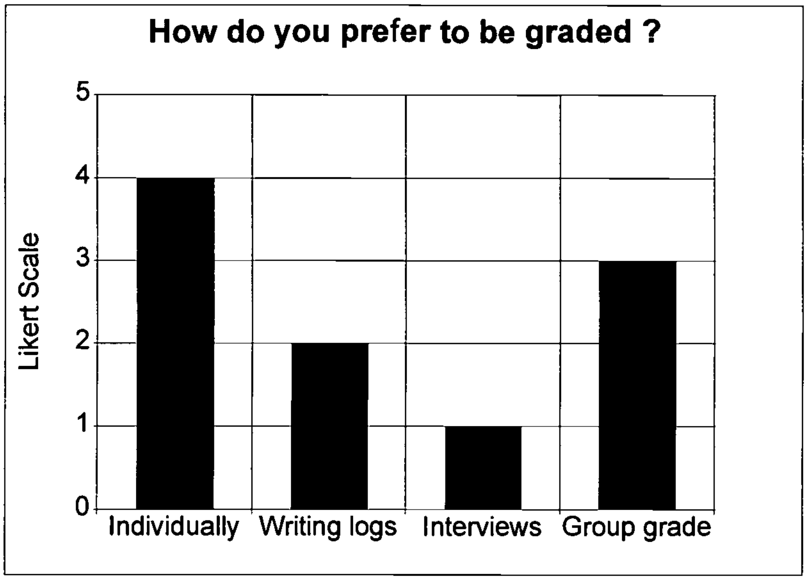
The next six graphs present the opinions and perceptions of the targeted population before any intervention took place. This material was gathered from responses to the Pre-Student Survey found in Appendix C.

Graph 2.9



Graph 2.9 indicates that most of the students prefer to learn by working alone and to receive the information through a direct lecture format. This is the teaching style to which most students have been exposed. Previous classes have been conducted using direct instructional techniques with little or no student interaction to solve problems in class.

Graph 2.10



Graph 2.10 shows that most of the math students prefer to have their grades determined by an individually assessed test. Few pupils found the process of writing journals or personal interviews to be a good method of judging comprehension. Again, until recently, most writing took place outside of the mathematics classroom.

Graph 2.11 focuses on the students perception of high school math. The targeted population gave responses to the following six items:

Question 1 - Do you feel that high school mathematics provides you with real work skills after graduation?

Question 2 - Do you feel that high school mathematics will prepare you for college?

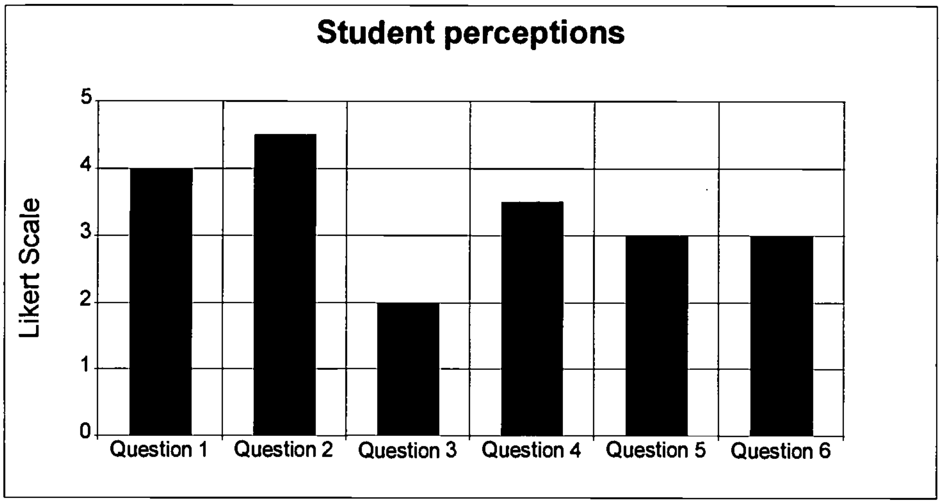
Question 3 - Do you feel that math is important just for people who are college bound?

Question 4 - Do you feel it is beneficial to learn to work with others?

Question 5 - Do you enjoy working with math?

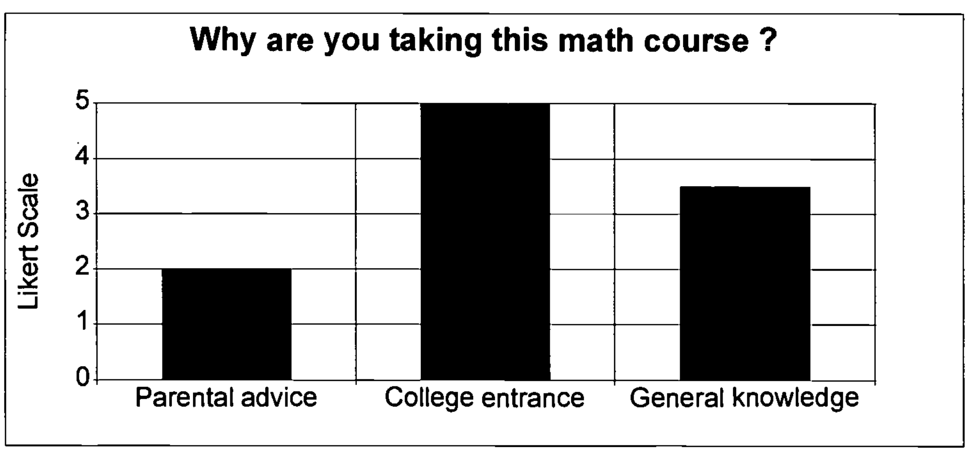
Question 6 - Do you use class time to work on math homework?

Graph 2.11



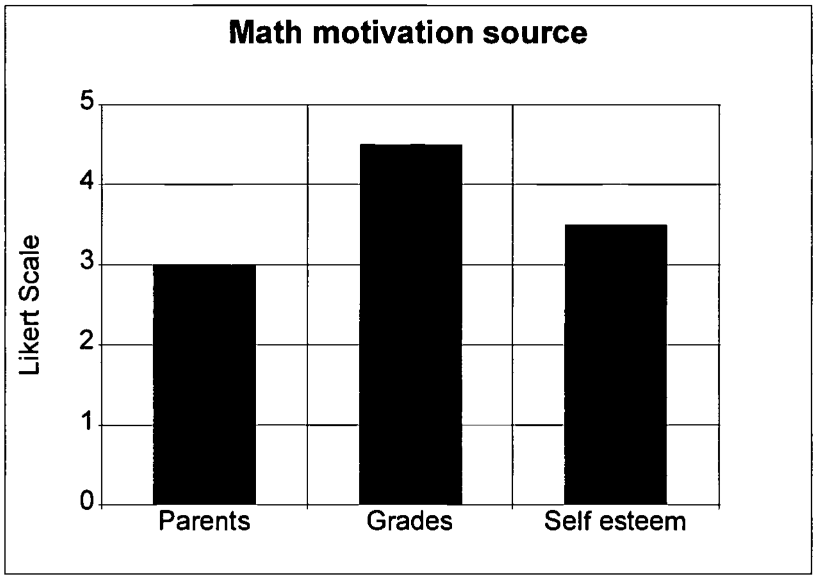
Most students felt strongly that math was important and that their math classes were good college preparation. Yet, they did not truly seem to enjoy math or display enthusiasm when asked about the subject. The topic, according to the surveyed students, seemed to be one needed only to succeed in college.

Graph 2.12



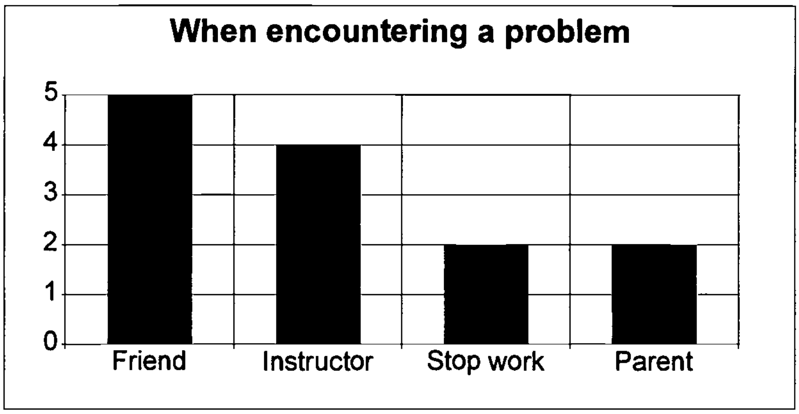
Graph 2.12 reveals that the primary reason that students at our school are taking math courses is to be prepared for the ACT, SAT, and other college entrance exams. These exams play a pivotal role in determining which college or university accepts the student and which classes they take once accepted. Scholarship money is also tied to these test scores.

Graph 2.13



Graph 2.13 shows the pressure that students are under to obtain high grades in order to get into the college of their choice. The actual grade itself seems to be the greatest motivator.

Graph 2.14

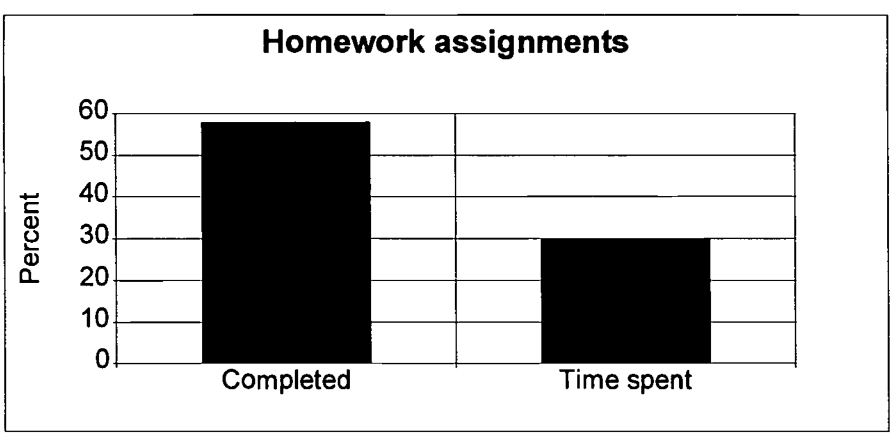


Graph 2.14 shows the average of 58 student responses to the likelihood of choosing the following sources or methods of help when encountering a problem with their homework assignment.

1. I would ask a friend for help.
2. I would seek help from the instructor.
3. I would stop working on the assignment.
4. I would ask a parent or guardian for help.

All students indicated that they felt most comfortable asking a friend for help first, and then the instructor. They were least likely to ask a parent for help.

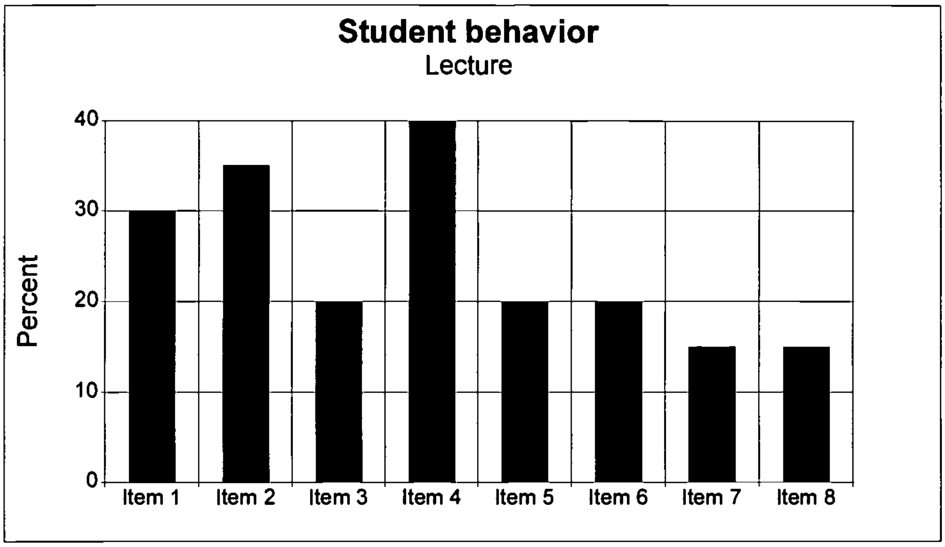
Graph 2.15



Graph 2.15 shows that 58% of the targeted population fully completes each day's homework assignment. These assignments took the students an average of 30 minutes to complete.

The third source in determining our baseline data was use of the Student Observation Checklist (Appendix D) during the first two weeks of school. These observations occurred in the traditional lecture environment in all three targeted classrooms. The instructors observed each other's class twice for a total of 112 student observations. The method of data collection was a tally system. The average class size was 24 students. The three participating teachers employed the traditional lecture style for distribution of math concepts. A typical fifty minute period was divided into three sections. First, the teacher reviewed the previous day's assignment for approximately fifteen minutes. Second, the teacher taught the next assignment by lecturing for approximately twenty minutes. Third, the teacher gave the students about fifteen minutes to start working on the homework in an individual and quiet setting. Instructors looked for and tallied the following student behaviors.

Graph 2.16



Item 1 - Percent of targeted students not paying attention during the lecture.

Item 2 - Percent of targeted students not taking notes.

Item 3 - Percent of targeted students working on other subjects.

Item 4 - Percent of targeted students who did not do math homework during seatwork time.

Item 5 - Percent of targeted students who did not bring books or materials to class.

Item 6 - Percent of targeted students who asked the instructor to leave the classroom for any reason.

Item 7 - Percent of targeted students who caused some type of discipline problem.

Item 8 - Percent of targeted students who are sleeping.

Very few students slept or caused discipline problems. The researcher found, however, that 35% did not feel the need to take notes on the material presented. Students have the tendency only to do or to bring what they deem absolutely necessary to class.

In determining the baseline position, 75% of the students surveyed and 71% of the parents surveyed feel that the best method of instruction is to have the instructor convey the material by lecturing followed by time for the students to work on the assignment in an individual setting. Both groups believe that the main source of motivation is grades, that most students spend about 30 minutes a day on homework, and that 58% of all assignments are completed. The students appear to be under heavy academic pressure to succeed. This pressure to learn mathematics leads many pupils down the mathematics road by achieving success through rote memorization of the facts. The students have little or no motivation to master the concepts.

Probable Cause - Literature Review

There appears to be a lack of motivation in secondary mathematics students because of the traditional conveyance of material through teacher lecturing and student doing individual work and drills. Students are not frequently grouped in order to experience the investigation of mathematical concepts as a team. Does there exist a correlation between advanced instructional methods that employ cooperative learning procedures based on whole life transfer and traditional - lecture style teaching methods? Chickering and Gamson (1987, p3) state:

> Learning is not a spectator sport. Students do not learn much just by sitting in class listening to teachers, memorizing prepackaged assignments, and spitting out answers. They must talk about what they are learning, write about it, relate it to past experiences, apply it to their daily lives. They must make what they learn part of themselves.

Motivation is an extremely complex issue to fully comprehend. What motivates one student may turn off the next, thus making a teacher's role as the prodder a difficult situation at best. This dilemma usually causes an instructor to rely on such techniques as grades and deadlines as their main strategy in tackling motivation. Whether one is motivated or not to dive into and fully complete an assignment is predicated upon three main items. First, does the student see any value in the lesson; second, does the student feel that he or she can succeed in accomplishing the task; and third, is there any gain associated with a completed assignment. It is very difficult for a student to see any merit in doing four pages of math problems that all focus on the same idea, when either he or she knows the method involved, or far fewer questions would serve the same purpose. In other words, don't assign busy work to keep students doing desk work. Assign them items that are meaningful and that have a good educational value. Traditional teaching techniques (explain, practice, review, test) do not fuel the mathematical fire. Predictability, and consequently, boredom drain energy and diminish motivation (math department meeting, personal communication, May 14, 1997).

Instructional strategies are effective when the task is meaningful and the task actively involves the learner (Mitchell, 1993, as cited in Teaching the Skills of the 21st Century). Granted, there are times when straight memorization and drill is a necessary evil in the mathematics classroom. A foundation both in fundamentals of the topic and in the team process must be laid in order to ensure success. A good background will help a student be comfortable with any new situation. Students will then be successful, and hopefully more interested in the content as the tasks become more meaningful. A direct connection of this correlation between relevant tasks and learner involvement is evident in the higher grades. Secondary students are looking to their future outside the classroom. They are constantly asking why a topic is relevant to them or why such processing is a necessary thing. They ask the age old question: 'Why do I need to know this?' Many view mathematics as something to be studied that is difficult and not very useful outside of the classroom (Renninger, 1992; Schiefele, et al. 1992 as cited in Teaching the Skills of the 21st Century).

Students like ownership and the ability to come up with their own solutions to a problem. Historically, students have been forced to devise solutions to problems in a prescribed manner. The student is limited by the parameters of the classroom. Today's society asks for more than rote repetition of the facts. New and innovative ideas are welcomed in the work place (B. Stortz, personal communication, June 23, 1997). Educators must instill in their students this willingness and motivation to try various solutions to a given problem.

Most teachers, after they are done lecturing, give their students the remainder of the class time to do seat work for the next day's assignment. Could students view this seat work as busywork or as work that will help them understand the concept rather than memorize the pattern? In the study by L. M. Anderson (as cited in Berliner and Casanova, 1993) many students were observed cheating with their neighbors just to finish the assignment. This would indicate that the student saw very little meaningfulness in the task. Then, teachers were observed as giving credit to these students for assignments that were not well done. The conclusion from this research was that students were doing minimal work and putting little thought into the assignment. The motivation was certainly there. This time, however, the motivation was to complete the assignment, not to learn anything from the experience.

A student is certainly a product of his own environment. The thinking skills that we educators are trying to motivate young minds with need to pertain to the student's ability to connect with their surroundings. A better understanding of our student's educational and social backgrounds can only benefit the ways that these students are instructed (Carr, 1996).

American children compete favorably overall with children of all cultures from grade one through four as reported by international testing results for 1996 as cited in Carr, 1996. However, after grade four, the results decline steadily through grade eight, and then more rapidly when the students are compared at the secondary level. Several factors such as the influence of a child's culture, the construction of a teacher's method of instruction, and the general curriculum can impact this downward trend on achievement.

The poor performance of American children in school mathematics has been the topic of national concern for at least the last decade. In international comparisons of highly industrialized nations, American children consistently perform at or near the bottom of the studies (Garden et al. as cited in Carr, 1996). There are three basic conditions that formulate the motivational levels in a child's culture. American parents are more likely to give credence to the belief that a child is born with certain abilities that allow for success in mathematics. Asian parents conclude that any child can excel in mathematics through hard and dedicated work patterns. The average American student in fifth grade spends about four hours per week on homework while fifth graders in Japan spend six hours and fifth grade Taiwanese students spend 11 hours. A continued look at the cultural differences also reveals that American parents consider themselves as being more talented and as having more innate abilities to succeed than Asians (Uttal, as cited in Carr, 1996). Third, American parents tend to rate the performance of their child at above average levels, while international testing clearly shows a lower achievement level for Americans versus Asians. Most American parents are more likely to be satisfied their child's performance in mathematics and also believe that their child has fewer problems in understanding mathematical concepts. This is surprising given the fact that

American students do not perform as well as their Asian counterparts (Uttal, as cited in Carr, 1996). This is not the case in the participating school. Here, parents are less than satisfied with below average performances of their students.

Parental expectations lead to an overall poor level of performance in grades five through twelve. This trend lowers levels of student motivation (or desire) to spend the time necessary to comprehend and master the topics in the students classroom. Too many American students view math as an extremely difficult subject and one that doesn't have much transfer to the real word in order to make the average person successful (Grows & Lembke, as cited in Carr, 1996).

It is easy to see why our students lack the proper motivation to do well in school. Daily, they sit in classes. The instructor lectures and then gives seat work to the students for the rest of the hour. Most of the lessons that students are presented are predominately text book oriented. The lessons from older texts tend to devaluate student thinking and overemphasize curriculum mastery. A review by H. Creel of a 1984 and a 1997 mathematics text reveals a difference in the emphasis and style of the book. The 1984 text is not as visually stimulating as the newer text. The color scheme is black/white and one other color used to emphasize key points. The newer text is much more colorful and includes color photographs . While the older text did have some application type problems, the new text ties these applications to careers. The book seems to do a better job of stimulating students. Also excluded from the newer text were the mainstays of mathematical calculations - the trigonometric and logarithmic tables. Technology and calculator use is introduced instead. Unfortunately, textbooks are expensive to replace and technology is initially expensive. Many teachers are still using the older books and looking for ways to interest the students.

Students are given no choices of what or how they will learn, no responsibility for their own learning and primarily do all work on an individual basis. Many sit alone for portions of almost every day completing workbook and ditto sheets. Consequently, the construction of new knowledge is not as highly valued as the ability to demonstrate mastery of conventionally accepted understandings (Brooks and Brooks, 1993). A traditional classroom environment does not necessarily support the motivation of our students. The controversy does not lie in the fact that both the educational and business communities recognize the problem, but in the varying opinions surrounding the solutions to the problem.

Several probable causes have been suggested and discussed as to why there is low motivation of secondary students in the mathematics classroom. These include:

1. Stagnant or traditional teaching techniques and strategies.
2. Students see little or no relevance to the topics presented in the mathematics classroom.
3. Students are afraid of failure; 'Failure makes cowards'.
4. Tasks are not meaningful.
5. Parent expectations may be too high or low.
6. Student perceptions of their math ability is too high or low.
7. There is a lack of ownership or control of the math learning process.

CHAPTER 3

THE SOLUTION STRATEGY

Review of Literature

We have already discussed how the traditional classroom environment does not support motivation of our students. The solutions would result in some drastic educational reform that would include ways of getting students actively involved in their learning process. The answers lie in a more constructivist approach to education. People with little knowledge of the constructivist's pedagogy would see this as a very radical and controversial way to conduct a classroom. As will be shown, there is much research that supports a constructivist approach to education to help solve the problem of motivation in the math classroom.

Research reported by Deci, Vallerand, Pelletier and Ryan in 1991 (as cited in McCombs) indicates that when teachers are non-controlling and non-pressuring, students are more likely to regulate their own learning, have higher intrinsic motivation, and feelings of competence and self worth. Students should be encouraged to make choices, share thoughts and feelings and take the initiative in learning activities. Such classrooms give the students a feeling of belonging. When young people feel an atmosphere of comfort and security, they are more likely to be motivated to learn. Other benefits of such an user friendly classroom include better academic performance, self-regulation of learning, increased self-esteem, awareness of the feelings of others and an overall enjoyment of school.

There seems to be many proposed solutions to the problem of a lack of motivation in secondary level mathematics students. Generally, the older the student, the less motivated they seem to be - especially in their junior and senior years. Overall, the research reviewed states that much of the motivation problem stems from the fact that students feel helpless when they have no control or responsibility for their own learning. To correct this problem, there are a variety of cooperative learning methods that can be used. Putting students together in groups and giving them control over their own learning helps motivate those students.

A study by McCabe and Rhoades (as cited in Costa, A. et al.,1992) found that, when students become responsible learners, they become more enthusiastic learners, their learning and retention increases and both students and teachers enjoy school - actually have fun! Students cannot become responsible learners by sitting in class every day and listening to teachers lecture. As the traditional classroom format is followed, the student returns, verbatim, the same material on assignments, quizzes and tests. At times, the student is memorizing for the grade rather than working to actually learn the material. There is a difference. If material is truly learned, the student will be able to recognize its use in ways other than the problems heretofore presented. Therefore, students must immerse themselves in the learning experience. They must talk about what they are learning, write about the topic, relate it to past experiences and apply it to their daily lives.

Students must be made to understand that in the end, they are ultimately responsible for their own learning. This will be best accomplished within a learning environment that includes student to student interactions (Brooks & Brooks,1993).

Besides giving students responsibility for their own learning, it is also imperative to give them some choices and some control over what they learn.

Providing students with a sense of control and choice over their learning enhances intrinsic motivation (Deci,1992). When students are given more choices in what goes on in class, research also reports that there is more interest in the course content, more value in the subject area and most importantly, more focus on learning for mastery rather that just for grades. This would lead to the belief that ability, not effort, is the source of success in school (Borlowski, 1990).

There is much research (Blumenfeld, et al., as cited in Berliner and Casanova, 1993) that supports the notion that learning is a social process and the best opportunities for learning occur during social interaction. When students are put in groups and given a task to complete, there is brainstorming and an exchanging of ideas taking place. Here, the students are talking about the subject and writing about the subject. As long as the task given to the group is novel, authentic and challenging, the student's curiosity and interest is piqued. This leads to a more motivated student.

Teachers can help motivate students in the cooperative process by doing team building activities. These activities get the individual ready to work in a group situation. One of the goals of the process is to get to know each other (perhaps like each other more). Research by Slavin (1996) says that the effects of cooperative learning on motivation are strongly mediated by the cohesiveness of the group. This means that students will want to help each other learn because they have learned to care about each other and want each other to succeed. As the students become more dependent on each other, they are more willing to help and encourage each other.

The interaction among students in a cooperative learning project will lend itself to improved student achievement. Students need to be given the opportunity to discuss, argue, present, and hear one another' viewpoints. This is a critical element of cooperative learning. Achieving students are motivated students. Through the mutual feedback and debate process, peers also motivate one another to abandon misconceptions and search for better solutions.

Varying the classroom procedure, such as using cooperative learning projects, will change a student's perception of learning. The student can get caught up in the activity and their attention is directed towards accomplishing the group goal. Learning can be interesting and fun!! A student may not even be consciously aware of being self-motivated or as having the self discipline to handle the situation presented in class. In many ways, the student is immersed in the activity because he or she enjoys what is going on. In this state, the process of learning is intrinsically motivating and motivation to learn is enhanced. The student has taken ownership.

When students value doing well as a group and the group can be successful only by ensuring that all group members have learned the material, then the group members are motivated to teach each other. This is an excellent way for students of all ages to learn. The potential benefit of group work also enhances advanced mathematical thinking.(Good,1990). Students who verbalize and interact with their peers become more adept at discovering more difficult concepts.

Cooperative interventions need to be used to create situations in which the only way group members can attain their own personal goals is if the group (as a whole) is successful. Therefore, for students to meet their personal goals, they need to help each other to do whatever helps the group to succeed. The cavalier attitude 'one for all and all for one' motivates everyone in the group to brainstorm, to help each other, to exert maximum effort, and to reach their common goal of solving the task presented.

According to the National Council of Teachers of Mathematics, learning mathematics has a social dimension that requires students to share, question, challenge and explore mathematics in groups (Carr, 1996). Cooperative learning teaches interactive social skills and provides peer bonding in the classroom. As students increase their capabilities to relate constructively with their peers, academic achievement and self-esteem improves. The more students work cooperatively with others, the more they see themselves as worthwhile and as having value. They also demonstrate greater productivity, greater acceptance and support of others, and greater autonomy and independence. They like school more (study by Johnson, as cited in Costa, A. et al., 1992).

Cooperative learning can be used as a vehicle to help motivate students to reach their full potential. Teachers have also found that cooperative learning is a great vehicle to introduce and refine social skills. Research by Lloyd, 1995, tells us that recent changes in business and industrial organizations have led to the encouragement of team work and cooperative, rather than individual achievement. Collaboration and project teams are taking the place of hierarchical chain of command structure. People who can work well in groups will have the edge as this trend continues. In a survey of 150 executives from the nation's largest companies, 57 percent agreed that team skills are most important to career success.

With this in mind, students can see the relevance of the cooperative experience not only in learning mathematics, but also in learning the life skills they will need in the work place. This will help motivate the student as he or she does cooperative learning projects. Right now, students have the perception that there is no direct correlation between what is discussed in the classroom and what will be needed later in life. New texts, teaching methods and career awareness that comes as the student prepare for post-secondary life will help them to see further, a classroom to career connection.

Conversely, there are researchers who see loop holes in the cooperative learning experience. Some feel that putting students in groups allows students to engage in off-task activities. If a group lacks individual accountability, one or two students in the group may do all of the work for the group, while the others engage in "social loafing". (Latane, William & Harkins, as cited in Slavin, 1996). If a teacher spends too much time with one or two groups, the others could become off task. Additionally, there is also concern that students in successful groups could learn more than students in groups whose members do not work for the good of the group. Teachers were spending too much class time reminding the students of their roles and trying to keep all groups on task. In this type of situation, the teacher was observed as more of a disciplinarian than as a facilitator. A good foundation in the art of group work or teamwork is essential for success.

Some educators and others may argue that the high achievers in the group can be held back on their learning. The high achiever was observed doing most of the work and spending too much time explaining the material to the lower achieving group members. Therefore, no one in the group was benefiting from the assignment (Slavin, 1996).

Some educators, such as Marianne M. Jennings of Arizona State University, proclaim that, by using newfangled and untested theories, we are not truly instructing students in the fundamental concepts, but rather producing mathematical nitwits. This belief is substantiated in the 1996 Third International Mathematics and Science Study that ranked the United States 28th out of 41 nations surveyed. Students in this situation may find that being able to explain a topic to their peers could actually reinforce their understanding of the material and give them self confidence. Even though the high achiever may find it hard to do, they could also make sure that every adheres to the assigned role. The high achiever could in essence, become a guide on the side.

Jennings feels that the problem is three fold. She states that current textbooks are more concerned about conceptual understanding of math rather than problems and practice. In order for a musician to achieve a good skill level, he must practice countless hours - doing and redoing. The same can be said of sports teams and numerous other activities that are based on performance outcomes. Secondly, she states that co-operative learning only forces students to teach themselves concepts that none have ever seen.. Her third point includes a statement from former chairman of the National Endowment for the humanities Lynne V. Cheney. He states " that some in the math community have proposed a scoring system for a national math exam under which students could get full credit for wrong answers if accompanied by appropriate strategies".

The role of the teacher is critical during a lesson done cooperatively. Teachers were observed using the lesson time to grade papers and catch up on schoolwork. Without a teacher facilitator, the lesson presented as a group exercise becomes one that students tend to complete individually (Good, 1990).

Cooperative learning also presents a time issue. During the course of a regular school year, teachers are expected to cover a certain amount of material. If a great deal of time is spent on cooperative learning projects, the required curriculum may not be covered thoroughly. Depending on the discipline or the content area, there may not be much cooperative learning material available for the teacher to use in order to cover the curriculum adequately.

Teacher education on the 'hows' of cooperative learning is lacking. This, in the writers' opinion, is where major problems lie. There is not enough professional development to educate teachers in the proper use of cooperative learning. Many teachers are now experimenting with the process of cooperative groups. They are getting caught up in the current educational trend. The problem lies in the fact that most teachers don't have the knowledge or experience to make cooperative learning a meaningful lesson for their students.

True cooperative learning experiences differ greatly from 'group work'. If cooperative learning is done correctly, as inserviced teachers have learned, most of the problems that researchers have presented would disappear. Teachers would be assured of getting the desired results if they follow guidelines of true cooperative learning tasks. These guidelines include:

1. Develop a clear, concise, group goal.
2. Make everyone in the group responsible for each other.
3. Make sure there is a positive interdependence.
4. Have a method to check individual accountability.
5. Teach and reinforce social skills.
6. Be a facilitator over the experience.
7. Assign everyone in the group a role.
8. Upon completion, ensure transfer of some type occurs.

In any sporting event, one person's success helps the entire team to succeed. In the academic classroom, one person's success makes success for others more difficult. Therefore, the difference between sports and academics is primarily in the interpersonal consequences of success. The classroom should be organized and maintained more like a team. Through the use of cooperative learning, the success of one person in the group will help the group succeed in its goals.

After considering both the positive and negative aspects of cooperative learning, we feel that this type of instruction will definitely benefit our students and motivate them to achieve to their full potential. As will be described in our action plan and in the accompanying appendices, several types of cooperative learning lessons will be used. These include jigsaw, expert jigsaw, shared pairs and will also include a social skill review. Students will be provided with the opportunity to reflect on the experience by using a journal or other reflective questions.

Action Plan For The Intervention

This action plan is presented in outline form for each week of the intervention. A certain week may cross over into two calendar weeks because of vacation days, parent - teacher conferences, emergency days, or a variety of interruptive items. The schedule covers the time frame that begins on August 19, 1997 (since this is the first day that students will be present) and ends on January 9, 1998 with week eighteen. Weeks 1 & 2 will be used to determine the baseline data, weeks 3 - 17 will have the intervention applied, and week 18 is designed to gather the post intervention data.

Week 1

A. Classroom discussion of the action research project.
B. Administer the Pre-Student Survey with instructional sheet.
C. Send home parental information letter and consent forms.
D. Teachers A,B, and C will observe each targeted group twice using the Student Observation Checklist Lecture Instruction.

Week 2

A. Pass out Pre-Parent Survey at Open House Night.
B. Send home Pre-Parent Survey to those not attending Open House Night.
C. Teachers will gather data and begin to formulate the baseline information.
D. Teachers to start a weekly journal for the Field Based Master's Program entry log.
E. Teachers will instruct students in the proper structures of cooperative learning group and discuss what will be expected.

Weeks 3 - 17

A. The teachers will design cooperative learning lesson plans to help ensure transfer of math concepts.

B. Students will reflect on their learning patterns by being able to demonstrate various learning techniques of cooperative learning.

1. Use of big paper for displays and discussions
2. Use of the in turn structure
3. Regular and expert jigsawing
4. Use of match-ups tasks
5. The IRI synthesis of the BUILD model
6. Use of plus, minus and interesting questions

C. Students will place various assignments onto wall space for display.

D. The teachers will rotate into targeted groups for observation process using Student Obsevation Checklist. Cooperative Groups.

E. The teachers will continue to journal their intervention notes, progress reports and fact finding observations into the entry log.

F. The teachers will, on a continual basis, introduce, review, and master cooperative learning skills.

Week 18

A. The teachers will review and gather data based on theStudent Observation Checklist Cooperative Groups.

B. Administer the Post-Student Survey.

C. Send home by mail the Post-Parent Survey along with a self addressed stamped envelope to help ensure a greater response to the questionnaire.

D. Gather all post intervention data and begin the process of tabulation.

CHAPTER 4

PROJECT RESULTS

Historical Description of the Intervention

The teacher researchers attempted to closely follow the outline structure set forth in the eighteen week intervention plan. Due to school scheduling and state testing periods, slight adaptations were necessary in order to insure a logical sequence of events for the implementation of the intervention strategy. During the first portion of the plan, the three teacher researchers participated in a round robin observation to accurately assess the classroom environment. The material was presented to the students in a traditional lecture format. During this two week period, the teacher researchers met daily after school to refine the action plan and prepare for cooperative lessons.

First, methods were researched to develop a plan that would work within the framework of the school. The goal was to promote successfully a change in instructional methods. The emphasis would shift from straight lecture, drill, and recall to more useful, real world transfer exercises that would help initiate a more skillfully thinking student.

The second set of material examined included proper modeling of social skills and various grouping techniques. Social skills were discussed with each intervention group and the possible individual roles were covered. For secondary level students, the researchers developed the following roles:

Calculator - checks work

Analyst - analyzes strategy

Recorder - post and presents results

Master - makes sure the group stays on task

The methods of grouping were designed to fit the interventions in this project. Group members were not assigned based on ability but were randomly assigned to groups. Mixers used included cartoon placement, jigsaws of portraits of great mathematicians, mathematical grab bag, and line up by various catagories. By rotating the chemistry of the groups, the students were not always with the same peers or personalities.

Third, the teacher researchers developed a uniform structure for creating and recording cooperative learning projects. This format was designed to facilitate individual teaching styles within the standards set forth by the math curriculum objectives. Each instructor designed two cooperative learning projects during this intitial period so that adjustments to the model could be made as the intervention period progressed. The goal of the teacher researchers was to implement an average of one project per week.

After the eighteen week research period, the teacher researchers administered post intervention surveys to both the parents and students in the targeted population. This was done to determine if any attitudes or learning patterns had changed since the beginning of the intervention period. The three teacher researchers also kept detailed weekly logs to serve as anecdotal notes of the intervention period. A fourth instrument of measurement, the Student Observation Checklist - Cooperative Groups (Appendix G), was also used by the teacher researchers.

During the last week of the first semester, those parents whose students participated in the study were sent a Post Parental Survey (Appendix E). Included in their literature were instructions for taking and returning the survey.

All three teacher researchers at this site found that the intervention for the eighteen week period went as planned until weeks seventeen and eighteen. Each teacher did one cooperative learning assignment every week of the designed intervention. The teachers observed each other at least once each week to measure the impact of cooperative learning on the atmosphere of the classroom.

Because of final examinations, weeks seventeen and eighteen did not follow the original plan. Week seventeen was devoted to review and week eighteen was the exam week.

The three teacher researchers instruct different levels of mathematics. The various cooperative learning styles were used in all three curriculum levels. Modifications were made to reflect the individual personalities and preferences of the teacher researchers.

In Classroom A, cooperative learning projects (Appendix H) were presented in which the students were placed in groups of three. One particular task was to graph fifteen quadratic equations on big paper. This was an in-turn cooperative project where one person graphed an equation while the other two observed and checked for accuracy. When the group was in agreement on the graph, the task went to the next group member and the process was repeated. The big paper was passed in turn until all fifteen graphs were completed.

Brainstorming occurred in all of the groups. The rotation of the graphing and observing generated excellent discussion. Many of the groups employed their conflict resolution skills during the experience. The final product was a picture of a man. The project also allowed the creative side of the students to shine as they decorated the picture with art materials. The students enjoyed the artistic part of the lesson and appeared to have fun during the entire assignment.

Junior (accelerated) and Senior students make up Classroom B. These students have had math presented to them in a mixed lecture and cooperative learning environment for one year. Therefore, they are used to the routine of cooperative learning. The students already understand and model the social skills that are essential in making a group exercise a true cooperative learning experience. A cooperative lesson, as found in Appendix I, always began with the formation of groups and assignment of tasks. The composition of the groups in Classroom B may vary due to the nature of the project, availability of students (absences due to field trips), or need for work outside of the classroom time.

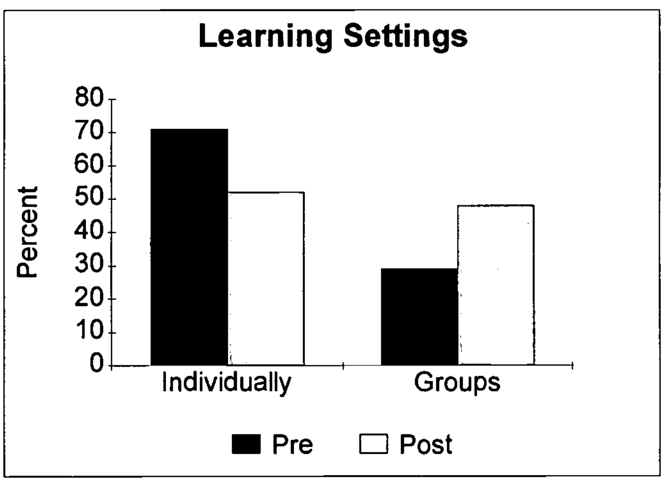
The jigsaw proved to be an effective way to attack the material for this class. Each group member worked on a piece of the puzzle. As the puzzle (graphs, equations, answers) was put together, the students really began to understand the ideas. So often, material is learned and repeated verbatim to achieve a high score. Excellent discussion was generated by the projects. The teacher enjoyed observing the exchange of ideas and enthusiasm that the students shared.

In Classroom C, the instructor used the jigsaw method of sharing information to design a computer program that would assign any individual their Illinois driver's license number according to the parameters set forth by the state (Appendix J). An unique element of this project was that the teacher appointed members to each base group. In advanced programming, there are students who are better equipped to handle certain techniques, assuming a role of specialist. By assigning members, the groups would be better balanced. If one were to view the activity as an observer, group members would be seen working on written algothrims, designing presentation screens, and collaborating with other members to ensure an accurate, flowing program. A grading rubric was posted so that the students knew what was expected. Because of the complexity of this project, the project was developed over a two week period. The students enjoyed this project because they were allowed for individuallized creativity.

Presentation and Analysis of Results

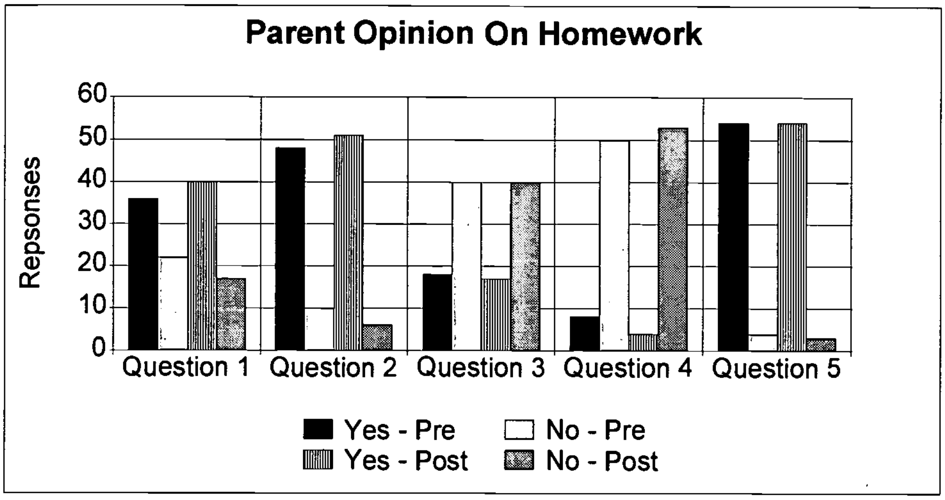
Graphs 4.1 through 4.4 compare attitudinal changes from the beginning of the cycle to the end of the intervention period as perceived by the parent group. The pre testing group consisted of 58 responses and 57 of these 58 original members participated in the Post Parental Survey. This represents a 98% total participation rate for the parent group. The entire targeted student population participated in the post intervention data collection process.

Graph 4.1



Graph 4.1 describes data collected with respect to the parents' perception of how their child learns better: individually or in a group setting. Of the 58 parents originally surveyed at the beginning of the intervention, 71% felt that their child learned better individually and 29% felt that their child learned better in a group setting. The post survey showed that the opinions reversed. Less than half (48%) of the parents now felt that their child learned better individually. This reflects a positive 19% change in opinion that the student learns better in a cooperative setting.

Graph 4.2



Graph 4.2 shows data collected from the parents' response to five different yes or no questions. The data represent the number of yes versus no responses.

Question 1 - Is your child motivated to learn mathematics?

Question 2 - Does your child bring home math assignments to work on ?

Question 3 - Do you feel competent in helping your child with math homework ?

Question 4 - Do you have a difficult time encouraging your child to do math ?

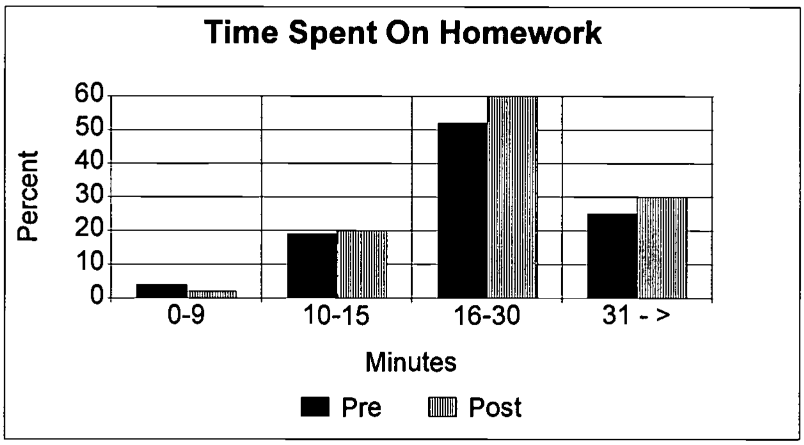
Question 5 - Do you feel math is important ?

Item	Pre intervention		Post Intervention		Change
	yes	no	yes	no	
Question 1	36	22	40	17	+4
Question 2	48	10	51	6	+3
Question 3	18	40	17	40	+1
Question 4	8	50	4	53	+4
Question 5	54	4	54	3	+0
Total					+12

Most parents of these college bound students felt that their child was already motivated. Therefore, the change in opinion was small in all categories.

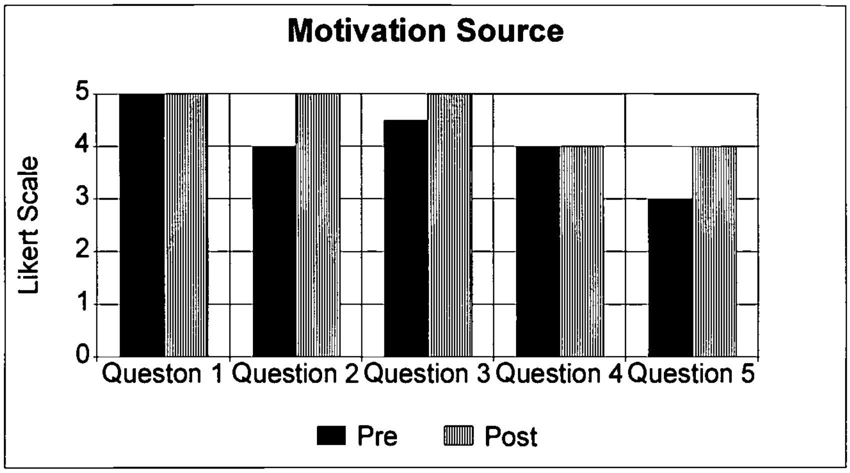
The responses did however show an overall positive change in homework attitude. Of the 57 surveyed after the intervention period, 21% reported a positive change of attitude with respect to how their child was motivated to do homework.

Graph 4.3



Graph 4.3 describes data collected from parents if yes was the answer to question 2 from the previous chart, 'Does your child bring home math assignments to work on?'. If yes, the parents responded by estimating the length of time spent daily by their child on math homework. Post intervention data suggest that parents now believe that their child is spending more time on his math lessons than at the beginning of the intervention period. The parent group stated that their students added approximately 8 minutes of effort to their daily math homework.

Graph 4.4



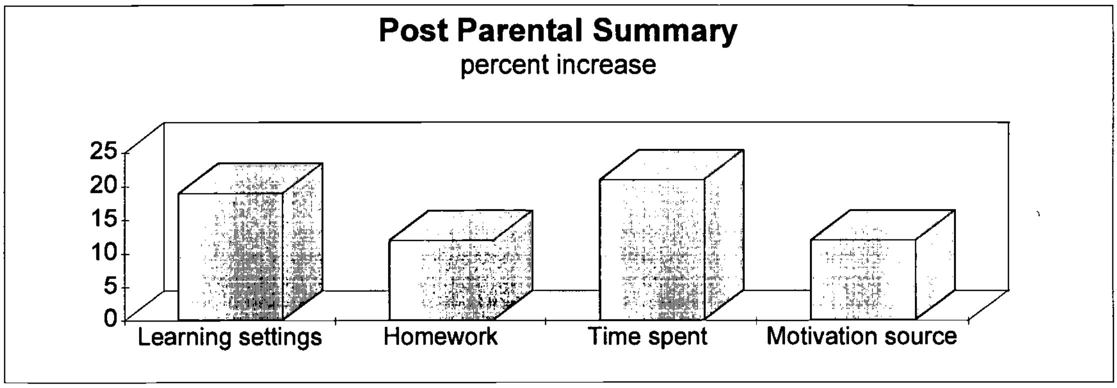
Graph 4.4 describes data collected from parents asking, in their opinion, what motivates their child to be successful in math. These responses are based on the Likert Scale where 1 is the lowest and 5 is the highest score. The responses were tallied and the mode was examined and used for reporting the results. The five different grade motivating criteria included:

Question	Topic	Pre	Post	Movement
1	Teaching methods	5	5	0
2	Parental concerns	4	5	+1
3	Grades	4.5	5	+.5
4	General knowledge	4	4	0
5	Rewards	3	4	+1

Three of the five categories represent a positive change in opinion about what motivates their child to be successful in mathematics.

The following graph 4.5 shows a summary of parental opinions with respect to the four survey topics that have been described above. The questions were posed before and after their child had experienced a significant amount of cooperative learning activities.

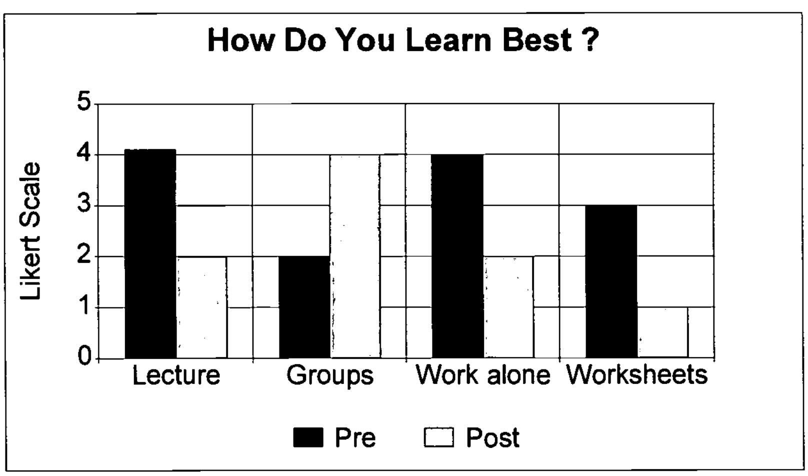
Graph 4.5



The summary above shows an overall increase in each category as recorded after analyzing data collected by the Post Parental Survey. The majority of our parents now believe that, after their child was introduced to cooperative learning techniques, the best environment seems to be one that fosters a blend of individual and group work situations.

The next seven graphs present the opinions and perceptions of the targeted student population after the intervention took place. This material was gathered from our Post Student Survey found in Appendix F.

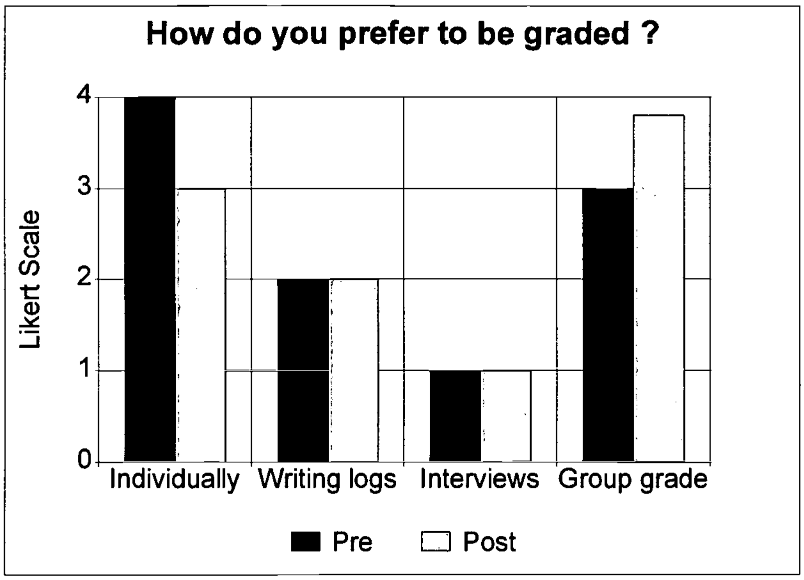
Graph 4.6



Graph 4.6 describes data collected by asking the students their opinion of how they learn best. The chart consists of four different teaching styles that the students were exposed to during the intervention period. In all four categories,

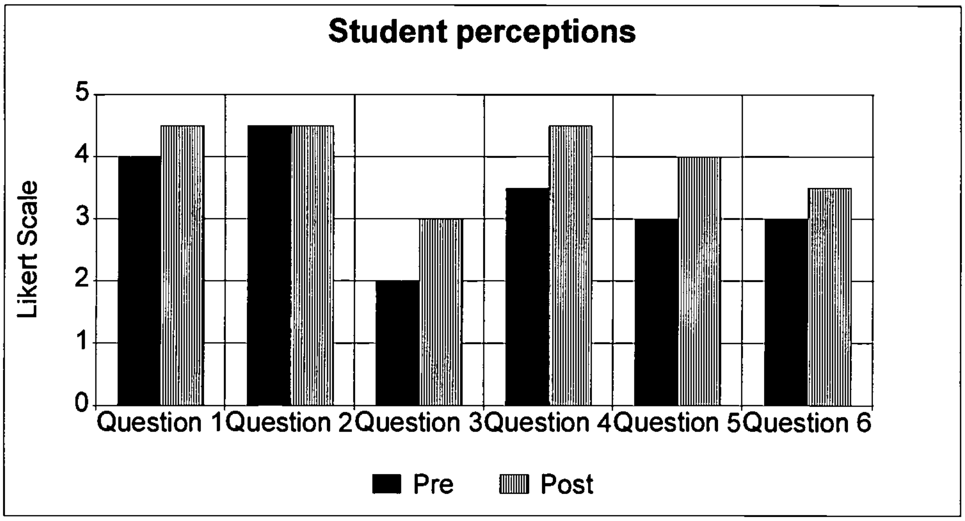
statistics indicate that the students now preferred the cooperative group setting for instruction rather than a more traditional, lecture driven format.

Graph 4.7



Graph 4.7 describes data collected from responses to questions that asked students how they preferred to be graded. The chart consists of four different means of assessing student work and understanding. We think it is very significant that, in the pre survey, the most frequent choice was individual grades. In the post survey, the group grades were ranked higher.

Graph 4.8



Graph 4.8 focuses on the students perception of high school math. The targeted population gave responses to the following six items:

Question 1 - Do you feel that high school mathematics provides you with real work skills after graduation?

Question 2 - Do you feel that high school mathematics will prepare you for college?

Question 3 - Do you feel that math is important just for people who are college bound?

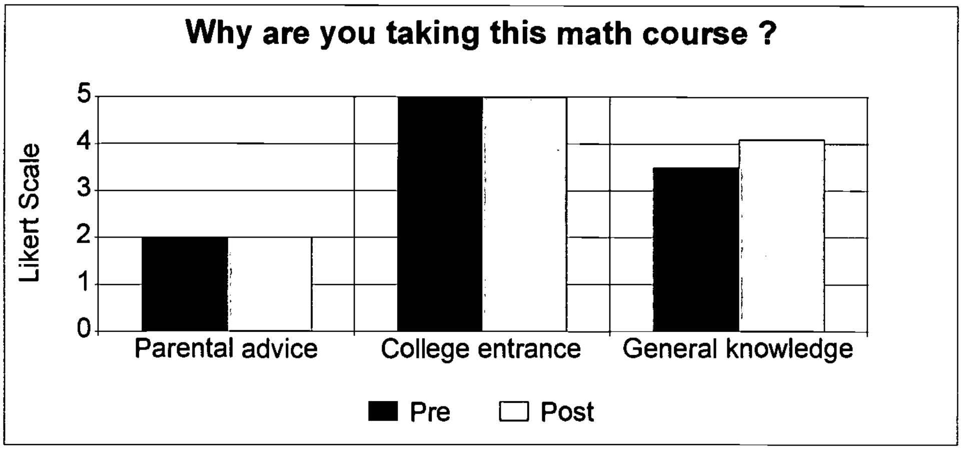
Question 4 - Do you feel it is beneficial to learn to work with others?

Question 5 - Do you enjoy working with math?

Question 6 - Do you use class time to work on math homework?

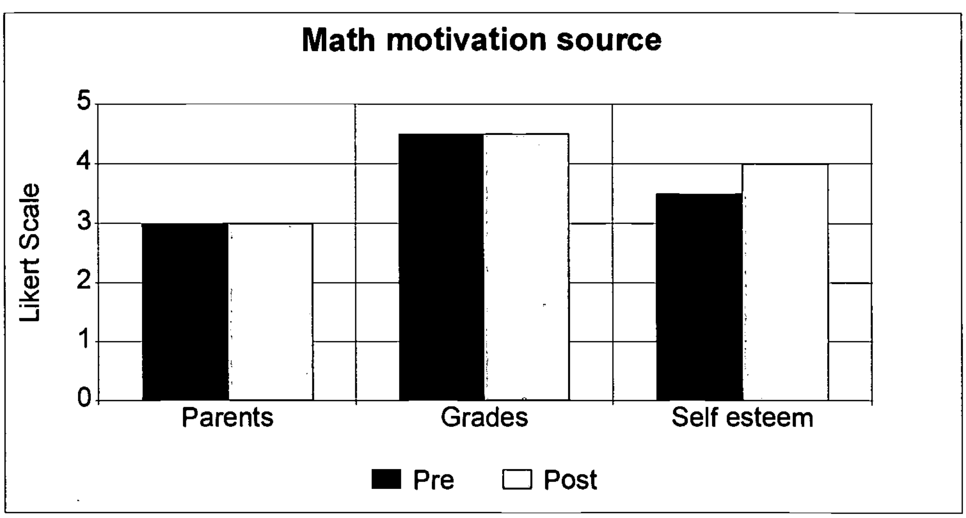
Perceptions changed very little. We saw significance in the responses to questions 4 - 6. The students showed an increased desire to work with others. They also seemed to enjoy math more and were more motivated to use class time to do their homework

Graph 4.9



Why are students still taking upper level math courses? Graph 4.9 describes student data collected for this topic. There was no change in the first two areas, but there was an increase in the category of taking math classes for the sole purpose of gaining more knowledge. We contend that this is because they are enjoying math classes more because of the varied teaching techniques that include cooperative learning activities.

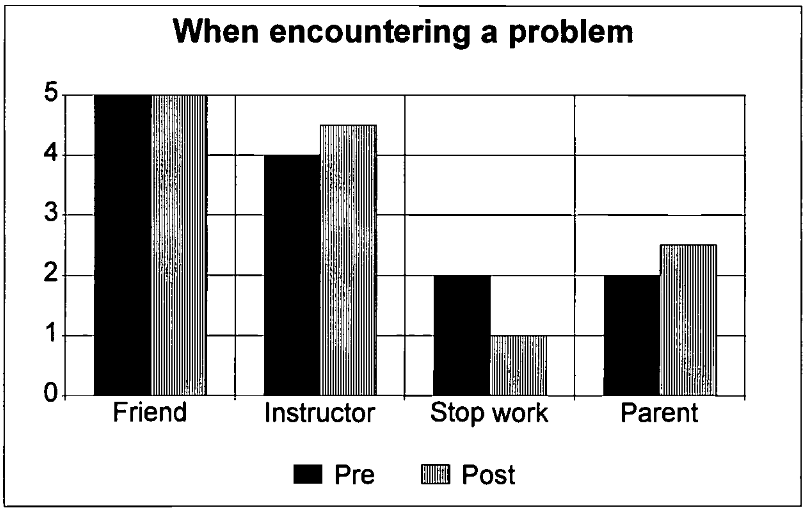
Graph 4.10



Graph 4.10 shows student response to what motivates them to do well in math classes. The first two categories remained the same, while the mode for self esteem category raised from 3.5 before the intervention to 4 after the

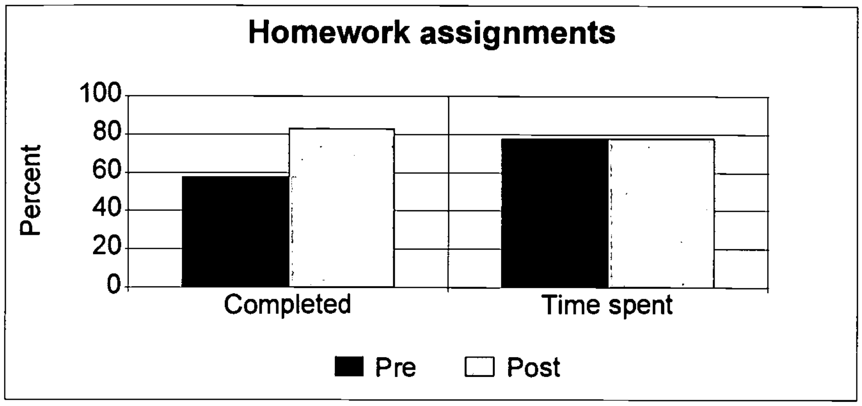
intervention period was over. This is another indicator that the students gained a better feeling about their math experience. Cooperative learning was a key component in that change.

Graph 4.11



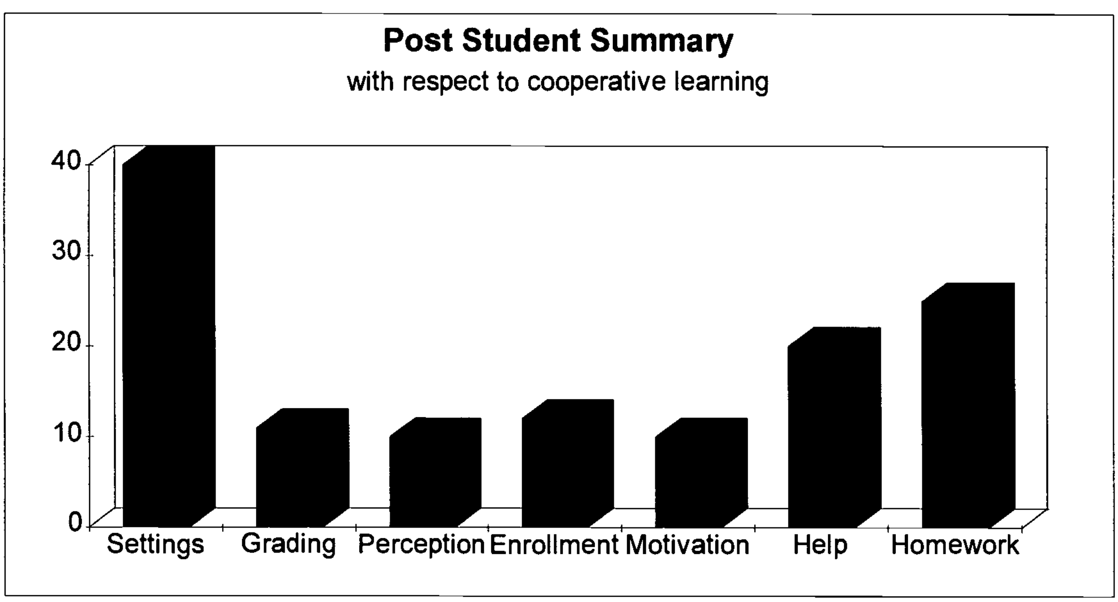
Graph 4.11 represents data dealing with how students handle difficulties while doing their math assignments. We find significance in the fact that fewer students stopped working. Also, students are now more comfortable in asking other people for help. This might be because of better social skills that have been developed by using cooperative learning during the course of the intervention period or due to the changing role of the teacher from presenter of learning to facilitator of learning.

Graph 4.12



Graph 4.12 depicts data representing percent of students who complete homework assignments along with how much time spent accomplishing the task. It is very significant that the targeted population went from 58% completing the assignments to 83% in assignments completed. The 25% increase definitely means our students are now more motivated to do their math assignments.

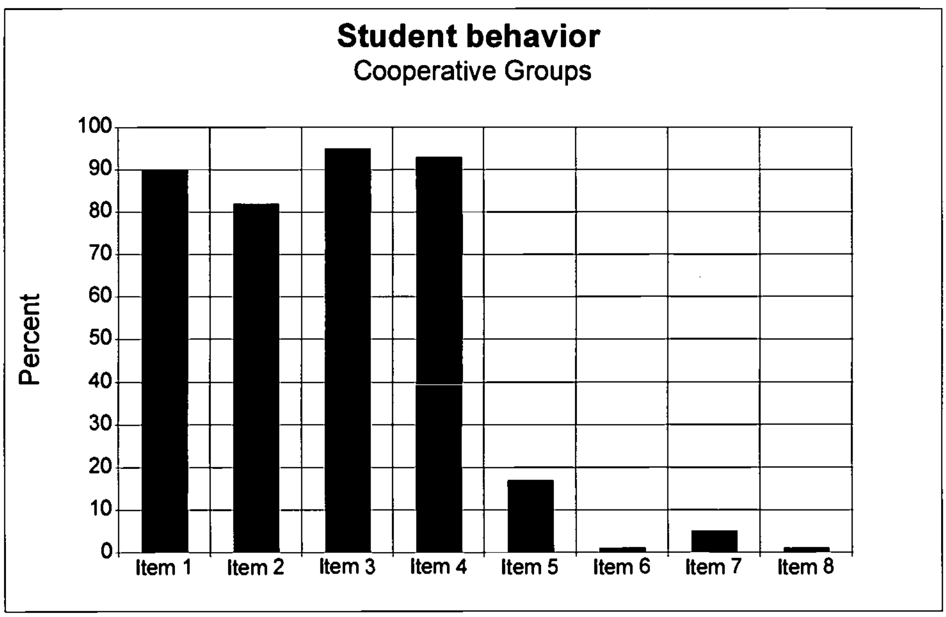
Graph 4.13



Graph 4.13 represents a summary of all the data collected through the Post Student Survey (Appendix F). The number depicts the percent increase shown in each category after the intervention period.

The third source in determining post data is a Student Observation Checklist Cooperative Groups (Appendix G) complied during the intervention period. These statistics were obtained by having each teacher researcher observe another a minimum of six times during the intervention period. This allowed a total of twenty data sheets tallied when viewing cooperative learning lessons in the mathematics classroom.

Graph 4.14



Item 1 - Percent of targeted students who actively participated in their group.

Item 2 - Percent of targeted students who demonstrated good social skills.

Item 3 - Percent of targeted students who stayed on task.

Item 4 - Percent of targeted students who seemed motivated to help one another learn.

Item 5 - Percent of targeted students who approached the instructor for help.

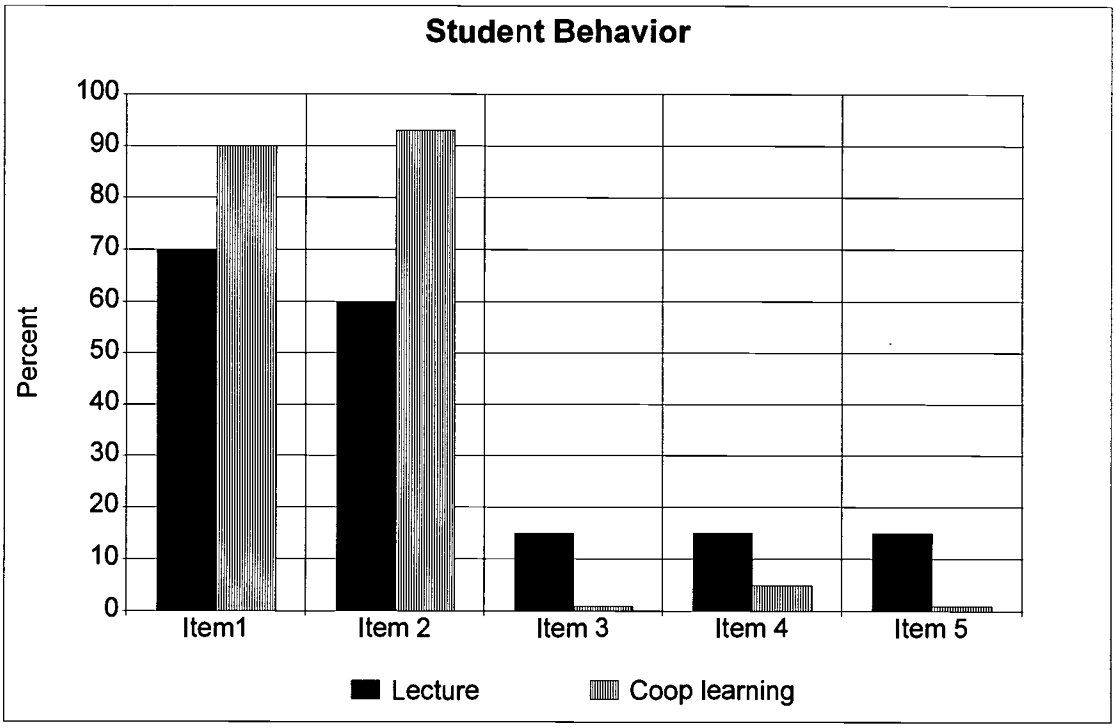
Item 6 - Percent of targeted students who asked to leave the classroom for any reason.

Item 7 - Percent of targeted students who caused some type of discipline problem.

Item 8 - Percent of targeted students who are slept.

Graph 4.14 was also complied from the Student Observation Checklist - Cooperative Groups (Appendix G). This chart supports, to a high degree, the perception that the student learning environment was extremely positive.

Graph 4.15



Lecture presentation was the only instructional style modeled prior to the intervention period. Graph 4.15 shows the comparisons of student behavioral attitudes towards the lecture style of instruction and cooperative learning groups. Item 1, which measured participation and interactive feedback responses, increased 20 base points. Item 2, which targeted the number of students on task, increased 23 points. Item 3 looked at the number of students who wanted to leave the classroom for any reason. This item showed a 14 point decrease. Item 4 measured the number of students that caused discipline problems. This item decreased by 10 points. Item 5 looked at the number of students that were sleeping in class. This item also decreased by 14 points. These changes support our conclusion that a huge swing in attitude towards cooperative learning, and away from the strict traditional lecture style of instruction took place.

Conclusion and Recommendations

By collecting and analyzing baseline data and intervention data from this action research project, we found strong evidence that the research, as well as collected data, truly supported the given hypothesis. Now, students definitely were found to be more motivated in mathematics than they were prior to participating in cooperative learning projects. The support of this finding comes from the answers to questions regarding preferences of lecture vs cooperative setting and by parent responses to the parent survey.

We found that cooperative learning, combined with varied teaching strategies can and does motivate high school student. The data that supports our claim is as follows:

1.) Parents surveyed felt that their child now learned better in groups rather than individually. This category showed a 19% increase.

2.) Twenty-one percent of the parents reported a positive opinion change in attitude toward what motivates their child to do homework.

3.) Twenty-one percent of the parents said that their children had spent more time doing homework after the intervention than they did at the beginning of the year. The parents also indicated they observed an increase that averaged 8 minutes per day of extra time spent on homework per student.

4.) The majority of parents now believe that, after their child was exposed to cooperative learning techniques, the best environment seems to be one which fosters a blend of individual and group work settings.

5.) Students now prefer a more relaxed group setting rather than strict lecture, workalone activities, or individual seatwork.

6.) Students now prefer to have more of their grades generated by cooperative learning projects rather than individually.

7.) Students are using more class time to do their homework.

8.) Through cooperative learning, students gained a better feeling about their math experiences. They felt part of a successful team.

9.) Students seemed more willing to turn to other people for help in their math assignments. We believe that is due to better social skills developed during the course of the intervention.

10.) The targeted students in this project went from 58% completing all assignments to 83% completing assignments. This 25 point increase definitely shows intervention strategies to be successful.

11.) Obeservations of each others' classrooms during the cooperative learning activities showed evidence, to a large degree, of an extremely positive learning environment.

12.) Observed behaviors during the intervention period were:

a.) Participation and interactive feedback responses increased 20 percentage points.

b.) The percent of students staying on task increased 23 points.

c.) As observed in the teacher observation checklist, there was a 14 point decrease in the number of students who wanted to leave the classroom for any reason.

d.) Discipline problems decreased 10 points.

e.) Students sleeping in class decreased 14 percentage points.

We were confident that the intervention results would support the contention that cooperative learning activities would help motivate students. This was evident in both student and parent post data information. We highly recommend the use of cooperative learning activities for all teachers in all disciplines. In order for this type of learning technique to achieve the results that we enjoyed, cooperative learning does need to be implemented properly. There is a huge difference between cooperative learning and group work. Cooperative learning has to be taught and teachers have to be trained in the technique in order for it to be effective. There are numerous graduate courses in the correct use of this model of teaching. Some coursework is highly recommended before any instructor attempts to do group projects.

We had a difficult time finding already developed cooperative learning projects to give to students. Most of the projects done during the intervention period were developed by the teacher researchers (us). Lesson development became a very time consuming task. If there is no time to devote to planning worthwhile activities, we would recommend not using this cooperative learning activities. Well planned activities take more time to construct than preparing for a lecture.

The role of the teacher researchers involved in this intervention project has changed from a teacher who uses the strict lecture method of instruction to one of a facilitator. Instead of spending an inordinate amount of time in one way communication, the roles of both the instructor and student have changed toward a more Socratic environment. We find our teaching styles lean more toward a constructivist approach. The students now are taking more responsibility for their own learning.

Due to time constraints, we were limited in the number of multiple intelligence activities that could be included in the cooperative learning projects. If this activity would be studied further, the teacher researchers would like to investigate the use of different modes of delivery from the multiple intelligence point of view.

If we would change any one item in our research project, it would be in the manner in which we gathered some of our data. Responses to many of the survey questions presented to both parents and students were given using a Likert scale. We found analyzing these responses very cumbersome and that reporting the collected data was difficult. We definitely would construct the questions to be responded to in a manner conducive to analyzation. Other than this recommendation, we like what we did and really enjoyed the results of the project. We would probably not change anything else.

No one asks an individual to build a house by himself. No one asks a factory worker to manufacture an automobile by himself. Nobody asks an accountant to audit an insurance company by himself. Nobody asks surgeons to perform a medical operation by themselves, nobody asks a political leader to govern a nation by alone. However, as educators, we continually ask our students to understand and develop math concepts, and to achieve high test scores based only on individual work. Why do we continually teach students in an individual setting that stresses only intrapersonal skills? The emerging work place is built around a team concept. Therefore, the emerging classroom needs to be built around the same concept.

Albert Einstein, a famous mathematician and physicist, failed algebra in high school. Dwight Eisenhower, 34th president of the United States, graduated last in his class at West Point. Jacques Cousteau, a renowned environmentalist and explorer, was expelled from his high school for breaking 17 school windows. Were these men troubled individuals who would never amount to anything? Or were they simply lacking the motivation necessary to escape boredom and achieve success in education. "Never tell people how to do things. Show them what to do and they will surprise you with their ingenuity" (George S. Patton).

The medical model of cooperative learning and sharing of ideas took root in 1888 with the formation of a small medical practice in Rochester, Minnesota. William Mayo, and his sons, William and Charles Mayo, opened their doors to a new style of practicing medicine that became the first private group practice in the world. Their practice featured the concept of organizing doctors into specialized groups that allowed for the sharing of knowledge within and between separate departments. This provided for interaction and advancement of medical procedures. Today this style has grown into the world renowned Mayo Clinic. People from all over the world travel to this small town in Minnesota because of its excellence and expertise in dealing with each patient's problems. This group practice based on cooperation and multiple medical opinions has now become the standard for numerous other organization. Let the classroom follow suit.

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Appendices

APPENDIX A

Math Department Survey

1. On a weekly average, what percent of time do you spend lecturing ?

0	10	15	20	25	30	40	50	60
70	75	80	90	100				

2. In your opinion by either observation or collected homework assignments, what percentage of students have incomplete work?

0	10	15	20	25	30	40	50	60
70	75	80	90	100				

3. What percentage of your students are not working to potential?

0	10	15	20	25	30	40	50	60
70	75	80	90	100				

4. What percentage of your students rarely or never participate in classroom discussions?

0	10	15	20	25	30	40	50	60
70	75	80	90	100				

APPENDIX B

Dunlap High School - Mathematics Department
Pre - Student Survey

1. **How do you feel you learn best?**

lecture

1	2	3	4	5

co-operative groups

1	2	3	4	5

working alone

1	2	3	4	5

drills/work sheets

1	2	3	4	5

2. **How do you prefer to be graded?**

individual test

1	2	3	4	5

journals/writing logs

1	2	3	4	5

interviews

1	2	3	4	5

group grades

1	2	3	4	5

3. **How often do you complete your math assignments?**

0%	25%	50%	75%	100%
1	2	3	4	5

4. **How many minutes do you spend on math assignments per day?**

0-15	16-30	31-45	46-60	over 60

5. **Do you feel that high school mathematics provides you with real work skills after graduation?**

1 2 3 4 5

6. **Do you feel that high school mathematics will prepared you for college?**

1 2 3 4 5

7. **Do you feel that math is important just for people who are college bound?**

1 2 3 4 5

8. **Do you feel it is beneficial to learn to work with others?**

1 2 3 4 5

9. **Are you taking this math course because of:**

parental advice/concerns
1 2 3 4 5

college entrance (ACT)
1 2 3 4 5

general knowledge
1 2 3 4 5

10. **Do you enjoy working with math?**

1 2 3 4 5

11. **Where does your math motivation come from?**

parents
1 2 3 4 5

grades
1 2 3 4 5

self esteem
1 2 3 4 5

12. **Do you use class time to work on math homework?**

1 2 3 4 5

13. **If you don't understand the assignment, are you more likely to:**

ask a friend for help
1 2 3 4 5

ask a teacher for help before class
1 2 3 4 5

stop working
1 2 3 4 5

ask a parent for help
1 2 3 4 5

APPENDIX C

INSTRUCTIONS FOR TAKING THIS SURVEY:

This survey is being done on what is known as a Likert Scale. Please be honest and rank your answers according to the following:

1 - dislikes

2 - low

3 - average

4 - good

5 - extremely well or often

Again, please be honest with your answers - there is no grade on this survey!

APPENDIX C

Pre Parent Survey

Please answer all of the questions to the best of your ability. Thank you for your time.

1. Do you feel that your child learns better individually or in a group setting?

   individual   group

2. Is your child motivated to learn mathematics?

   yes   no

3. Does your child bring home his math assignments to work on?

   yes   no

4. If yes to #3, How many minutes does your child spend on math homework daily?

   none   10-15   15-30   more than 30

5. Do you feel competent in helping your child with math homework?

   yes   no

6. Do you have a difficult time encouraging your child to do his math homework?

   yes   no

7. Do you feel that math is important for your child to succeed after high school?

   yes   no

For those questions involving a scale of one to five , one is none and five is extremely likely.

8. In your opinion, what motivates your child to be successful in math?

teaching methods
1 2 3 4 5

parental concerns
1 2 3 4 5

grades
1 2 3 4 5

general knowledge
1 2 3 4 5

rewards
1 2 3 4 5

APPENDIX D

Student Observation Checklist - Lecture Instruction

1. How many students targeted are not paying attention to the lecture material?

2. How many students are not taking notes?

3. How many students are working on other subjects during the lecture?

4. How many students did not do math homework during seat work time?

5. How many students did not bring their book or other materials to class?

6. How many students asked the teacher for a pass to leave the room for any reason?

7. How many students caused any type of discipline problem?

8. How many students are sleeping?

APPENDIX E

Parent Survey - Post

Please answer all of the questions to the best of your ability. Thank you for your time.

1. Is your child more motivated in math now versus the beginning of the school year?

   yes no

2. Do you see your child's interest and motivation in math as:

   less than at the beginning of the school year ______

   same as at the beginning of the school year _____

   more than at the beginning of the school year _____

3. Do you now feel that your child learns better individually or in a group setting?

   individual group

4. Does your child bring home his math assignments to work on?

   yes no

5. If yes to #4, how many minutes does your child spend on math homework daily?

   none 10-15 15-30 more than 30

6. Do you feel competent in helping your child with math homework?

   yes no

7. Do you have a difficult time encouraging your child to do his math homework?

yes no

8. Do you feel that math is important for your child to succeed after high school?

yes no

For those questions involving a scale of one to five , one is none and five is extremely likely.

9. In your opinion, what motivates your child to be successful in math?

teaching methods
1 2 3 4 5

parental concerns
1 2 3 4 5

grades
1 2 3 4 5

general knowledge
1 2 3 4 5

rewards
1 2 3 4 5

APPENDIX F

Post - Student Survey

1. **How do you now feel you learn best?**

lecture

1	2	3	4	5

co-operative groups

1	2	3	4	5

working alone

1	2	3	4	5

drills/work sheets

1	2	3	4	5

2. **How do you now prefer to be graded?**

individual test

1	2	3	4	5

journals/writing logs

1	2	3	4	5

interviews

1	2	3	4	5

group grades

1	2	3	4	5

3. **How often do you now complete your math assignments?**

0%	25%	50%	75%	100%
1	2	3	4	5

4. **How many minutes do you spend on math assignments per day?**

0-15	16-30	31-45	46-60	over 60

5. **Do you feel that high school mathematics provides you with real work skills after graduation?**

1 2 3 4 5

6. **Do you feel that high school mathematics will prepared you for college?**

1 2 3 4 5

7. **Do you feel that math is important just for people who are college bound?**

1 2 3 4 5

8. **Do you now feel it is beneficial to learn to work with others?**

1 2 3 4 5

9. **Are you taking this math course because of:**

parental advice/concerns
1 2 3 4 5

college entrance (ACT)
1 2 3 4 5

general knowledge
1 2 3 4 5

10. **Do you enjoy working with math?**

1 2 3 4 5

11. **Where does your math motivation come from?**

parents

1 2 3 4 5

grades

1 2 3 4 5

self esteem

1 2 3 4 5

12. **Do you now use class time to work on math homework?**

1 2 3 4 5

13. **If you don't understand the assignment, are you more likely to:**

ask a friend for help

1 2 3 4 5

ask a teacher for help before class

1 2 3 4 5

stop working

1 2 3 4 5

ask a parent for help

1 2 3 4 5

APPENDIX G

Student Observation checklist - Cooperative Groups

1. Are the students actively participating in their respective groups?

2. Are the students demonstrating good social skill?

3. How many of the groups are on task?

4. How many students seem motivated to help one another learn?

5. How many times do they approach the instructor for help?

6. How many students asked the instructor for a pass to leave the room for any reason?

7. How many students caused discipline problems?

8. How many students are sleeping?

APPENDIX H

Sample of Cooperative Projects
Classroom A

MATH DEPARTMENT

Subject/Class: Alg II

Lesson Name: The Quadratic Man

Co-operative style: Jig Saw

Content Focus: Graphing Quadratic Equations.

Materials: Big Paper, graph paper, Compasses, Markers, rulers, ect.

Product: Big Paper

Grouping: Groups of 3

Activity: On the back

Evaluation: 60 point quiz

Reflection: Like always, They thought this was a lot of fun.

The Graph Of The Quadratic Man

Listed below are 15 quadratic equations. Make sure you graph #1 first. I would do all the graphs in pencil, then when finished, use colored markers to finish off your project. Be creative! Add anything to your man that you want. Beware — some graphs have certain limitations. (8, 9, 10, 14, 15).

Roles

1. Materials GATHERER
2. Recorder For Mrs. Potter's Questions
3. Time Keeper

Every person does every third problem.

1. $(x+2)^2 + (y-2)^2 = 225$

2. $\dfrac{(x+2)^2}{25} + \dfrac{(y+7)^2}{4} = 1$

3. $\dfrac{(x-4)^2}{9} + \dfrac{(y-6)^2}{4} = 1$

4. $(x-4)^2 + (y-6)^2 = 1$

5. $(x+8)^2 + (y-6)^2 = 1$

6. $\dfrac{(x+8)^2}{9} + \dfrac{(y-6)^2}{4} = 1$

7. $\dfrac{(x+2)^2}{1} + \dfrac{(y-2)^2}{4} = 1$

8. $y = 11$ Graph until you hit a curve. Stop the line there.

9. $y = 14$ Graph until you hit a curve. Stop the line there.

10. $\dfrac{(x+2)^2}{16} - \dfrac{(y+13)^2}{4} = 1$ Just graph the bottom 2 curves of the parabola. Don't graph the upper curves.

11. $(x+2)^2 + (y+16)^2 = 1$

12. $(x+2)^2 + (y+20)^2 = 1$

13. $(x+2)^2 + (y+24)^2 = 1$

14. $x = -3(y-4)^2 + 15$

15. $x = 3(y-4)^2 - 19$

$\Big\}$ Stop when you hit a curve. Don't worry about how wide or narrow make them fit the figure

MATH DEPARTMENT

Subject/Class: Alg II

Lesson Name: Jig the Story Problems

Co-operative style: Jig saw (Expert)

Content Focus: Problem Solving

Materials: Big paper, paper, markers, tape, ect.

Product: Big paper

Grouping: Group them by height. Groups of 3.

Activity: Each group got a copy of the six story problems attached. Groups 1, 2, 3, and 4 were responsible for #'s 1-3, and group 5, 6, 7, 8 were responsible for #'s 4-6. They counted off in their groups to 3, with each doing a problem with in their assignned problems. They then put all 3 of their respective problem on big paper for display. We taped these around the room when done and everyone in the class found the problems that they couldnt do and found out how to do that problem. Each person did one problem but was accountable for knowing how to do all six.

Evaluation: This was a 20 pt quiz.

Reflection:

I will find out later after a Chapter test how many out of the 6 different story problems the kids learned. The way the activity was set up through the jig saw each student only had to do one of the 6 different types.

Alg II Cooperative Learning
Quiz

Names ____________

____

____

(1) The length of a rectangle is 4 cm. more than twice the width. If the perimeter is 44 cm., what are the dimensions of the rectangle?

(2) A coin bank contains twice as many nickels as quarters, three times as many pennies as quarters, and no dimes. If the bank contains $7.60, how many of each coin does it contain?

(3) 2 trains start from the same point and travel in different directions. The north bound train starts 2 hrs before the south bound train. The north bound travels at 45 mi/hr, The south bound train at 55 mi/hr. How long will it be before they are 470 miles apart?

(4) Sherman is 4 times as old as his rattle snake. In 5 years, Sherman will be 3 years more than twice the snakes age. How old is each now?

(5) Find 3 consecutive even integers such that the sum of the 1st and 2nd is 32 more than the 3rd.

(6) Gloria's average on 3 music tests is between 90 and 93. Gloria scored 12 fewer points on the second test than on the 1st and 9 fewer points on the third test than on the 1st. How many points must she have scored on the 1st test?

MATH DEPARTMENT

Subject/Class: Alg II

Lesson Name: The Music Venn's

Co-operative style: People in their group were given roles and did the assignment on big paper.

Content Focus: Working with Venn Diagrams to represent intersections and unions of sets.

Materials: Big paper, markers, scissors, tape, ect.

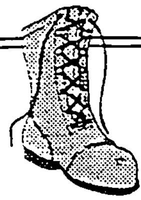
Product: Big paper

Grouping: Counted off to get groups of 3

Activity: On the next Sheet.

Evaluation: Graded as a 10 point quiz.

Reflection: Worked out well. The kids enjoyed the assignment.



Make Your Own

Well done! Venns are so useful in music!

LESSON NAME: The Music Venn's

TARGETED INTELLIGENCE: Logical/Mathematical

SUPPORTING INTELLIGENCES: Inter. / V.S.

THINKING SKILLS: Analysis, Reasoning, Problem Solve, Decision Making

SOCIAL SKILLS: Follow Directions, Communicate, Working with teams, Consensus Cooperation

CONTENT FOCUS: Math Problem Solving (Deals with sets and subset

MATERIALS: Sheet with directions, Poster Board, Markers, Ruler, Compass

TASK FOCUS: This activity is designed to facilitate a problem solving situation.

PRODUCT: A Poster with Venn Diagrams

PROBLEM: To recognize different sets and subsets.

ACTIVITY: This exercise helps define intersection and union of sets.

1) Put in groups of 3.
2) Divide groups into 1) Materials gatherer
   2) Reader
   3) Recorder
3) Give the groups the sheet with directions and a picture of the Venn Diagram they are to use.
4) Then they have to figure out where the numbers fit on the Venn Diagram.

REFLECTIONS:

1. What does this show you about intersection and unions of sets
2. What part of the Venn diagram must be filled in first.
3. Why did not all of the 200 people surveyed fit into the circles.
4. Where did those remaining people fit into the Venn Diagram

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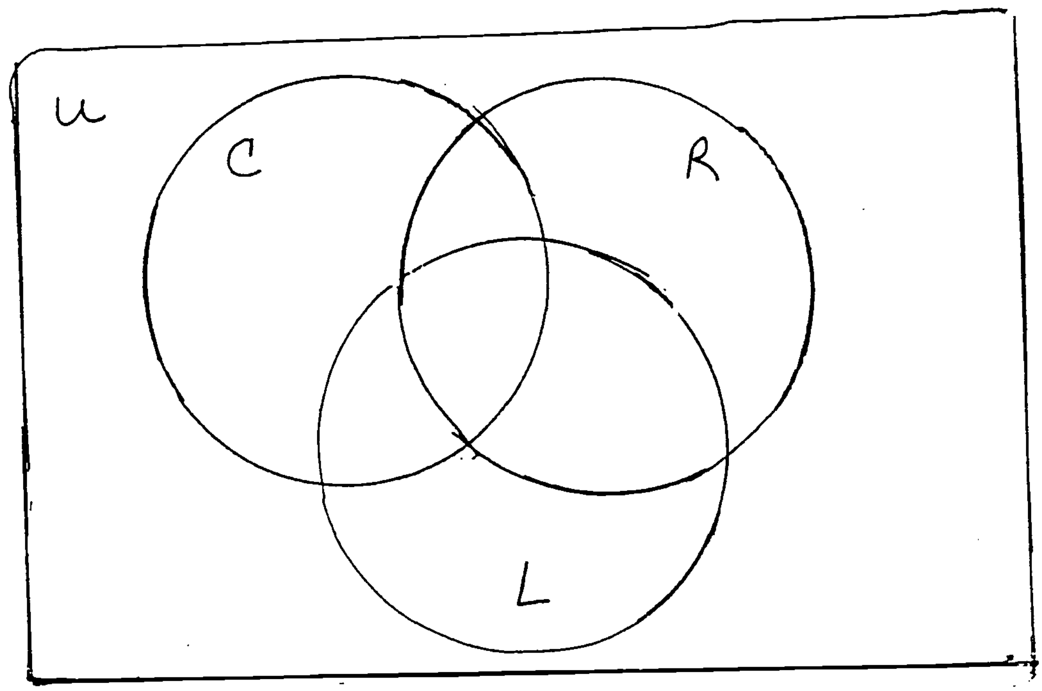
Project

Put on a poster board a Venn Diagram that demonstrates the following survey of 200 people interviewed on what kind of music they like. An example of the Venn diagram is on the back. Let circle C represent classical, circle R rock, and circle L light opera. Here is the result of the survey.

9 people liked all three.
27 people liked classical and rock.
33 people liked rock and light opera.
30 people liked classical and light opera.
72 people liked classical.
80 people liked rock.
93 people liked light opera.

Now, in your groups, fill in the appropriate numbers in the correct places on the Venn Diagram.



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MATH DEPARTMENT

Subject/Class: alg II

Lesson Name: What The 3 points Say

Co-operative style: Brainstorm Ideas

Content Focus: All they know about lines, points, angles, and triangles.

Materials: Graph paper, markers, rulers, big paper, ect.

Product: Big Paper

Grouping: Groups of 4

Activity: I gave each group the following points; A(−10, −8), B(12, −8), and C(−10, 16). They had to plot these 3 pts., draw the triangle, and then tell me at least 20 different things dealing with the Δ., the lines, the <'s, ect.

Evaluation:

If they came up with 20 valid mathematic concepts, they got 20 pts. If they came up with only 15, they got 15-20 pts. This was a 20 pt. quiz.

Reflection:

There was alot of great brainstorming that went on. They even asked for Geometry books to look things up in it. This was a great way to get them back to some of the things they also did last year

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MATH DEPARTMENT

Subject/Class: Alg II

Lesson Name: Linear Programming

Co-operative style: Jigsaw

Content Focus: Solving Story problems using
1) Inequalities
2) Graph the inequalities
3) Use the points of inter section to find the maximum value in the profit statement

Materials:
1) Graph paper
2) Markers

Product:
Big Paper

Grouping: Groups of three

Activity:

attached to the back

Evaluation: 30 point quiz
1) 10 points for writing the proper inequalities
2) 10 points for graphing the inequalities
3) 10 points for substituting the points of intersections into the profit statement to come up with the maximum value

Reflection:

It was a fun way for the kids to do a linear programming problem.

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Problem Solving Using Linear Programming

The Blair Company makes 2 types of pianos spinets and consoles. The equipment in the factory allows for the making of at most 450 Spinets and 200 consoles in a 1 month peri The Chart Shows the cost of making each type and the profit on each. During the Month of June, the company can spend only $360,000 to make pianos. That is their budget for the month. To make the greatest profit, how many of each type of piano can be mad

piano	cost per unit	profit per unit
Spinet	$ 600.	$ 125.
console	$ 900.	$ 200.

Group Roles

1) Write all the inequalities involved in the problem.
2) graph all the inequalities
3) Write the profit statement and Substitute the points in the profit statement to find the maxim.

MATH DEPARTMENT

Subject/Class: Alg II

Lesson Name: The Drink Problem

Co-operative style: Jig saw

Content Focus: Solve Systems of Equations in 3 variables 3 different ways.

Materials: Big Paper, Markers, Rulers, Tape, ect.

Product: Big Paper

Grouping: Groups of 3

Activity: Attached to back page

Evaluation: 20 pts.
5 pts each for the 3 different ways th
Solved the system and 5 pts for creativi

Reflection: Like always, they love to do the "Big Paper" projects.

1) Recorder
2) Write the System of Equations in 3 variables
3) Materials Manager and Time Keeper

1) Eliminate the x Column
2) Eliminate the y column
3) Eliminate the z column

Jim bought 97 cans of soft drinks. The number of root beers exceeded the number of colas by 15. The total number of colas and orange drinks was 23 less than twice the number of root beers. How many cans of each did he buy?

MATH DEPARTMENT

Subject/Class: Alg II

Lesson Name: Story Problems in 3V

Co-operative style: Jigsaw

Content Focus: Problem Solving using 3 equations in 3 variables

Materials: Big Paper, tape, Scissors, markers, ect.

Product: Big Paper

Grouping: Groups of 3

Activity: Each person in the group was responsible for doing 1 of the 3 problems. When done, they had to teach the other group member their problem.

Evaluation: 30 pt. quiz. Each problem was 10 points each.

Reflection: As always, they liked this project.

Super bats Inc. manufactures 2 different baseball bats; the Wall banger and the Dingbat. The Wall banger takes 8 hours to trim and turn on a lathe and 2 hours to finish. The Dingbat takes 5 hours to trim and turn on a lathe and 5 hours to finish. The total time a day for trim and lathe is at most 80 hours. The total time a day for finishing is 50 hours. The profit that must be made on the Wall banger is $17 a bat and for the Ding bat $29 a bat. How many of each type of bat must be made to maximize profit?

Group Roles

#1 Write the inequalities - 10pts.

#2 Graph the inequalities - 10pts.

#3 Take the points of inter Section and Substitute them in the profit statement - 10pts.

MATH DEPARTMENT

Subject/Class: Alg II

Lesson Name: Linear Programming

Co-operative style: Jigsaw

Content Focus: To Problem Solve

Materials: Graph Paper, Big Paper

Product: Big Paper

Grouping: Groups of 3.

Activity: attached to the back

Evaluation: 30 point quiz
10 pts. for writing the proper inequality
10 pts. for graphing the proper inequalities
10 pts. for putting the vertices of the polygon formed into the profit statement.

Reflection: It was a fun way for the kids to do a linear programming problem.

21. **Consumerism** Assorted nuts, bolts, and washers are packaged and sold. A package containing 1 nut, 1 bolt, and 1 washer costs 20¢. A package containing 2 nuts, 2 bolts, and 4 washers costs 50¢. A package containing 5 nuts and 4 bolts costs 70¢. Find the price of a nut, a bolt, and a washer.

22. **Consumerism** Travel packs contain toothpaste, combs, and toothbrushes. A pack containing 2 combs and 1 toothbrush costs \$1.00. A pack containing 5 combs and 5 toothbrushes costs \$3.75. A pack containing 2 toothbrushes and 2 tubes of toothpaste costs \$2.50. Find the price of a tube of toothpaste, a comb, and a toothbrush.

23. **Geometry** x, y, and z, which are related by this system of equations, represent the number of sides of three different polygons. Name the polygons.

$$\begin{cases} x + y + z = 14 \\ 2x - z = 0 \\ y + 2z = 17 \end{cases}$$

APPENDIX I

Sample of Cooperative Projects
Classroom B

MATH DEPARTMENT

Subject/Class: TRIGONOMETRY

Lesson Name: EXPLORE TRIG GRAPHS

Co-operative style: JIGSAW.

Content Focus: Amplitude, period, phase shift. Vert. displacement

Materials: paper, graphs, pencil, paper, glue.

Product: 1 poster with 5 graphs depicting amplitude, period, phase shift, vert. displacement and one of the students own.

Grouping: → groups of 4 - eye color!

Activity:
students get in groups - Tackle each section - 1st Amplitude - Period - etc. each member does key pts and graphs his/her function on designated piece of paper. Group follows this procedure until project completed

Evaluation: worth 50pts (10 each piece)
→ for accuracy
creativity
description / get the point accross

Reflection: The activity really reinforced the concept. We all enjoyed this!

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Group Activities Chapter 6 Graphing Trigonometric Functions

Amplitude

For the values of x between -360^o and 360^o constuct a table that lists the key points for the following functions. When completed each member should graph his/her funcition on the same set of axis. (Each group member should do one of the functions.)

$y = \sin x$
$y = 4 \sin x$
$y = 1/2 \sin x$
$y = -2\sin x$

What do you notice????

Period

In the same manner as 'Amplitude', table and graph the following:

$y = \sin x$
$y = \sin 2x$
$y = \sin 4x$
$y = \sin 1/2x$

what do you notice???

Vertical Displacement

As before, table and graph the following:

$y = \sin x + 2$
$y = \sin x - 1$
y = sin x and your choice

Phase Shift

again table and graph the following

$y = \sin(x + 90^o)$
$y = \sin (x - 90^o)$
$y = \sin (x + 45^o)$

now be creative!!!!!! graph the function as $y = 4 \sin (2x + 30^o)+ 2$ and one of your own. Give the amplitude, period, phase shift and vertical displacement of each.

MATH DEPARTMENT

Subject/Class: Trigonometry/Polar

Lesson Name: Vectors

Co-operative style: student/student interaction

Content Focus: learning about vectors both algebraically & geometrically

Materials: - text - information sheet, protractors - ruler - graph paper

Product: One complete set of answers signed by group

Grouping: → groups of 3 after line up by middle name.

Activity:

↓ group members choose roles — set out to explain graphing and calculating vectors.

Evaluation: - One paper per group.

Reflection: — In this group exercise, I believe all tried their hand at graphing. This generated more vector discussion than I could have imagined - also reinforced the concept of 'standard position'.

Vectors-----

Exercise 1

Plot points A(2,3) and B(5,1). Connect A to B. Put arrow at B.

Find the ordered pair that represents the vector from A to B.

Plot that ordered pair and connect it to the origin. What do you notice?

Repeat the above exercise to find the vector from B to A. Use a different color.

Exercise 2

Given $\vec{v} = (4, 3)$ and $\vec{w} = (-6, -1)$

Plot the two vectors.

Graphically find $\vec{u} + \vec{v}$; $\vec{u} - \vec{v}$; and $2\vec{v}$. Please use separate axis for each. Be sure to label and give the co-ordinates of the resultant in each case.

Now, confirm the co-ordinates of each resultant by algebra!!! Please show your work!!!

Exercise 3

Write a rule for algebraic vector addition, subtraction and scalar multiplication.

Exercise 4

Give the ordered pair that represents the following:

a. $6\vec{i}$ b. $2\vec{i} + 4\vec{j}$ c. If $\vec{u} = 6\vec{j} + 4\vec{i}$, find $4\vec{u}$

Exercise 5

Given C(8,25) and D(17,3): Express the vector from C to D as the sum of unit vectors. Find the co-ordinates of the position vector of the point ¾ of the way from C to D. The later should be done graphically as well as algebraically.

MATH DEPARTMENT

Subject/Class: Trig / Pre Calc

Lesson Name: Triangle Challenge

Co-operative style: Jigsaw

Content Focus: Solving Triangles using trig and algebra

Materials: worksheet, ruler, protractor, calculator, paper

Product: 1 product per group with each Δ worked

Grouping: match cartoons

Activity: Each person calculates a part of Δ, while other(s) watch — pass to next Complete the triangle — then people sketch Δ using equipment, etc. Since All work, sign product.

Evaluation: 3pts for each part found and points for accuracy.

Reflection: Worked well, was surprised that the students had forgotten how to recreate the Δs!

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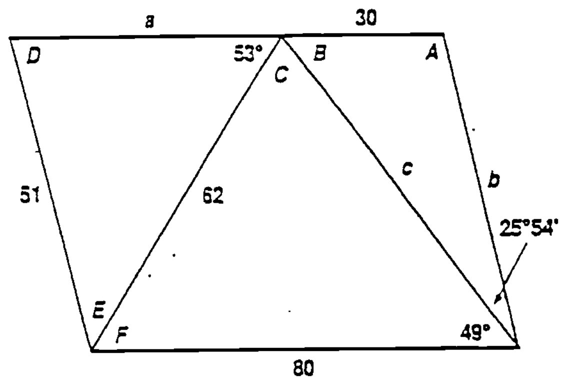
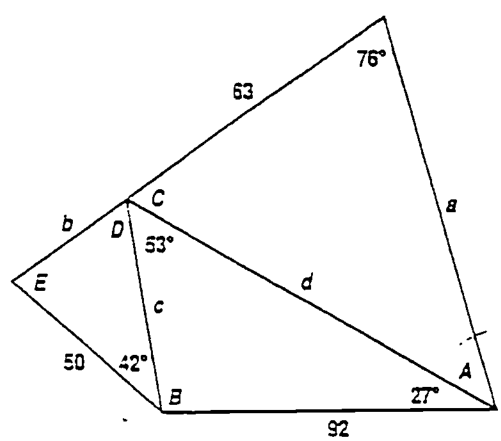
Triangle Challenge

A surveyor took the following measurements from two irregularly-shaped pieces of land. Some of the lengths and angle measurements are missing. Find all missing lengths and angle measurements. Round lengths to the nearest tenth and angle measurements to the nearest minute.

1.



2.



MATH DEPARTMENT

Subject/Class: TRIGONOMETRY / Pre Calc

Lesson Name: APPLICATIONS!!!

Co-operative style: 4-5 person teams. each w/ 6

Content Focus: Using trig function to solve real world problems

Materials: - hypsometer, tape measure, paper, calculator

Product: 1 paper per group as described in attachment

Grouping: pick - your - own - (due to need for work outside class time)

Activity: Students are given equipment and sent to measure various "sites" around the school. They use measurements and trig to calculate given values.

Evaluation: As described in handout

Reflection:
The students "look" professional. They enjoy getting out of the building - By why so cold?

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TRIGONOMETRY: SINE & COSINE APPLICATION QUIZ

Group Members: ______________________________

____

____

____

The attached sheet has four problems for your group to solve. Each problem is worth 12.5 points. Your submissions should include:

An accurate sketch - factor in the height at which the observation was made: eye level when measuring angles (2.5 points each problem)

A **written description** of how all measurements were made; any logistic difficulties encountered and how your group solved them; techniques tried or rejected and why; and suggestions for improvement. Include a rationalization of why you chose the method you used. (5 points each problem)

Complete calculations, using correct notation and with variables corresponding to your sketch. (5 points each problem.)

Notes

Due date is ______________________________

Each member of your group should have a job when you go out to take your measurements.

Do not write in solutions until the entire group has approved of each sketch, write-up and calculations!

You are required to use the law of sines or the law of cosines on at least one problem.

Staple this sheet to your solution set. The sheet must be signed by all group members.

Any misconduct will result in the forfeiture of this grade for the entire group as well as a referral to the office.

Problem 1: If a cable from the top of the flagpole in front of the high school were tethered 75 feet from the base of the flagpole, how long would the cable have to be? What angle would this cable make with the ground? With the flagpole?

Problem 2: Compute the height of the highest point of the gym roof:

a. From the front of the building
b. From the back of the building - you may not use information from part a!!!

How do your methods differ? How do your answers compare? Discuss which answer you are more confident of and why.

Problem 3: Choose a spot on the parking lot behind the school from which you can see the top of the cooling system over the math/science wing. How many feet are your eyes from the top of the tallest tower as the crow flies?

Problem 4: Choose any horizontal or vertical object on this campus to measure the width or height. Design a method for measuring this object using non-right triangle trig. Describe your problem in depth. Carry out your plan.(NOTE the object should be something big or hard to reach I.E. something that cannot be measured with a tape measure.

MATH DEPARTMENT

Subject/Class: Trigonometry/Pre Cal

Lesson Name: What would you do?

Co-operative style: -

Content Focus: - team building - problem solving

Materials: Big paper - situation slips

Product: Big paper depicting solution

Grouping: Groups of 3 - lined up by house #

Activity: Students choose (randomly) situation slip and then discuss up to 5 possible solutions. They come to a consensus and present on big paper their 'pick'.

Evaluation: - informal evaluation for my grade book -

Reflection: This was learning exercise to build cohesive groups - at the end of the group work, we looked at the various ways to reflect on situations/ learning experiences such as these.

MATH DEPARTMENT

Subject/Class: Trigonometry

Lesson Name: "go round in circles"

Co-operative style: Small group - maintain roles

Content Focus: introduce radians - the wrapping function

Materials: white paper, circles, grid, white strip, compasses

Product: - one set of circles : questions per group

Grouping: groups of 3 by last name - alphabetic.

Activity: Each student follows steps 1-6 discussing vocabulary as they occur. Choose best of 3 for part of final product. Then they work together to answer the remaining questions - respect their roles - recorder checker, encourager

Evaluation: Graded final project - (sets 1-7) students from each group

Reflection:
Not sure all "got" the concept of a radian. Some students had trouble with a circle over graph paper and plotting a point both on the circle & on the graph, too!

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WRAPPING FUNCTION

1. Draw a 10 cm line.
2. Using that line as the radius, construct a circle.
3. Draw an x-y axis on the circle.
4. Using the strip of paper, mark off segments whose length is equal to the radius of the circle.
5. Starting on the positive x-axis and moving in a counter-clockwise direction, wrap the strip around the circle. Make arcs on the circle where the marks hit.
6. One arc on the circle equals one <u>radian</u>. A radian is length of an arc equal to the radius of the circle.

---

1. Approximately how many radians are there in a semi-circle?
2. Approximately how many radians are there in a circle?

3. Take a strip of paper and wrap it around the circle, mark on the strip the length of the semi-circle arc.
   + What does it measure?
   + Divide the number by 10. What is it close to?
   + Figure 1/2 of the circumference of the circle.

4. S is the symbol for arclength. If you have a positive arc length, it is measured counter-clockwise. A negative arc length is measured clockwise. START at the positive x-axis, wrap the paper strip in a clockwise direction and mark the negative arclengths in a different color. Use the circle to tell which quadrant each arc is in.

   A. S = 2 B. S = 9 C. S = -5
   D. S = 5 E. S = -2 F. S = -7

QUESTIONS 5 AND 6 USE THE GRAPH PAPER CIRCLES

5. On the x-y axis, measure the point with the coordinates (5,8.7). Mark this point on your graph. Label the arc X. The symbolism for this is C(X) = (5, 8.7). where C represents the circular function. Answer the following by giving the appropriate co-ordinates.

   A. $C(X+\pi) =$ B. $C(X + 2\pi) =$
   C. $C(X - \pi) =$ D. $C(x + \pi/2) =$

6. On another circle, mark off arcs to correspond to 45 and 135 degrees. Measure the x and y values to that point. How do they compare?
   Using the x and y values for 45 degrees as X & Y, use the distance formula to find the value of the points in terms of radicals.

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Discovering Pi

The diameter and circumference of a circle are linked to each other. To discover the relationship, you will need 3 round objects, a piece of string, ruler and 2 books. Fill in the chart below.

	Object 1	Object 2	Object 3
measured Circumference	______	______	______
Diameter	______	______	______
C/d	______	______	______

The radian.......

A circle whose radius is one is called a <u>unit circle</u>. The signed (+ or -) length of an arc of the unit circle is called the <u>radian</u> measure. (If the radius does not equal one, a radian is deined as the ratio of the arc length to the radius. When the arc length is equal to the radius, the radian measure is 1.) Radians are measured in terms of pi or numerically. For our purposes, we will use 3.14 for pi.

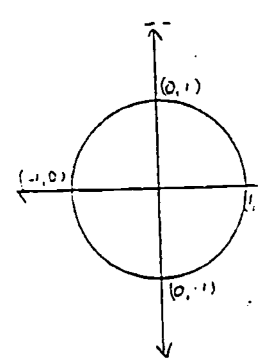
Also, remember that an angle whose vertex is at the center of a circle is called a central angle. What is true about the measure of a central angle and its intercepted arc ?

Complete the following:

Radian in pi	Radian numeric	Degree
2π	6.28	360°
______	______	______
______	______	______
______	______	______

HISTORICAL NOTE

It is not at all obvious that π is an irrational number. In the Bible (I Kings 7:23) π is given as 3. In 1892 The New York Times *printed an article showing π as 3.2. In 1897, House Bill No. 246 of the Indiana State Legislature defined the value of π as 3; this definition was "offered as a contribution to education to be used only by the State of Indiana free of cost ...." The bill was never passed. In a book written in 1934 π was proposed to equal $3\frac{13}{81}$. The symbol itself was first published in 1706 but was not used widely until Euler adopted it in 1737. By 1873 William Shanks had calculated π to 700 decimal places. It took him 15 years to do so; however, computer techniques have shown that his last 100 or so places were incorrect.*



MATH DEPARTMENT

Subject/Class: TRIGONOMETRY

Lesson Name: SUM, DIFFERENCE, DOUBLE/HALF

Co-operative style: Expert jigsaw

Content Focus: Review and introduction of (tan) above

Materials: text, extra example sheets, white paper

Product: 1 sheet per expert group w/formulas and examples for their topic.

Grouping: Hand out slips of paper - color coded. Base group(4) by color; expert group(6) by topic.

Activity:

students meet with 5 classmates in expert group and discuss formula(s) and decide on potential examples. They create a 1-2 page handout to help teach their base group topic. Base groups - then discuss all sections of formula

Evaluation: Teacher hands out worksheet to be completed individually. This sheet plus an evaluation of each group's handout serve as the grade.

Reflection: Questions - were base groups too big. Some people really got into exercise some did not -

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Sum or Addition Formula

Using angles ie. cos 75 = cos(30+45)

page 149 1-12

Using trig values of given angles

page 149 13-24

Difference Formula

Using angles page 149 1-12

Using trig values page 149 13-24

Double Number Formula

page 153 1-3; 7-9; 22-24

Half Number Formula

when you know the angle and when you don't

page 153 4-6;10-12; 13-18; 25-27

MATH DEPARTMENT

Subject/Class: Trigonometry

Lesson Name: compound graphing

Co-operative style: pairs

Content Focus: Examining compound graphs

Materials: computers, and/or graphing calculator, worksheets

Product: 1 packet per group. consist of: computer generated / student generated } pics. sets of ordered pairs for each curve.

Grouping: students choice.

Activity:

(1) students use Mathematics Toolkit to generate computer graphs need to pay attention to limits, choose 4 of 6 possible equations

(2) Using computer graphs as guide, generate enough ordered pairs needed to replicate the graph

(3) Student creates graph.

Evaluation: 60pts

5 each comp. graph
5 each ordered pair chart
5. each student generated graph

4 of 6 graphs.

Reflection: - Could have used more direction
Students not motivated to look for "best" student graphs —

Project
Graphing Compound Trigonometric Functions

Following are instructions for completing this project. All materials must be completed by Tuesday, November

You are given four of the six compound trigonometric functions listed below. For each compound function, you must:

1. **Graph on the computer** - you will need to set the limits to get an accurate representation of the function. Note the location of points.

2. **Complete the table of values** for the compound functions. Values should be to the nearest hundredth.

3. **Graph the compound function** on the provided graph paper. Check your graph for accuracy by to the computer produced graph. Please give the key points (max, min zero) of each

Now it is your turn! Graph the compound functions circled below.

a. $y = x\cos(x)$

b. $y = x + \cos(2x)$

c. $y = (2\cos(x + \pi))(3\sin(2x))$

d. your choice

e. $y = \cos(2x) - \cos(3x)$

f. $y = \sin(-x) + \cos(x)$

APPENDIX J

Sample of CooperativeProjects
Classroom C

MATH DEPARTMENT

Subject/Class: PROGRAM

Lesson Name: DRIVER'S LICENSE

Co-operative style: JIGSAW

Content Focus: SHARING OF INFORMATION

Materials: COMPUTER, PENCILS, PEN.

Product: A PROGRAM, COMPLETE WITH GRAPHICS

Grouping: 3 MEMBERS

Activity: SEE ATTACH SHEET

Evaluation: 100 PTS BASED ON

1) SCREEN PRESENTATION
2) DEGREE OF DIFFICULTY
3) OUTLINE
4) COMPLETENESS

Reflection:

Drivers License
Team Project

Set Up

1. 19 students divided into two groups of 2 = 4 people
   five groups of 3 = 15 people

2. Group will agree as to the responsibility of each member

3. Group will present a typed algorithm BEFORE beginning with coding
   This outline will also explain the task to the accomplished by each member

4. Group with be graded by the attached rubric

Instructions

L A S T - F I R Y - R B D G

Last Name

1. Delete all occurrences of h and w.
2. Assign numbers to the remaining letters as follows:
   a,e,i,o,u,y-->0; b,f,p,v-->1; c,g,j,k,q,s,x,z-->2;
   d,t-->3; l-->4; m,n-->5; and r-->6.
3. If two or more letters with the same numeric value are adjacent omit all but the first.
4. Delete the first character of the original name if still present.
5. Delete all occurrences of a,e,i,o,u,y.
6. Retain only the first three digits corresponding to the remaining letters; append trailing zeros if less than three letters remain; precede the three digits by the first letter of the last name. Put the result in L A S T.

First and Middle Initial

7. Look up first name code: 000 A; 020 Albert, Alice; 040 Ann, Anna, Anne, Annie, Arthur; 060 B; 080 Bernard, Bette, Bettie, Betty; 100 C; 120 Carl, Catherine; 140 Charles, Clara; 160 D; 180 Donald, Dorothy; 200 E; 220 Edward, Elizabeth; 240 F; 260 Florence, Frank; 280 G; 300 George, Grace; 320 H; 340 Harold, Harriet; 360 Harry, Hazel; 380 Helen, Henry; 400 I; 420 J; 440 James, Jane, Jayne; 460 Jean, John; 480 Joan, Joseph; 500 K; 520 L; 540 M; 560 Margaret, Martin; 580 Marvin, Mary; 600 Melvin, Mildred; 620 N; 640 O; 660 P; 680 Patricia, Paul; 700 Q; 720 R; 740 Richard, Ruby; 760 Robert, Ruth; 780 S; 800 T; 820 Thelma, Thomas; 840 U; 860 V; 880 W; 900 Walter, Wanda; 920 William, Wilma; 940 X; 960 Y; 980 Z.
8. Look up middle initial code: 0 None; 1 A; 2 B; 3 C; 4 D; 5 E; 6 F; 7 G; 8 H; 9 I; 10 J; 11 K; 12 L; 13 M; 14 N; 15 P,Q; 16 R; 17 S; 18 T,U,V; 19 W,X,Y,Z.
9. Add the results of steps 7 and 8. Put the results in F I R.

Birth Date and Gender

10. Put last two digits of year of birth in Y - R.
11. Subtract 1 from number of month of birth; multiply by 31; and add the day; if female, add 600. (For example, if male and birthday is May 14th, the result is 31(5 - 1) + 14 = 138, and if female and birthday is May 14th, the result is 31(5 - 1) + 14 + 600 = 738). Put results in B D G.

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SCORING RUBRIC
PROGRAM 1
SPECIAL PROJECT

FEATURES	4 EXCELLENT	3 ACCEPTABLE	2 DEVELOPING	1 UNACCEPTABLE
Follows required directions	• Clear and concise instruction set included • Printout,outline,and disk provided in excellent format	• Some instruction(s) are not completed • Printout, outline,and disk provided in good format	• Instruction set is provided; however it is vague • All three items are provided; however they are in poor form	• Instruction set not provided • Outline isn't in proper format • No printout provided
Meat and potatoes	• 6 or more programming structures • 3 calls to subroutines • Complete use of parameters	• 5 programming structures • 2 calls to subroutines • Used mostly globals variables	• 3 programming structures • 1 call to subroutines • Used few local values	• 2 or less programming structures attempted • No calls to procedures or functions • Used no local variables
Coding	• shows complete use of appropriate programming techniques	• shows nearly good use of programming techniques	• Shows some use of good programming techniques	• Only elementary techniques used • Lacks direction
Screen presentation	• Solution process is completed • Program is very superior in eye appeal	• Solution process is nearly completed. • Program is fairly good in eye appeal	• Solution process has several gaps • Program is very generic	• Program doesn't work correctly • Poor screen use • Limited use of color

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MATH DEPARTMENT

Subject/Class: C.P. M

Lesson Name: Differentiate by use of Product, Quoti and chain rules.

Co-operative style: Jig Saw

Content Focus: The Derivative

Materials: – Big Paper, scissors, markers, rulers, tape

Product: Big Paper presentation of solutions.

Grouping: by groups of three

Activity:

\# 13, 14, 6

1) Each group to do 3 programs
2) Each member to do 1 problem, display step by step the solution
3) In turn each member of the group will jigsaw (teach their solution to each of the other.
4) Post their solutions for comparison to other groups.

Evaluation:

10 points per member on A) correctness
B). Display.

Reflection:

As Homework each student to individually

do P 155 – # 3
P 156 – # 6
P 157 – # 11

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$$y = 3x\sqrt{1-2x^2}$$

156

6 $\quad y = t^2\sqrt{1-t}$ find $\frac{dy}{dt}$

4 $\quad y = \sqrt{x}\,(1+x^3)^2$ find $\frac{dy}{dx}$

157

6 $\quad y = \frac{\sqrt{9-x^2}}{2x}$ find $\frac{dy}{dx}$

11 $\quad f(x) = \frac{a^2-x^2}{\sqrt{2ax}}$ find $f'(x)$

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Homework

#3 $f(x) = 2\sqrt{x^2+1}$ or $2(x^2+1)^{\frac{1}{2}}$

$f'(x) = 2 \cdot \frac{1}{2}(x^2+1)^{-\frac{1}{2}}(2x) = \dfrac{2x}{(x^2+1)^{\frac{1}{2}}} = \dfrac{2x}{\sqrt{x^2+1}}$

#6 $y = t^2(1-t)^{\frac{1}{2}}$

$\frac{dy}{dx} = 2t(1-t)^{\frac{1}{2}} + t^2 \cdot \frac{1}{2}(1-t)^{-\frac{1}{2}}(-1)$

$2t(1-t)^{\frac{1}{2}} - \frac{1}{2}t^2(1-t)^{-\frac{1}{2}}$

$\frac{1}{2}t(1-t)^{-\frac{1}{2}}[4(1-t) - t]$

$\frac{1}{2}t(1-t)^{-\frac{1}{2}}[4 - 4t - t]$

$\frac{1}{2}t(1-t)^{-\frac{1}{2}}[4 - 5t]$ $\dfrac{t(4-5t)}{2\sqrt{1-t}}$

#11 $f(x) = \dfrac{a^2-x^2}{(2ax)^{\frac{1}{2}}}$

$\dfrac{(2ax)^{\frac{1}{2}}(-2x) - \frac{1}{2}(2ax)^{-\frac{1}{2}}(2a)(a^2-x^2)}{2ax}$

$(2ax)^{-\frac{1}{2}}[-2x(2ax) - a(a^2-x^2)]$

$(2ax)^{-\frac{1}{2}}[-4ax^2 - a^3 + ax^2]$

$\dfrac{-3ax^2 - a}{\sqrt{2ax}}$

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9 $y = 3x\left(\sqrt{1-2x^2}\right)$

$3x(1-2x^2)^{\frac{1}{2}}$

$\frac{dy}{dx} = 3x \cdot \frac{1}{2}(1-2x^2)^{-\frac{1}{2}} \cdot (-4x) + 3(1-2x^2)^{\frac{1}{2}}$

$-6x^2(1-2x^2)^{-\frac{1}{2}} + 3(1-2x^2)^{\frac{1}{2}}$

$3(1-2x^2)^{-\frac{1}{2}}\left[-2x^2 + (1-2x^2)^1\right]$

$\frac{dy}{dx} = \frac{3(1-4x^2)}{(1-2x^2)^{\frac{1}{2}}}$

#14 $y = \sqrt{x}\,(1+x^3)^2$

$\frac{dy}{dx} = x^{\frac{1}{2}} \cdot 2(1+x^3)(3x^2) + \frac{1}{2}x^{-\frac{1}{2}}(1+x^3)^2$

$6x^{\frac{5}{2}}(1+x^3) + \frac{1}{2}x^{-\frac{1}{2}}(1+x^3)^2$

$\frac{1}{2}x^{-\frac{1}{2}}(1+x^3)\left[12x^{\frac{6}{2}} + (1+x^3)\right]$

$\frac{1}{2}x^{-\frac{1}{2}}(1+x^3)(12x^3 + 1 + x^3)$

$\frac{(1+x^3)(13x^3+1)}{2\sqrt{x}}$

or

$\frac{13x^6 + 14x^3 + 1}{2\sqrt{x}}$

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#6 $y = \dfrac{(9-x^2)^{\frac{1}{2}}}{2x}$

$$\frac{dy}{dx} = \frac{2x \cdot \frac{1}{2} \cdot (9-x^2)^{-\frac{1}{2}}(-2x) - 2(9-x^2)^{\frac{1}{2}}}{4x^2}$$

$-2x^2(9-x^2)^{-\frac{1}{2}} - 2(9-x^2)^{\frac{1}{2}}$ Top only

??

$-2(9-x^2)^{-\frac{1}{2}}(x^2 + (9-x^2))$

$-2(9-x^2)^{-\frac{1}{2}}(x^2 + 9 - x^2)$

$$\frac{-\cancel{2}(x^2 - x + 9)}{4x^2(9-x^2)^{\frac{1}{2}}}$$

$$\cancel{\frac{-(x^2 - x - 9)}{2x^2(9-x^2)^{\frac{1}{2}}}}$$

we got

$$y' = \frac{-9}{2x^2(9-x^2)^{\frac{1}{2}}}$$

~~Homework~~

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MATH DEPARTMENT

Subject/Class: C. P. M.

Lesson Name: National Graphing

Co-operative style: Jig Saw

Content Focus: Meta cognitive Thinking skills

Materials: Q Basic, MEK, Big Paper.

Product: 3 graphed equations

Grouping:

Activity:

Evaluation:

Reflection:

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INSTRUCTIONS FOR VERBAL GROUP WORK 1

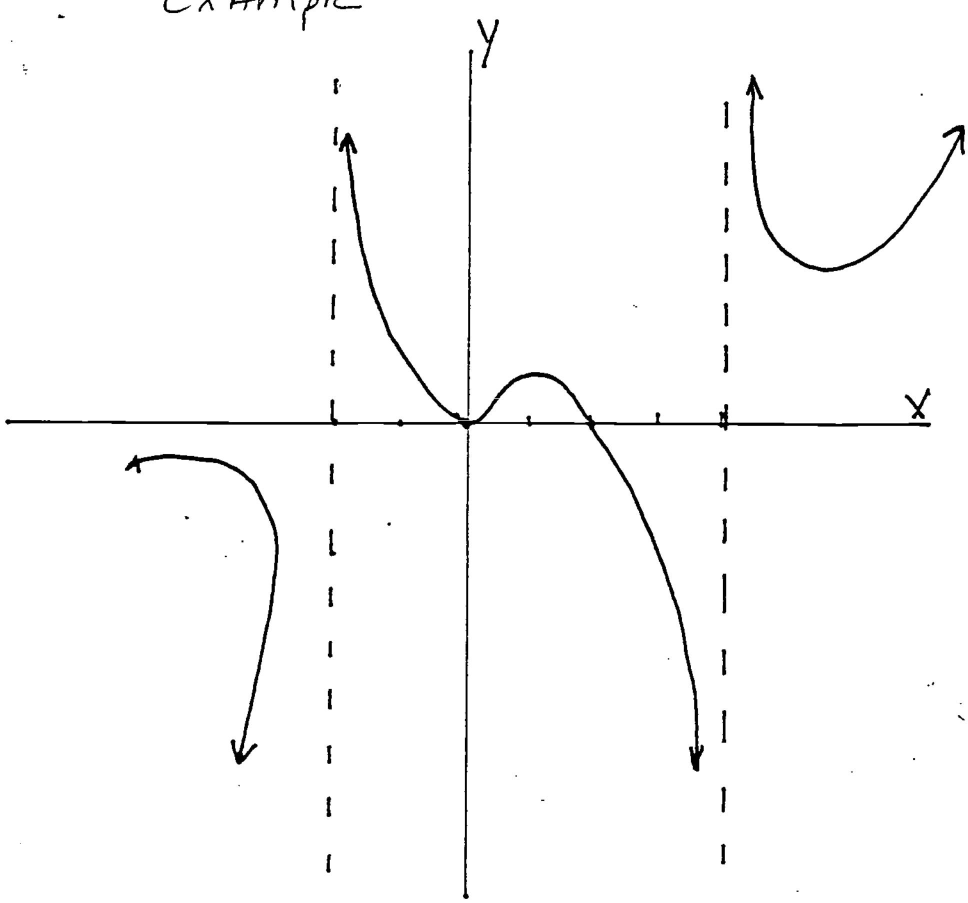
1. Choose a member of your group to be the reader. This individual will pick at random a rational graph for the stack.

2. This member will look at the drawing and describe the different features of the graph . One may, for example, say that there are three zeros, two which cross and one that touches the x axis at points, A, B, C. There are two vertical guides located at D,E. There is one horizontal guide at F. In boundary region one the graph starts in the yyy quadrant.

3. The other members will graph the item

4. All member will use co-operative learning to generate the equation for the function.

Example



MATH DEPARTMENT

Subject/Class: Calculus (C.P.M)

Lesson Name: Polynomial functions

Co-operative style: Interactive partners

Content Focus: examine P/Q, even, odd exp.

Materials: Math Exp. Kit

Product: Big Paper of 3 graph

Grouping:

Activity: attached Sheets

Evaluation:

Reflection:

50

COLLEGE PREP MATH

NATURE OF POLYNOMIAL FUNCTIONS

The general form of a polynomial equations is $f(x) = ax^n + bx^{n-1} + cx^{n-2} + \ldots + k$ The zeros of a polynomial function are those values of the domain for which the function has a value of zero. These can often be determined by factoring.
Ex.
$f(x) = x^2 - x$ has zeros of 0 and 1 because $f(x) = x(x-1)$

Symmetry - (with respect to the axis and origin) - see sheet labeled function 7,8,9,10

Consider the equation $f(x) = x^3 + 4x^2 - 3x - 18$ which in factored form is $f(x) = (x-2)(x+3)^2$

1. graph this equation with the use of plotted points one needs about 12 - 15 orderd pairs - shown them in a table

2. what happens at $x = 2$

3. what happens at $x = -3$

Consider the equation $f(x) = x^6 + 6x^5 + 12x^4 + 6x^3 - 9x^2 - 12x - 4$ or in factored form

$f(x) = (x+2)^2(x-1)(x+1)^3$

1. graph the function 12-15 ordered pairs

2. what happens at $x = -2$

3. what happens at $x = 1$

4. what happens at $x = -1$

What conclusions can be drawn in regard to odd and even exponential factors

77

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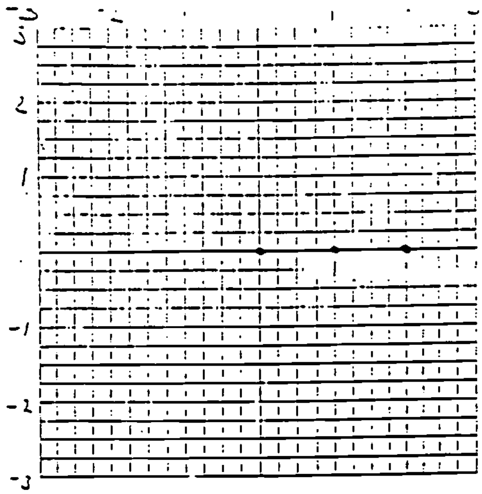


DRAW THE GRAPH OF

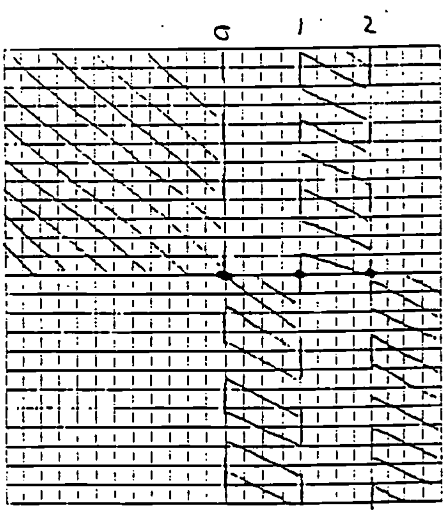
$P(x) = x^3 - 3x^2 + 2x$

$P(x) = x(x^2 - 3x + 2)$

$P(x) = x(x-1)(x-2)$

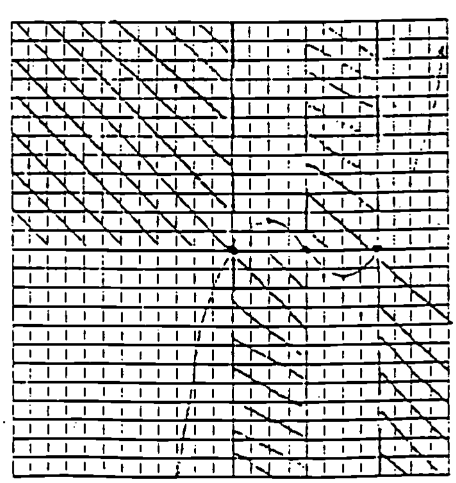
THE X-INTERCEPTS ARE
(0,0) (2,0), and (1,0)

THE Y-INTERCEPTS ARE
(0, P(0)) = (0,0)



SINCE x = 0 & x = 1 ARE ZEROS DRAW THE GRAPH FIND AT LEAS ONE POINT BETWEEN (0,0) + (1, SIMILARLY BETWEEN (1,0) + (2, ALSO SHOULD FIND POINTS (c, WHEN c> 2 and c<0

X	-1	0	$\frac{1}{2}$	1	$\frac{3}{2}$	2
P(X)	-6	0	$\frac{3}{8}$	0	$-\frac{3}{8}$	0



MATH DEPARTMENT

Subject/Class: CPm

Lesson Name: Derivative

Co-operative style: Jig Saw

Content Focus: Formal - alternative - Short Cut Method

Materials: Big Paper, markers, scissors

Product: large scale picture of the solution

Grouping: 3 in a group.

Activity: PAGE 142-#9, #11 PAGE 144 - 16, 18, 21, 22

Each group will assign 2 problems per student
After completely doing the 2 problems each student will teach the other two their problems.
* All three work on problems together - Post work.
Then carousel each group - examine the work, then move to next problem.

Evaluation:
Team grade as weekly Homework mark.

Reflection:

#9 $f(x) = \sqrt{x^2+1}$ @ 2

#11 $f(x) = \sqrt[3]{x}$ @ 2

#16 $f(x) = x^3$ @ 2

#18 $f(x) = x^3 + x^2 + x + 1$ @ -2

#21 $y = \frac{x}{x-1}$ @ -2

22) $y = \frac{1}{x^2}$ @ -2

Methods F = formal
A = alternate
SC = Short Cut

#9 — F & —
#11 — F & —
#16 — F & A
#18 — F & SC
#21 A & SC
#22 A & SC

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MATH DEPARTMENT

Subject/Class: C P M

Lesson Name: Derivative of the Trig functions

Co-operative style: Expert jigsaw from page 163

Content Focus: Trig function / Chain rule

Materials: Big Paper / markers

Product:

Grouping: by 3's in a group

Activity:

On Page 163 all the one(s) to do #9

1/3 of time all the two(s) to do # 10, all the three(s) #12

2/3 time Each group to evaluate # 14 for the second derivative

Evaluation:

Each group to earn a max of 10 pts per member toward accumulation of 60 pts towards test score

Reflection:

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1. $f(x) = (x^2 + 1)^2$

2. $f(x) = (3x - 2)^2$

3. $f(x) = \frac{1}{4}(x^2 + x - 1)^4$

4. $f(x) = \frac{(x + 1)^3}{3}$

5. $f(x) = 4 \sin x$

6. $f(x) = -6 \cos 2x$

7. $f(x) = \frac{1}{2} \sin^2 x$

8. $f(x) = \frac{-1}{3} \cos^3 x$

9. $f(x) = \frac{\sin x}{1 + \cos x}$

0. $f(x) = \frac{-1}{5} \cos^5 2x$

1. $f(x) = 3 \tan 3x$

2. $f(x) = \operatorname{ctn} x$

3. $f(x) = \sin 2x + 3 \cos x$

4. $f(x) = \frac{\sin x + x}{\cos x}$

15. Compute the second derivative of the functions in problems 3, 6, 9, 13, and 14.

16. $f(x) = \sec x$

17. $f(x) = \csc x$

18. True or false?: The derivative of $f(x) = \sin^3 x$ equals the derivative of $g(x) = \sin x^3$.

19. $f(x) = \sin(\sin x)$

20. $f(x) = \sqrt{\tan x}$

21. $f(x) = \cos(x^3 + x + 5)$

22. $f(x) = \sqrt{\frac{x + 2}{x - 2}}$

23. $f(x) = x\sqrt{x^2 + 1}$

24. $f(x) = \sqrt[4]{x^3 + \sin x}$

25. Find the second derivative of $f(x) = \frac{1}{x + 1}$

26. Show that $f(x) = 5x^2 + 3x + 1$ is always concave downward.

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MATH DEPARTMENT

Subject/Class: Calculus (CPM)

Lesson Name: Nature of graphs

Co-operative style: Interactive partners

Content Focus: Examination of quadratic function

Materials: Computers - one for programming, one for Math Exp. Tool Kit.

Product: 2 completed sheets - 4 graphs

Grouping: Groups of 2 to 3 students

Activity: attached sheets

Evaluation:

Reflection:

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COLLEGE PREP MATH

NATURE OF GRAPHS

A. Using the equation of $Y = AX^{n}$ determine the shape of the graph as : substitute at least six values for A

		1	2	3	4	5	6
1. A-->oo+	A						
	Y						

Conclusion

2. A-->oo-	A						
	Y						

Conclusion

3. A-->0	A						
	Y						

Conclusion

B. What governs the shape of the graph due to the value of A

C. What governs the shape of the graph due to the value of N

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