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ABSTRACT

This paper reports on a study that examines mathematics scores when hands on manipulatives and group activities are used in the classroom at the middle school level. The study also explores changes in students' opinions of mathematics, assesses the intentions of females to take higher mathematics classes in high school, and surveys the amount of parental assistance students receive on homework. Students (N=27) in two pre-algebra classes participated in the study by responding to a pre-test, then participating in various activities related to the curriculum. Their scores and information collected via a survey complete the data. Survey data provides insight into student attitudes and perceptions. Results indicate that: (1) student performance is enhanced by the use of manipulative materials; (2) students' attitudes toward mathematics are significantly more positive than those in previous years; and (3) homework did not seem to positively affect student performance. The analyses suggest that the benefits of using manipulative materials in teaching algebraic concepts may not be evidenced by student grades. Contains 22 references. (DDR)

Masters Thesis:

Use of Manipulatives in Mathematics at the Middle School Level and Their Effects on Students' Grades and Attitudes

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CHAPTER 1

Rationale

"A belief that all children can learn must be at the heart of any and all teacher education and professional development. This is not to say that all children learn in the same way. What it does say is that we must educate teachers not to make assumptions that only an elite few are capable of learning anything more than the basics of mathematics and science." (8:10) According to Carol E. Greenes, associate dean and professor of mathematics at Boston University, as reported in the Secretary's Conference on Improving Mathematics and Science Teaching and Instructional Resources, October 1992, good math teachers do much more than assign workbook exercises. They teach mathematics in investigative ways, continually assessing what their students are learning, and know which of the remedial strategies to use. Teachers need to know how to teach students to explore ideas and allow them the flexibility to develop problem-solving skills. They need to do much more than lecture and drill. (8:11)

"Attitudes create a self-perpetuating cycle: children with positive beliefs about math perform well, which makes them like math and feel good about themselves; students with negative beliefs fall farther behind, which reinforces their low expectations and sense of failure," according to a report from the Council for Education Development and Research. (4:5)

Questions which are important include the following: do students who have had little, if any, success at mathematics benefit from activities that allow them to participate in learning rather than the traditional lecture presentation? Do student test scores and daily grades increase using a hands-on approach to teaching mathematics? Will female attitudes toward mathematics show more improvement than male attitudes?

STATEMENT OF THE PROBLEM: 1) Is there any improvement in overall math scores when hands-on activities are used in the classroom at the middle school level? 2) Have students' opinions toward math changed from their intermediate grade school years? 3) Are females planning to take higher math classes during their high school years? 4) Are students obtaining assistance from parents or guardians on assignments?

HYPOTHESIS: Students, when given the opportunity, will better understand certain mathematical concepts after using manipulatives, hands-on and group activities. Students will achieve a greater increase in grades compared to their 7th grade performance.

When surveyed, eighth grade students at Tygarts Valley Jr/Sr High School enrolled in Mathematics 8 or Pre-Algebra (advanced or regular) will find hands-on activities to be beneficial in problem solving. Students will develop an increased positive opinion of their individual mathematics ability compared to their intermediate grade school years.

PURPOSE OF THE STUDY: It is anticipated that the study will show that students who have traditionally been below average in mathematics scores will develop a better attitude and more enthusiasm for mathematics after having used manipulatives to explore some areas of mathematics. It is also anticipated that female students will feel better prepared to take higher level classes and feel more encouraged to do so. Also, quarterly and/or semester grades will show improvement on skills necessary for higher level mathematics courses as well as the basic computation skills.

SIGNIFICANCE OF THE STUDY: Based on the responses from the students surveyed, results will show that hands-on activities are a necessary part of the bridging between general mathematics and algebra, and that student confidence has been increased so that more female and male students will enroll in higher mathematics classes and future college or trade school plans.

ASSUMPTIONS: The time frame of eighteen weeks was adequate. The sample size was adequate. The sample was typical of most eighth grade students. The survey instruments being used and the tests used were valid.

LIMITATIONS: The survey is limited to the first semester grades for approximately 75 eighth grade students at Tygarts Valley Jr/Sr High School in Randolph

County, West Virginia. The survey results were limited to only those surveys returned and only those questions answered. Answers will reflect the environment and current surroundings of those students. Information on the use of manipulatives and hands-on activities at the middle school level will be limited to that which is published. The time frame of this study is limited to eighteen weeks. The test comparisons will be limited to those tests given during the aforementioned time frame.

DEFINITION OF TERMS:

manipulatives: objects that appeal to several senses; can be touched, handled or moved

hands-on activities: activities using objects or items which can be held, touched, moved, cut, etc.

middle school: usually including grades five-six or six through eight.

junior high: a school usually including the seventh, eighth, and ninth grades.

pre-algebra: the preliminary study of mathematics in which symbols (as letters and numerals) representing various entities (as numbers and functions) are combined according to specific rules of operation.

general mathematics: mathematics curriculum that is not specialized or specific in course material.

mathematics: the science of numbers and sets and their general operations, relations, and combinations and of space configurations and their structure, measurement and transformations.

CHAPTER 2

Literature Review

"In today's schools, more and greater expectations are placed on classroom teachers to improve student achievement in mathematics and science. If teachers are to meet this challenge they must have the ability and freedom to make sound curricular decisions and to structure the daily mathematics and science experiences of students. The teacher knows the students best and is, therefore, the professional who should decide what is best for the students." (2: 1)

According to James Kelly, president of the National Board for Professional Teaching Standards, teachers also need to know how to manage and monitor student learning; continually improve their practice; and work collaboratively with parents, other teachers, and administrators. College pedagogy courses should duplicate or model what teachers want the teaching of mathematics and science to look like in their classrooms. School systems must also help practicing teachers enhance their teaching skills by providing better and more extensive professional development. School leaders and policy makers can demonstrate their support for professional development by giving their teachers time to participate in programs to enhance their teaching skills. (8:11)

Teaching for understanding means students do not just memorize information but actively seek it, building relationships among data. It means that teachers are facilitators, not just preachers of facts. It means moving away from simply absorbing facts, to constructing knowledge. (8:7) Teaching for understanding means realizing that children need to know certain concepts, but not dictating *how* they must learn them. It means understanding that there is more than one way to solve a problem, or to learn a scientific concept. Such teaching is not going on in the majority of the classrooms today. To teach for understanding schools must shift from a teacher-centered classroom to a student-centered one. Interactive mathematics and science programs have students work in groups to solve open-ended, long term problems. (8: 8)

American education has traditionally viewed the student as a kind of jug into which one pours information. Finally, some schools are rethinking this premise and more actively engaging students in the learning process. (4: 19)

Student self-esteem has been a concern of educators for as long as educators have been nurturing, caring for, and preparing young people for their place in society. However, in more recent times, self-esteem has taken a back seat to grade point averages, SAT and ACT scores, and preparation for college, and has led educators to cover content and overshadow the fact that student self-esteem provides a very necessary balancing effect in student growth. Student success should come in a variety of attributes--not just the grade point average, the National Honor Society or the academic honor roll. (18: 107)

A recent issue of *Teaching for Excellence* suggested that "Repeated lack of success in one area frequently carried over to other areas. At very young ages, these children got the feeling that they were not good at the 'game of school' and their self-esteem began to erode." (18: 107)

According to Diane Resek, to teach for understanding, teachers should provide students with hands-on experiences, not just paper-and-pencil assignments. They should introduce problems related to real life situations, not those that are neatly formulated. (8: 8)

Most teachers agree that the use of manipulative materials helps students build a strong understanding of mathematical concepts and enhances students' achievement in mathematics. The universal anxiety today about achievement in mathematics should prompt educators in this field to heed results from studies which indicate that by using manipulative materials at every level, test scores are dramatically improved.

Teachers of mathematics at the elementary level employ manipulatives frequently and extensively while the use of manipulatives gradually decreases in succeeding grade levels. Mathematics in the upper grades has been traditionally reluctant to use a hands-on approach. (21: 22)

According to an article by David E. Williams in *Arithmetic Teacher,* entitled "Activities for Algebra," it is as necessary to involve students physically in active learning experiences in an algebra class as it is in a first-grade classroom. (14: 23)

A major barrier to the use of manipulatives at the upper grade levels is attitude. Students' attitudes have been conditioned by the traditional view of mathematics as a body of technical algorithms. By the time students enter middle school they believe that in mathematics there is always a rule to follow. They want to be told the rule and resist the original and creative thinking required by an activity-oriented program.

Because abstractions are an integral part of algebra and because students derive their abstract ideas primarily from their experience, it is imperative that they experiment with a variety of manipulative materials on the concrete level to develop an understanding of algebraic symbols and concepts. (21: 23)

Active instruction encompasses a range of instructional approaches: small groups and cooperative learning, class discussion, teacher interviewing, and the use of hands-on experiences and concrete objects. It is well-suited to teaching higher order skills. Active instruction builds on each child's level of understanding and conceptual development. The teacher becomes less of a transmitter and more of a facilitator and organizer. The classroom becomes a lively place where students freely exchange ideas and learn concepts by talking, exploring, and discovering. Communication is a major part of active instruction. The goal is to create an atmosphere in which independent thinking flourishes. Students have shown that instruction which features active and hands-on experiences has a positive effect on mathematics achievement and improves student attitudes toward math. (4: 19)

The results of a study of teachers who were known to have begun implementation of the instructional practices suggested by the National Council of Teachers of Mathematics (NCTM) showed that the instructional practices of four teachers were diverse. Three utilized a lecture approach as the main mode of instruction. Each teacher had an instructional focus. One frequently used manipulatives, one used a curriculum that emphasized computer-assisted student explorations, one assigned projects through which students gained understanding, and one used a constructivist-learning approach. Each of the teachers interviewed articulated a desire to change their assessment practices, but felt constrained by time, lack of collegial contact, and curricular demands. (6: 21)

According to the report, an unexpected finding was the use of a conventional lecture/discussion approach by all the teachers. The teachers who had students construct understanding through activities used the lecture time to summarize and extend the concepts which were explored by the students. Another unexpected finding was that teachers' instructional practices and assessment practices were aligned. Teachers cannot develop into interactive, conceptually-oriented, constructivists without having assessment tools which support them; they can only progress as far as their assessment techniques allow.

According to the study results, assessment was the area in which they felt the weakest, realizing that assessment methods which reveal student understanding must become an integral part of their preparation. (6: 21-22)

Kober notes that U.S. students are not developing the higher order skills they need to compete in the modern work place. Research corroborates that most of the time in elementary math classes, perhaps as much as three-fourths, is spent teaching lower level skills, often through paper-and-pencil drill and seatwork. Problem solving, when it is taught at all, is more often done using end-of-chapter or workbook story problems. (4: 17)

According to Fancie Alexander, Deputy Assistant Secretary of OERI, the "old way" of teaching, an overreliance on print, pencil, and paper, and the teaching-by-telling approach, is overused, and many teachers still teach math and science using text and worksheets, rather than the new hands-on activities. (8: 14)

Mechanics without meaning does not enable children to visualize relationships that make mathematics interesting, elegant, and logical. If students forget the mechanical procedure, they have nothing to fall back upon. When students understand the "why" behind something, they remember the facts longer and use them more frequently. They also apply their knowledge to learning new tasks and acquire higher order skills and strategies that fuel lifelong learning. (4: 17)

An article in the *Middle-School-Journal* entitled "Why Aren't Manipulatives Used in Every Middle School Mathematics Classroom?" cites interviews of thirty teachers of fourth through eighth grades who felt uncertain of how to use manipulatives in their classroom. The interviews also revealed these teachers felt manipulative instruction was inappropriate for students above the fourth grade. (1: 61-62)

Reform in mathematics has broad support, and it is beginning to push toward changes in standardized testing procedures and questions. However, those changes will require a constant effort over a number of years. Since the late 1980s, published reports such as *The Underachieving Curriculum, Everybody Counts, Curriculum and Evaluation Standards for School Mathematics,* and *The Road to Reform in Mathematics Education,* have addressed the seriousness of students' poor performance and their poor preparation to meet the needs of business and industry in the twenty-first century. (15:22)

The *"Standards",* as they have come to be called, have received a great deal of attention from mathematics educators. They advocate fundamental changes in the mathematics curriculum, mathematics instruction, and in student assessment so that the mathematics classrooms of the twenty-first century will bear little similarity to the mathematics classrooms of today and, in addition, meet the needs of business and industry. Among the changes are the discovery of new mathematics, applications of mathematics to many types of problems, the development of personal computers, and computer applications of mathematics necessary to adequately prepare students for the expectations of industry. The mathematics that is offered and/or taught to all students must reflect these expectations. (15: 23)

To facilitate the transition to a new secondary curriculum, the middle level curriculum, especially grades 7 and 8, needs to be broadened. According to NCTM Standards, teachers need to "expand students' knowledge of numbers, computation, estimation, measurement, geometry, statistics and probability, patterns and functions, and the fundamental concepts of algebra. These topics should be taught as an integrated whole so that the connections among them are prominent." (15:24)

Students should learn mathematics in the context of problematic situations that are open-ended and give opportunity for multiple approaches to solutions. Students need the opportunity to discuss problems with others, work cooperatively, and justify their choices. Cooperative learning groups can be an important part of this process. "In addition, the middle level or secondary teacher needs to use manipulatives, calculators, and computers as an integral part of instruction." (15:25)

Schools can achieve this by eliminating repetition of material covered from one year to the next and expanding coverage of the last half of the textbook being used, which is often skipped. It was also noted that emphasis be removed from the computational skills now required for progression to higher level classes and that calculators be used to assist in computation. (15:24)

In a survey of 744 kindergarten through eighth grade teachers in Arizona, eighth grade teachers indicated a desire to stay away from worksheet items where students work problems that have a set of numbers (no pictures), and prefer to focus a bit more on the concrete, pictorial type problems. Some teachers remarked that they use to teach rules and give practice but now feel it is better to let the students explore and figure things out for themselves. Opinions on the use of calculators to assist student problem solving was mixed. (10:9)

The use of manipulatives stimulates the senses of students as they are able to touch the manipulatives materials, move them about, rearrange them, and/or see them in various patterns and groupings. (5:3) "The manipulation of these materials assist students in bridging the gap from their own concrete sensory environment to the more abstract levels of mathematics." (5:3) Therefore, manipulatives are effective and motivating tools for assisting and enhancing the development of mathematical concepts.

Some suggested ways in which manipulatives may be used and the variety of ways in which they should be used was delivered in an article entitled "Manipulatives, Motivating Mathematics". Among these suggestions were: the introduction of new mathematical concepts, to reinforce previous learning, to provide concrete representations of abstract ideas, to provide for individual learning style differences, to foster creative thinking processes, to provide experiences in problem solving situations, to provide an opportunity for students to exchange viewpoints with their classmates, to diversify the educational activities, and to enhance interest and motivation for learning new concepts. (5:3)

According to the article, the general consensus is that manipulative materials help provide a strong basis for conceptual learning and can, therefore, be recommended for use by all students. Additional information shows that manipulative use with handicapped students can be very effective as these students often benefit from an active learning approach. Manipulatives can also be used with special students to assist them in organizing their thinking so that they can begin to see relationships or follow computational procedures. Manipulative use can also be valuable for those students in need of remediation. Often, these students have developed misunderstanding or misconceptions and, therefore, by allowing these students to use manipulatives would give them an opportunity to rebuild the necessary conceptual foundations.

Manipulative materials are also valuable tools for gifted students. The use of manipulatives often allows these students to pass through the concrete stages of learning much more rapidly. These materials can also be used to extend the gifted students' thinking to higher levels, to improve their spatial visualization, to enhance their creativity, and to provide them with problem solving experiences. (5: 4)

In a study of fifty-three seventh grade students in a large suburb public middle school, the observer noted the need for student engagement in the curriculum. "Educational engagement", as defined by Wehlage and his colleagues, refers to the psychological investment required to comprehend and master knowledge and skills explicitly taught in school, and the two levels of engagement: simply doing what they are asked, or demonstrating real interest in and commitment to school tasks. (9:10)

The students interviewed revealed similar attitudes about mathematics in the styles of mathematics problems or activities that they preferred. The three main preferred activities that students responded to most often were: solving of open-ended word problems or questions; problem solving when working in groups; and actually "doing" the activities with manipulatives. Several students talked in terms of action, actually doing the mathematics and how they like working with manipulatives or visual aids while studying mathematical concepts. (9: 11-12)

It was also revealed that interviewed students disliked problems that required less thinking and those that only emphasized procedures. These problems fell into two groups: when reviewing over and over problems that they already knew and "just watching" the teacher work problems. The students' grades showed that they had mastered the skills even though they may not have enjoyed them. (9: 14-15)

The study also revealed that when students were engaged in low level activities or lessons, they spent time talking instead of listening, laying heads down on their desks, playing with items on their desks, and scribbling. These students' attitudes toward these types of problems revealed that they were "boring," or "that they have better things to do," and "I hate math." (9: 17)

In conclusion, this study provided some indication that the difficulties can be overcome. A teacher who provides student-centered approaches to mathematics plays a major role. Students must want to learn and feel good about learning. Educators need to become aware of situations that can cause low engagement and learn to work with students in ways that can increase engagement levels. Effective mathematics teaching needs to focus on instruction that promotes students' activity and move away from lecturing. (9:23)

"Without motivation, learning is reduced to only a sequence of activities externally imposed by the teacher on the student." (9: 23)

According to a booklet entitled, "Helping Your Child Learn Math with Activities for Children Aged 5 through 13", the focus of instruction today is less on the quantity of memorized problems, and more on understanding the concepts and applying thinking skills to arrive at an answer. Even though accuracy is important, a wrong answer may help parents and children discover what is not being understood. Children do not want incorrect responses or red marks on their papers. Parents need to be patient and ask questions when they help their children with assignments. By encouraging children to talk about what they are thinking, one can help them to become stronger mathematicians and independent thinkers. (3: 7-8)

As reported in the document titled "What We Know about Mathematics Teaching and Learning," involving parents in their child's mathematics education is one of the first steps toward the goal that every child must gain mathematics power. One of the studies used in this document concluded that when parents monitor their child's homework, the child completes more assignments, has higher test scores and higher math grades. It also stressed that parent involvement alone does not ensure that homework is useful and that teacher feedback on homework assignments is essential. The document also indicates that sometimes community and school tutoring groups are essential components to the student's homework problems if parents are unable or unavailable to help their child. Hotlines and parent workshops have been developed within communities and towns to assist these students. A very important point was made in this document: parents should never use math homework as punishment. (4:51)

Parents can affect their child's math achievement through the value they communicate about education, the childs' effort, the long-term rewards of hard work and persistence, and their personal responsibility. Parents who let their children know that math is important and that effort yields success are more likely to have children who do well in math. By the same token, negative parent attitudes about math can color children's perceptions and ultimately their achievement. Parents who may have had negative educational experiences in math themselves can pass along their fears to their children. Enrollment in advanced math courses often depends on parents pushing their children to take rigorous courses. Parents have great influence over their children's mathematics course decisions especially if they talk to their children about the relevance of math to future jobs and education and let their children know they can succeed. (4:47)

While time spent on homework is not a potent predictor of student math gains, homework does not hurt and may very well help. According to the document, studies have found that math achievement is higher when students have regular homework and just about as many studies found no significant correlation between homework and achievement gains. No studies have revealed negative effects from homework. The document also reports that positive effects of homework may accumulate over time and that homework helps students become more independent learners.

There is also some evidence that positive effects of homework may accumulate over time and that homework helps students become more independent learners. Homework appears to be most useful in improving students' computational skills. The practice of grading homework may be counterproductive. The most beneficial approach is for teachers to make home drill-and-practice activities risk-free; to credit students for doing homework and not punish them when they have difficulty. Homework, from the teacher's standpoint, should be a primary source of information about a child's progress, which the teacher can use to adapt instruction to student needs. (4:49)

How do students' perceptions of math influence their math learning? Attitudes and beliefs are powerful forces that work beneath the surface to enhance or undermine students' math performance. Students who dislike or fear math, thereby doubting their own competence, are likely to achieve below their capabilities. Students who like math and consider themselves competent at it are more apt to achieve higher grades and pursue more advanced math classes. (4:6) Student attitudes create a self-perpetuating cycle: students with positive beliefs about math perform well, which makes them like math and feel good about themselves; students with negative beliefs fall farther and farther behind, thereby reinforcing their low expectations and sense of failure. This is not to say that all students with positive attitudes toward math classes will pursue advanced studies and careers in math and science. In a poll of seventh and eleventh graders conducted by the National Assessment of Educational Progress (NAEP) in 1986, the majority considered math important and they had positive images of themselves. However, fewer than half the students in either grade said they wanted to take more mathematics classes. In the same poll, most of the students believed math was a factor in getting a good job, but fewer than half expected to work in careers that required math. An overwhelming number of students polled said they wanted to do well in math and were willing to work hard; however, their performance on the NAEP math assessment did not reflect this. As the survey implies, other factors, such as the way math is taught, strongly affect students' math competency and career goals. (4: 5)

In a study conducted of boys and girls in grades three, five, and eight in urban classes, and examining not only sex differences but also examining cognitive and motivational factors as well as standardized test scores, it was found that males were more confident than were females about their math ability based on their responses to twenty questions. The study showed no main effect for grade, and a significant main effect for sex. A significantly higher mean confidence score was shown for males than for females. This study also revealved that no notable sex differences were found in any of the computation measures, but sex differences were found in motivational measures. In this study, sex differences were found in both student confidence with respect to mathematics performance and student willingness to perform mathematics. At all grade levels, male students were more confident than female students. Also found in this study was the willingness of eighth grade male students to attempt an unfamiliar task more often than females. (7: 12-13, 28)

Willingness of students to attempt mathematics was found to be consistent with a previous study summarized by Dweck (1986) whereby it states that bright girls tend to prefer tasks on which they can do well but on which they will also find success and bright boys prefer tasks that present a challenge to mastery. Using the information from this study to predict standardized achievement test scores, it was noted that neither sex nor accuracy on the computation task predicted achievement scores. However, a combination of confidence and failure attributions to luck was the best predictor of achievement. In contrast to previous research, this study found sex differences in standardized test scores for eighth grade students only, but sex differences in confidence over all three grades. The results of this study support a view that sex differences in motivational factors rather than cognitive deficits in computation problems in young students are important for their performance and the performance of older students on mathematics tasks. (7: 32-33)

In an article entitled "The Real Testing Bias: The Role of Values in Educational Assessment," much attention has recently been devoted to the changing nature and role of educational assessment. There is certainly much said about testing today. There has been a great deal of attention paid to the methods used to find out what and how well students are learning. This attention has led to the promotion of what are sometimes called more "authentic" assessments; basically meaning increased attention to test validity. Educators can frequently be heard talking about their highest instructional priorities such as stimulating students to be creative problem solvers, wanting students to be responsible citizens, independent thinkers, team workers and so on. (16: 83-89)

Evaluation is a necessary part of instruction. A growing body of evidence shows that multiple and varied measures, often known as performance-based assessment or alternative assessment, offers a more valid picture of student performance. Major professional math organizations have endorsed alternative means of assessment such as teacher observations, interviews, student projects, and presentations.

In math, new forms of assessment ask students to manipulate concrete objects while teachers or other trained personnel observe and assess student skills. Manipulatives are especially useful for evaluating the development of young children, for whom paper-and-pencil tests are not very illuminating. Multiple choice exams seldom adequately evaluate higher order skills. (7: 38)

Standardized tests play an important role in mathematics education. They are used to diagnose student needs, inform instructional decisions, evaluate student progress and judge teachers and schools. The provide a report card of local, state and national performance.

Because standardized tests are usually considered more objective and reliable than other evaluation methods, educators, students, parents, and the public view their results with gravity. Teachers are held accountable for scores on district wide standardized tests. Testing at different points of time can tell teachers where they need to adjust their instructional approaches.

Even the most sophisticated tests can cover only a limited part of what can and should be taught. Some of the new tests, such as those designed for use with calculators, holds promise for alleviating some concerns about standardized testing. Multiple choice items have limited utility in assessing higher order skills and the answers can create an inappropriate focus on lower order skills.

Little evidence supports the contention that annual standardized testing drives teacher decisions about content. Teachers are more likely to base their instructional decisions on objectives, textbook tests, and tests they develop themselves. Evaluation instruments that are closely aligned with the objectives of the curriculum are generally more useful for diagnosing instructional needs and modifying classroom instruction than norm-referencing tests. (7: 37)

As stated in the article, "Math Ability", math achievement is rising, the gap in achievement between males and females in narrowing, and technology use is growing, according to *Reaching Standards: A Progress Report on Mathematics.*

Basing their results on the comparisons of the NCTM standards, little progress has been made in the goal area of learning to value math. Students still average more time watching television than they do studying math, reading, or writing.

As for the goal of becoming confident in their ability to do math, 9- to 13-

year-olds showed significant improvement in math achievement in the past 20 years. Students' problem-solving ability, however, remains weak. This third goal of the NCTM standards is only being reached by about 10 percent of the students because most do not have opportunities through instruction to practice such skills. Communicating in math classrooms has increased, according to teachers and students; but the fifth goal, writing about math, found that very little activity was reported. (12: 72-73)

In the article, "All-Girl Settings for Teaching Math and Science," it was reported that a decade of national research on gender difference learning has documented that girls assimilate information differently from boys. More distressing is the recent report that widespread classroom bias favors boys. Co-educational classes tend to short change girls by ignoring their unique learning styles and ways of knowing. Nowhere is the disparity in attitudes, persistence, and achievement more apparent than in the traditionally male based curriculum of math and science. Suddenly, girls' schools are regarded as successful models for teaching these disciplines.

Girls' schools across the country are enjoying new recognition, and increased admissions applications, for their achievements. At most of these schools, students take four years of math and choose at least three years of science. Group learning is a natural for girls and it begins early. Knowing this, cooperative and collaborative learning groups are a major component of these girls' schools. Peer teaching is especially effective. In a collaborative all-girl setting it is easier to foster the longer response time some girls need to formulate an answer. (11: 60-64)

"Career and Educational Planning in the Middle Level School", by Susan Sears, discusses the characteristics of middle school students and the need for solid career planning programs at the middle level. Middle level youth are becoming more complex human beings. Most of these students are more cognitively mature and are able to comprehend relationships and to use abstract terms and symbols. Middle level school students are involved in the continued development and strengthening of basic skills begun in elementary school and in activities and choices that can either limit or expand their horizons. Choosing classes to take in high school is important. Many students and parents are not aware of the significance of these decisions. For example, if students choose to avoid advanced mathematics courses, they are probably eliminating later career choices. Girls at this age do not see themselves as competent, and their self-esteem decreases the longer they stay in school. Research reported by the Search Institute (1988) offered the following insight: test scores continued to reveal persistent differences between boys and girls on crucial matters of self-concept and self-esteem. In many instances, the girls' self-descriptions were unflattering even when objective data contradicted them. It was found that some adolescent girls develop fear of success and that could account for a number of the differences. (19: 36, 39)

Children become turned off to math at different ages and for different reasons. Experiences inside and outside school, along with negative or stereotyped messages from teachers, classmates, parents, the media, and society have enormous influence. In elementary school, the majority of students say they like math and are good at it. At this age, few differences are found between boys' and girls' attitudes. However, negative attitudes set it, especially among girls, about the sixth grade. This negative attitude keeps girls out of the math pipeline by their not taking higher math courses. Children who experience difficulty in math may come to associate mathematics with feelings of frustration and anxiety. When students feel that teachers and parents do not expect them to be able to perform difficult math problems, they develop the syndromes known as math anxiety, math avoidance, and learned helplessness.

Even children who seem to be doing well in math can be turned off by the way mathematics is taught in most schools. The emphasis that has been placed on drill and practice, paper-and-pencil exercises, and standardized multiple-choice tests makes mathematics seem dull and sterile. Negative messages from outside reinforce unstimulating classroom experiences: parents who boast of their own incompetence in math; programs that depict high-achieving math students as "nerds"; adults who cling to stereotyped notions about math being mostly for boys. Taken together, these experiences can quash student interest in math by the time students reach secondary school. (4: 6)

The more students know about themselves and the world of work, the more likely they will be to make satisfying decisions about their future. By helping students learn how to relate their interests to information on occupations, they can select and explore unknown areas. Middle level students need the opportunity to investigate skills and abilities required for different occupations, and to assess their own abilities in relation to opportunities of interest to them. (17: 30-31)

Negative perceptions are hard to overcome. Questions such as: how can schools build positive student attitudes and beliefs toward math? Teachers and other adults can foster positive attitudes even when there is little support from the home. Teachers, for starters, need to let students know that they think math is challenging, fun, and useful. Teacher enthusiasm can set the tone for the whole classroom. In addition, teachers must back up positive words and feelings with stimulating and enjoyable math activities. Concrete objects -- calculators and computers, for example -- can inject excitement into the classroom while, at the same time, promote student learning. Giving students chances to discuss and even write about their attitudes toward math can help them confront and conquer math anxiety.

By providing some activities that provoke thought, such as open-ended questions or problems in which students must weigh a variety of solutions, teachers can counteract the perception of math as a fixed set of rules. Schools need to create a climate of expectation that every child can learn math. Teachers must stress the importance of effort and persistence over innate ability and structure opportunities for every child to have some early, successful experiences.

Students need reassurance that errors are a part of learning. Discussing why answers are right or wrong is vital feedback to students, for even incorrect answers can exhibit good logic. (7: 7)

The soundest way to convince students of the relevance of math is not by saying so, but by offering a curriculum that is relevant to today's job and life demands, one that builds students' problem-solving skills, challenges their powers of reasoning, and incorporates technology. Students must see how the skills they are learning can be applied to other situations, and how the knowledge they already have leads to new knowledge.

Teachers can make mathematics more relevant by using problems or situations from everyday life, such as consumer or sports related problems, and problems with practical significance; by developing class projects that connect math to the real world; and by inviting parents and community people to discuss how they use mathematics in their jobs. (7: 8)

Literacy is crucial to the acquisition of math skills. Math experts view communication as an essential component of the mathematics curriculum. Some children compute well until they are faced with word problems. For these children it is the language of mathematics that presents difficulty. Teachers must make special efforts to teach the language of math especially when students reading and writing skills are not fully developed. In addition, teachers should present problems in a variety of ways -- for example, using diagrams or symbols instead of word, or reading aloud -- so that reading comprehension does not always factor in the solution.

Research also supports the use of writing activities to improve math skills. Writing problems or keeping journals helps students communicate about math and order their thoughts. Writing is an especially effective way to develop conceptual and higher order skills. (7: 12)

One last major component of the teaching of mathematics is the textbook. "Textbooks should not be asked to serve as the curriculum." (20: 11)
In an article by Robert Shutes and Sandra Petersen, "Seven Reasons Why Textbooks Cannot Make a Curriculum," they discuss why it is time for everyone to realize that textbooks have not really served the basic functions of curriculum and can never do so. The seven reasons they give are as follows:

> 1. Textbooks do not make philosophy or goals explicit. Textbooks may not clarify a particular view of education because they are commercial products that must appeal to school systems with differing beliefs. Inevitable, most textbooks must try to be compatible with many value systems and with various goal structures. Therefore, they cannot offer

help to local schools in setting goals. Instead, they supply enough content to allow the users to serve whatever goals they choose.

2. Textbooks are not selective of content. Textbooks generally do not attempt to be selective of content for the same reasons as mentioned above. They try to appeal to the widest population possible and to offend no one. They include very little depth about any topic and provide little assistance to teachers in either assigning differential importance to the several parts of the material, or in identifying selections from the total content. Without explicit indications of more or less importance, there is a danger that teachers will attempt to cover all the content of the textbooks equally.

The repetition of unelaborated information makes the teacher active and the learner passive; it ensures that almost all the instruction will be direct exposition, and it almost guarantees that most students will be overwhelmed by the information overload and will forget most of the information before the course is over.

3. Textbooks do not consider the pace of instruction. Textbooks that are designed to include all the topics teachers could possibly desire cannot suggest a pace of coverage that is appropriate for students without implying that large segments of their content are not essential. Educators can argue that their task is to see that all the potentially demanded content is included and to design the pace at which this information is covered.

4. The expository material in textbooks does not support learning. Although definitions of concepts are sometimes given, they are not usually supported with enough examples to generate complete understanding.

5. Textbook content is abstracted from its real world uses.

6. Textbooks cannot reflect local conditions or concerns. Textbooks are designed to appeal to people everywhere. But it is impossible for a textbook to reflect the realities of every community in which the books may be used. Whatever the content, there are opportunities for teachers to add meaning by using local experiences, local historians, and the real

> people and activities of the community. Matters of local concern can add real meaning to the learning process.
>
> 7. Textbooks do not support interdisciplinary studies. Sometimes connections between subject areas can be accomplished by team teaching. Sometimes it is accomplished by teams of teachers planning thematic units that can be approached with complementary content drawn from all fields. (20: 13-18)

In *Mathematical Power: Lessons from a Classroom,* Ruth Parker argues that existing textbooks are simply incompatible with mathematics reforms such as those envisioned by the NCTM. The NCTM standards handle the textbook problem very sensitively, by listing mathematical skills that need 'increased emphasis' and those that need 'decreased emphasis.' (13: 61-63)

The NCTM standards which have been given 'increased attention' status include: pursuing open-ended problems and extended problem-solving projects; reasoning with proportions, from graphs, inductively and deductively; connecting mathematics to other subjects and to the world outside the classroom; using estimation; developing and using graphs, tables, and rules to describe situations; developing an understanding of variables, expressions, and equations; using statistical methods; developing an understanding of geometric objects and relationships; stimulating and using measurement to solve problems; actively involving students individually and in groups; using appropriate technology for computation; being a facilitator of learning; and using concrete materials.

These are just some of the recommendations for grades 5-8 mathematics.

Several areas have been rated as 'decreased attention.' Some of those are: practicing routine, one-step problems; doing fill-in-the-blank worksheets; answering questions that require only a yes, no or number response; memorizing rules; practicing tedious paper-and-pencil computations; memorizing formulas; memorizing geometric vocabulary; converting within and between measurement systems; teachers being the dispenser of knowledge; and testing for the sole purpose of assigning grades. (22:70-73)

CHAPTER 3

Methods and Procedures

Throughout the first 18 weeks of the 1995-96 school year, a variety of hands-on activities in both eighth grade pre-algebra classes were used. Students were assigned to these classes by their seventh grade math teachers based on their seventh grade math performance.

Students in the third period pre-algebra class were students who were identified by their previous teacher as 'lower to average' grade performance students; those who would probably not take higher math classes in high school but who did not need to be placed in a general math class for their eighth grade year. The class size was fifteen students; six females and nine males. One female student was repeating the eighth grade year because of a lack of credits earned for high school. One student, male, was only in seventh grade. All other students were in a general mathematics class for their seventh grade year and achieved averages ranging from D- to C+.

Students in the seventh period pre-algebra class were students who were identified by their previous teacher as 'average' grade performance students; those who would probably take higher math classes. The class size was nineteen students: eleven females and eight males. Students in this class were in a general mathematics class for their seventh grade year and achieved averages ranging from B- to A-.

There were two other eighth grade math classes at Tygarts Valley Jr/Sr High School. They were Mathematics 8 (general math) and pre-algebra (advanced, these students achieved previous averages of A- to A+). They were both taught by another teacher in the math department. The Mathematics 8 class consisted of twenty-three students, of whom six are repeating the class from the previous year. The pre-algebra (advanced) class consisted of 18 students, all of whom are taking the class for the first time.

The two groups of students being studied were both regular pre-algebra classes. The main objective in this study was to use hands-on activities and small group activities to reduce the anxiety that some of these students had developed toward higher math classes and their individual math abilities. By doing small group activities, group projects, and hands-on activities, it was anticipated that the future plans of these students would include more higher math classes than they previously thought they would take.

During the 18 week grading period, students were given the opportunity to learn new algebraic concepts using various manipulatives. Activities included: the use of colored disks to represent integers; the use of clear cups to represent variables in equations and inequalities; the use of negative and positive charges in addition and subtraction of integers; algebra tiles to demonstrate the distributive property; and the assignment of cooperative groups of no more than four students to assist in problem solving and design and construction.

As part of the school's multi-disciplinary instruction units, the Olympic Events was a one-week unit of instruction. Activities for this week were in alignment with the upcoming 1996 Summer Olympic Games. Activities included the discussion of timing results in some events, rounding of these answers, and the construction of a platform on which the 1996 Olympic Mascot, IZZY, could be placed. Students were to construct (using classroom supplies), measure, and describe their group designs for their mascot platforms. Ticket order forms were shown and explained and students were to have the opportunity to plan a three day trip to the Olympic Games. Students were to be active in computing mileage, expenses, and planning their event times and dates.

Chapter tests were administered to each class and class averages were used to determine the overall effect of manipulative use on test performance. Notebook tests were administered to evaluate the effectiveness of homework as related to class performance. Nine weeks exams were administered to all students at the end of the first nine weeks grading period. Semester exams were only administered to those students who had exceeded the allowed absences or who were failing the class at the end of the semester. The average absence for each class were also used in comparing these classes.

Students in all eighth grade math classes were asked to answer a student survey designed to provide information about their attitude and class performance in their intermediate grade school years and their attitude and class performance this year. Students were asked to indicate whether or not hands-on activities were helpful in their current math class. Students were also asked to indicate whether or not they plan to take higher math classes during their high school years. Students were asked to evaluate the amount of homework given and the amount of help they receive on assignments done outside the classroom. Students were asked to rate their math ability and they were given the opportunity to give comments or suggestions concerning the curriculum, teacher, textbook, or any other item they felt was important. Test and exam averages were used to make t-test comparisons between the two regular pre-algebra classes. (Appendix A, pp 57-58)

Surveys were distributed by both eighth grade teachers to all eighth grade students present and the completed survey results were compiled and evaluated. In the event that activities previously planned could not be completed, some activities were to eliminated and some activities were to be rescheduled.

Results of the survey were used to indicate the importance of manipulatives as related to their curriculum and the importance of homework in this subject area. The results were evaluated based on male/female responses.

Results of student surveys were presented in chart or graph form based on both the differences in male and female responses and the classes in which these students were enrolled. Answers to selected questions on the survey were reported in a frequency distribution format. Reports were generated based on the number of survey responses received and student grades for all students enrolled in the eighth grade at Tygarts Valley Jr/Sr High School.

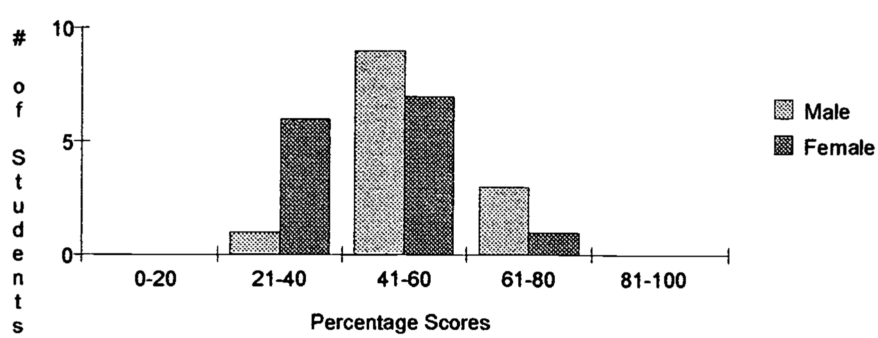
Two sample t-tests were used to compare class performance on a pre-test given during the first week of school, the end of the first nine weeks grading period averages, the class averages at the end of the first semester, and a post-test.

Chapter 4

Procedures and Findings

Throughout the first eighteen weeks of the 1995-96 school year, students in two pre-algebra classes were observed and evaluated to determine the effectiveness of the use of math manipulatives at the secondary level. The sample size consisted of twenty-seven students: seventeen males and ten females. Students were assigned to these classes based on their previous year's performance in math class. The two classes being observed were given a pre-test during the first week of class. Students were not given any information as to what types of questions or mathematical problems they would be given. Twenty questions were asked on the pretest, which covered basic algebra concepts such as order of operations, solving simple equations, properties of mathematics, area and perimeter of geometric shapes, addition/subtraction of integers, etc. The results of the pretest, based on male and female responses and the number of correct responses expressed in percentages, are shown below.

Pre-Algebra Pre-Test



Topic weaknesses as revealed by the pre-test were as follows:

Subtraction of integers:

# of Questions Missed	% Incorrect
4	15%
3	15%
2	41%
1	22%
0	7%

Properties of mathematics:

# of Questions Missed	% Incorrect
2	48%
1	37%
0	15%

Area of a square:

# of Questions Missed	% Incorrect
1	81%
0	19%

Based on the percentage of incorrect responses, it was determined that the particular topics which should be given increased practice and concentration were solving equations involving negative and positive integers, and order of operations.

Pre-test scores were used to construct a two-sample t-test comparison between the third period class (Group A) and the seventh period class (Group B). Again, these students had been previously assigned to these classes based on their seventh grade math performance. In an attempt to show that the use of manipulatives will increase student achievement, $\mu_A - \mu_B = 0$ was used as the null hypothesis; $\mu_A - \mu_B \neq 0$ was used as the alternate hypothesis. {It should be noted that not all students were present for the pre-test.}

Based on the following information, the null hypothesis was rejected.

Statistical Information

Level of Significance: 0.05

$N_A = 14$ $N_B = 13$

$A = 57\%$ $B = 43\%$

Est. sigma of $\bar{A} - \bar{B} = 4.13$

$t = 3.39$; critical $t = 2.060$

During the first nine weeks of instruction, students in the third period class were given several opportunities to explore algebraic concepts using hands-on activities. After each chapter of text material, the averages from the third and seventh period classes were compared to determine the effect of the use of manipulatives on test scores. The third period class average on the chapter one test was 85% and the seventh period class average on the chapter one test was 94.8%. However, a grading error was found in the seventh period test which was not detected in the other class and accounts for some of the difference in the averages. After correcting this mistake on the third period tests, the average on that same test increased to 90%.

Homework assignments were not graded; however, notebook tests were given to determine if students were completing and correcting assignments. The class averages on the first notebook test differed by only 4/10ths of a point; third period averaged 87.6% and seventh period 88%.

Manipulative activities continued to be used in the third period class during the remainder of the first nine weeks. Only selected activities were used with the seventh period class.

The first nine weeks averages for both classes which included all current students taking a nine weeks comprehensive exam, when used to construct a t-test, yielded the following information: null hypothesis, $\mu_A - \mu_B = 0$; alternate hypothesis, $\mu_A - \mu_B \neq 0$; thus resulting in the acceptance of the null hypothesis.

Statistical Information	
Level of significance 0.05	
$N_A = 15$	$N_B = 19$
A = 84%	B = 86%
Est. sigma of $\bar{A} - \bar{B} = 3.37$	
t = 0.593; critical t = 2.042	

Second nine weeks tests comparisons continued to show better results in the seventh period class than the third period, even with continued use of manipulative activities. Test averages differed by three percentage points on the chapter two test, from 88% (seventh period) to 85% (third period), and seven points on the chapter three test, from 82% to 75%, respectively. Notebook tests continued to yield the same differences: third period 64%, seventh period 75%.

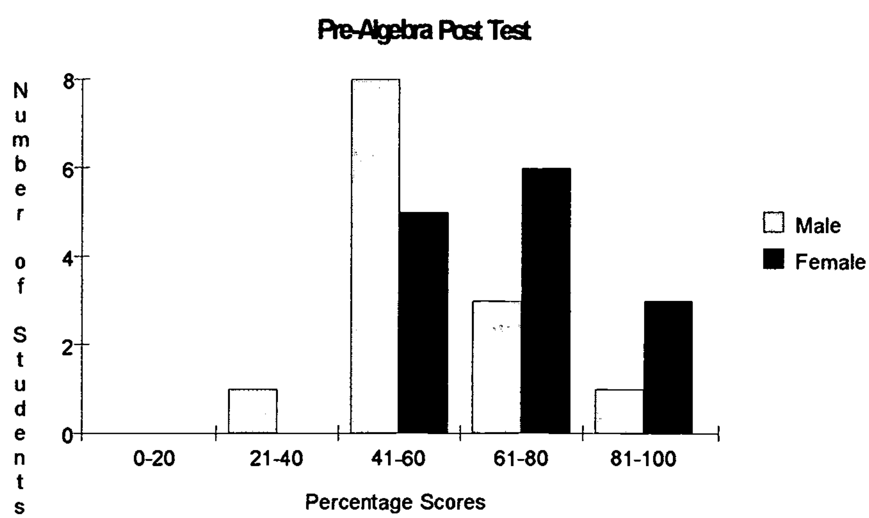
The class averages for both classes at the end of the first semester were used to construct a two-sample t-test. The null hypothesis used was $\mu_A - \mu_B = 0$; the alternate hypothesis was $\mu_A - \mu_B \neq 0$. Based on the following information, the null hypothesis was accepted.

Statistical Information	
Level of significance 0.05	
$N_A = 15$;	$N_B = 19$
A = 83%	B = 87%
Est. sigma of $\bar{A} - \bar{B} = 3.99$	
t = 1.00; critical t = 2.042	

The third period class grades were as follows: two students received A's; six received B's; three got C's; one D and three F's. The total number was 15.

The seventh period class compiled eight A's; five B's; three C's; no D's and three F's. The total number was 19.

At the end of the first semester, students were given a post-test (same test as the pre-test). Class averages on the post-test are shown in the following chart:



Again the two classes were compared utilizing a two-sample t-test with a null hypothesis of $\mu_A - \mu_B = 0$, thus showing that manipulative use will increase student achievement; alternate hypothesis of $\mu_A - \mu_B \neq 0$.

Statistical Information

Level of significance 0.05

$N_A = 14$ $N_B = 13$

A = 64% B = 68%

Est. sigma of $\bar{A} - \bar{B} = 5.17$

t = 0.774; critical t = 2.060.

Based on this information, the null hypothesis was accepted.

Absences for each class during the same time frame were as follows:

Third Period	Average of 1.06 days/18 weeks/15 students
Seventh Period	Average of 1.68 days/18 weeks/19 students

Surveys were distributed to all eighth grade students in any mathematics class to determine their opinions and feelings of mathematics and the extent of their involvement in class work and assignments.

Students in all classes were asked to respond to questions concerning their attitude in elementary school toward mathematics and their extent of manipulative use in their mathematics class this school term as well as their opinion of the meaningfulness of these activities. They were also asked to respond to the amount of homework assigned and to what extent, if any, they receive help with their homework assignments.

When these students were asked if they liked math in grades 5-6, survey results revealed that 62.5% of the females responded that they did like mathematics, 37.5% of the females responded that they did not like mathematics. Of the males responding to the same question, 56% responded that they did like mathematics; 44% responded that they did not like mathematics at the elementary school level.

When considering the responses of only those students in the third period class, 66.6% of the females responded that they did like math, 33.3% responded that they did not like math in elementary school. Male responses to the same question showed that 55.5% did like math in elementary school, 45.5% did not.

In the seventh period class, female students responses showed that 45% liked math in elementary school, while 55% did not. Male students in the seventh period class responded that 62.5% did like math in elementary school, 37.5% did not.

Students were also asked whether or not their elementary school teacher used manipulatives in mathematics. Over 78% of the females responding said that their teacher did use manipulatives in elementary school; 22% responded that their teacher did not use manipulatives. Of the males responding to the same question, 74% responded that their teacher did use manipulatives; 26% responded that their teacher did not use manipulatives.

Students from the same elementary schools and the same elementary teachers responded differently to the use of manipulatives. This difference was attributed to their lack of knowledge about the meaning of manipulatives. When questioned about their differences, and after further explanation of the meaning of manipulatives, approximately 10% of those who had originally responded that their teacher did not use manipulatives reversed their original response.

Student responses to other survey questions included the following:

Length of mathematics class period in elementary school:

1 hour	1/2 hour	Over 1 hour
48	20	4

Number of manipulative activities students felt were beneficial:

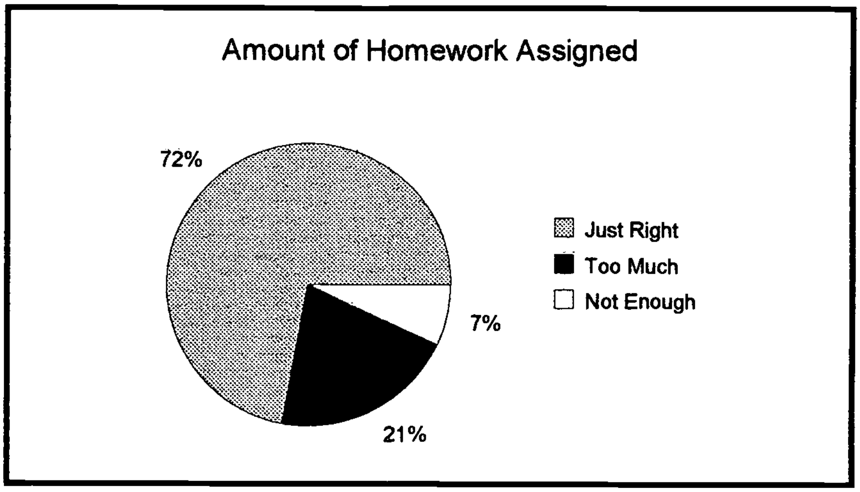
Most	Some	All
37	25	4

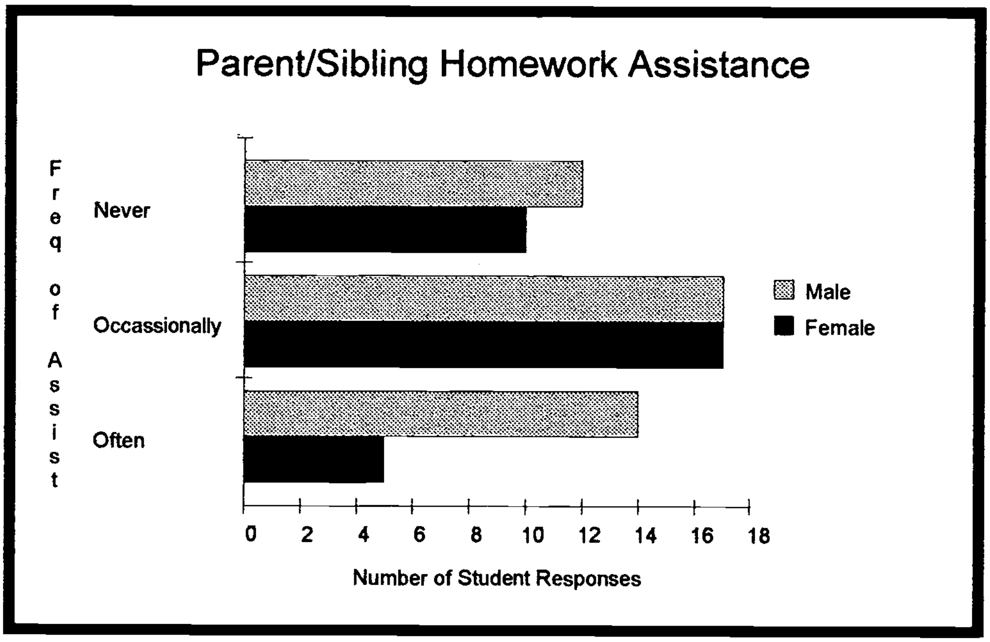
Number of students taking their present class for the first time:

Male	Female
38	26

Students' response to teacher use of manipulatives this school year was extremely positive. Sixty-five of the seventy-five students surveyed, or 86.6%, responded that their teacher did use manipulatives in their classes this year; 10.6%, responded that their teacher did not. Two students did not respond to this question.

Student responses to questions about the amount of homework assigned and any assistance they may receive on their homework are shown in the charts that follow.





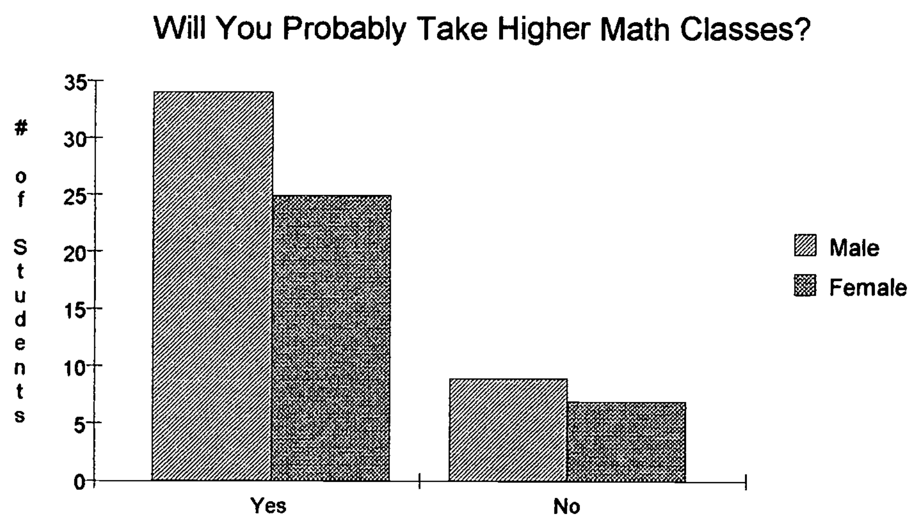
Student survey comments revealed that they were pleased with the opportunity to complete assignments during class time and could receive teacher assistance on any assignments they did not understand. They also expressed their approval of small group activities and cooperative learning groups within each class.

Students felt that the cooperative learning groups gave them an opportunity to work on any weaknesses they had without being embarrassed.

The student survey also inquired as to the students' feeling regarding their individual math ability. Of the students who responded, eight females felt very good about their math ability; thirteen males responded that they felt very good about their math ability. Fifteen males responded that they were satisfied with their ability level as compared to thirteen females. Of those responding that they felt their math ability needed improvement there were eleven females and fifteen males.

Students were asked if they felt they would now take higher level math classes such as Algebra I, Geometry, Algebra II, and/or Pre-Cal/Trig. Students in the third period class, when considered separately, showed that 66.6% of the females in this class would probably take higher math classes; 91% of the females in the seventh period class responded favorably to taking higher math classes. Male responses showed that 89% of the students in the third period class, almost twenty percentage points higher than the females in the same class, would probably take higher math classes; 75% of the seventh period male students, sixteen percentage points lower than the females in the same class, would take higher math classes.

The following graph shows these responses.



Students were asked to rate on a scale of one to five, with five being the highest, how much they enjoyed their math class this year. The following results were revealed:

Scale:	5	4	3	2	1
Male responses:	8	13	13	4	5
Female responses:	8	9	12	0	3

At the end of the first semester of classes, students were given a post-test, the same test which they had taken at the beginning of the semester. Results of the test showed much improvement in some areas of original weakness and little, if any, improvement in some areas.

Of the original topic weaknesses, i.e. subtraction of integers, properties of mathematics, and area of a square; student responses on the post-test revealed the following information:

Subtraction of integers:	# of questions missed	% Incorrect
	4	11%
	3	11%
	2	39%
	1	24%
	0	15%

Properties of mathematics:	# of questions missed	% Incorrect
	2	30%
	1	48%
	0	22%

Area of a square:	# of questions missed	% Incorrect
	1	85%
	0	15%

Of the students in the class who had used manipulatives more often, seven performed better on the test while five did worse and two stayed the same. In the seventh period class, eleven students did better while only one did worse and two stayed the same. Although the increase in scores on the post-test may not have been entirely because of the use of manipulatives, the scores do indicate better understanding of certain algebraic concepts which were also topics that were taught with manipulative use.

Although students are not "tracked" or "ability grouped", students with the same areas of learning difficulty were placed in the smaller, third period class so more individual instruction and one-on-one assistance from the teacher and from other students in the class could be given. Students worked in small groups, randomly selected and changed, and assisted others in their groups in areas of difficulty. Students in the seventh period class also did cooperative group work. These students were also assigned to cooperative groups and the students were regrouped for further assignments. Student interaction and cooperation in these groups was helpful and beneficial for both the "student/teacher" and the "student/learner." Class averages in both classes increased as was expected; however, no dramatic increase was found in the grades of those students in the third period class.

Chapter 5

Summary, Conclusions & Recommendations

SUMMARY:

Based on the percentage results of the pretest given to both classes, it was anticipated that approximately one-third of the students in the third period class would not be able to pass the class by the end of the first semester of school. Although the failure rate for that class for the first semester was 20%, somewhat lower than originally expected, the reasons for those results were not unexpected. Of those students failing the class, one (female) of those students was repeating eighth grade, one (male) had repeatedly scored a percentile rank in the mid-twenties in mathematics on the CTBS tests and other standardized testing, and one (female) was not only repeating this grade but was also absent on a regular basis and did not complete make-up work.

Based on survey results and class comments after lectures and assignments, students in the third period class expressed their appreciation for the manipulative activities and the opportunity to better understand some algebraic concepts. Of these students, the failure rate was not a factor and student grades, when compared to their previous year, resulted in increases of twelve of the fifteen students.

The students' performance in the seventh period class, when compared to the pretest scores, appeared to be along their grade level. A total of 83.3% of the students in this class stayed at the same level of performance, or increased slightly, as their seventh grade year. Of the three failures for the semester in this class, one (male) consistently slept in class and refused to do any work, one (male) became very careless and forgetful with completion of homework assignments and note-taking but performed well on tests and quizzes given in class, and one (female) did not attend school and quit when she reached her sixteenth birthday.

The student survey results of both classes were encouraging as to the number of students who plan on taking higher math classes during their high school years. When discussed in class, approximately 80% of the students asked planned to attend college and realized the importance of a good, solid math background as preparation for their future education.

According to the student surveys, students responded favorably as to their attitude toward math this year as compared to previous years. Student comments revealed that students felt more comfortable with math and found more success because their teachers this year liked math and **wanted** to teach it as compared to their elementary teachers who **had** to teach it. Student comments also revealed that they felt more comfortable in their math classes this year because they were given the opportunity for success based on teacher recommendations and placements.

It was apparent from the student survey responses that students enjoyed the use of manipulatives in activities and learning of algebraic concepts, although students expressed dissatisfaction with two of the activities which they felt were confusing in the explanation of the concepts being presented. Full agreement with this dissatisfaction was given and those activities have since been eliminated from the lesson plans and activities. (See Appendix A, Page 59)

The amount of homework, or lack of, assigned on a nightly basis did not appear to have a significant effect on student grades as most of the activities and assignments were given in class with ample time for completion before the end of the class period. Also, the assistance from parents or siblings on homework assignments was not a surprising factor as most of these students either do not have parents who are at home and/or who have not completed high school and, therefore, do not have the necessary skills to assist their children with any homework assignments, especially in mathematics.

CONCLUSIONS AND RECOMMENDATIONS:

Although a t-test performed between the third period class pre-test and the seventh period pre-test did not result in acceptance of the null hypothesis, the individual grades earned on those tests were not surprising. This result indicates that there was a significant difference between Group A and Group B. Students in the third period class (Group A) averaged 57% on the pre-test compared to only 43% from students in the seventh period class (Group B).

A t-test comparison was made at the end of the first semester on the post-test given and the results, although not as good as preferred, showed a greater increase in grades in the third period class (Group A) than in the seventh period class (Group B). However, this still resulted in the rejection of the null hypothesis and again, showed a significant difference.

Overall, the research did not show any dramatic differences in grades with the class that used manipulatives and the class that did not. However, the overall feelings of the students and their attitude toward mathematics did improve.

Manipulative use is an important part of the teaching of algebraic concepts, even if the results are not shown in student grades. Students are much easier to keep interested in mathematics if they enjoy it, and manipulative use has done just that for these students during the course of this research.

The research and data collected was consistent with anticipated results. Although the sample size was adequate, a larger group of students would prove to be more representative of the effects of manipulative use. It was also found that the use of manipulatives in this program would be beneficial with students currently in the seventh grade as well as those in the eighth grade. After attempting some of these activities for the first time, it was apparent that alternative manipulative examples needed to be used for some activities, i.e. subtraction of integers and multiplication of integers, and that additional class time would be very helpful in explanation and use of manipulatives.

The grade level being compared had not taken a standardized test since sixth grade and, therefore, was limited to only one year of secondary mathematics grades to use as a base or comparison grade. The implementation of a uniform year-end test for all students in the school, county, or even the state, would provide a better basis for comparison of the use of manipulatives.

Given more time, a county wide survey of all seventh graders would have been useful and informative in the study of curriculum across the county, since Randolph County consists of one middle school (grades 6 - 8), approximately 1,000 students; one six year Jr/Sr high school (grades 7-12), approximately 200 students grades 7 & 8; two twelve year schools (grades K-12) which have enrollment differences of approximately fifteen students grades 7 & 8, to forty grades 7 & 8. With the exception of the middle-school, which is located in the only city in this county, most students attending the county schools receive free or reduced lunches, and most families are recipients of welfare or social security programs. Although these students attend school on a regular basis, their family structure and support is very different from that of the students who attend the middle-school.

Student and class data was based on an eighteen week grading period and fifty minute class periods. Several school systems, and even individual schools within a system within West Virginia and surrounding states, have elected to go to a form of block scheduling, i.e. ninety minute class periods for eighteen weeks.

If given more time, not only during the class period but also more days, grades and test results may have shown better understanding of concepts in the third period class and even less of a difference in class averages and test scores. At the present time, the Randolph County school system plans to implement some form of block scheduling for the 1996-97 school term.

Based on the above mentioned comments, the results of chapter tests and notebook tests, the original hypothesis, (that students, when given the opportunity, will better understand certain mathematical concepts after using manipulatives; that students will achieve a greater increase in grades compared to their seventh grade performance; that students will find the use of manipulatives beneficial in problem solving; that students will develop an increased positive attitude of their individual ability in mathematics), although proved to be successful in student reponses in most cases, did not result in acceptance of the null hypothesis.

STUDENT SURVEY

Y N	1. Did you like math in grades 5-6?
Y N	2. Did you use activities in grade school that included the use of objects and items to assist you in problem solving?
Y N	3. If you answered yes to #2, did you enjoy these activities?
A B C	4. If yes, how often? a) 1 day/week b) 2-3 days/week c) 4-5 days/week
A B C	5. Approximately how long was your 5th-6th grade math class per day? a) 1 hour b) 1/2 hour c) more than 1 hour
Math 8 Pre-Algebra	6. Are you enrolled in Math 8 or Pre-Algebra? (Circle one)
Y N	7. Is this your first year in this class? (from question #6)
Y N	8. Does your teacher this year use hands-on activities? (If no, go to question #11)
A B C	9. If yes to #8, how often? a) frequently b) sometimes c) seldom
A B C	10. How many of these activities were useful in learning the new concept? a) most of them b) some of them c) none of them
Y N	11. If you answered NO to #8, do you feel hands-on activities would help you in math class?
A B C	12. How would you rate the amount of homework in math? a) just right b) too much c) too little

PLEASE TURN TO BACK SIDE OF SURVEY!!

A B C 13. How often do your parents/guardians/siblings assist you with homework?

A) never b) occassionally c) often

A B C 14. What is your feeling about your math ability?

a) Very good b) Satisfactory c) Needs improvement

15. How much do you enjoy math?

A lot - - - - - -Some- - - - - Little

5 4 3 2 1

Y N 16. Will you probably take higher math classes in Senior High (i.e. Alg I, Alg. II, Geometry, Pre-Cal/Trig)?

Please indicate your sex. (Circle one) MALE FEMALE

If you have any comments you would like to make about your school's math program, the teacher, the textbook or the materials used in class, please feel free to state them below.

Thank you for your cooperation.

Appendix A
Student Survey Comments

FEMALE RESPONSES:

"Researcher is a pretty cool teacher and has been helpful when I had problems."

"I like math at times. It depends on what we are doing. I think if we did hands-on activities more, I might get a very good grade."

"I like my math teacher. She explains things so we can understand them."

"The math is easy. It just depends if you want to do it or not. "

"I feel that the textbook should give more examples in some of the lessons."

"I think math class should be longer so kids are able to get more help so they can get a better grade."

"I do not think that the textbook we have explains some lessons very well so we can learn from doing these activities."

"I finally like math."

MALE RESPONSES:

"My teacher tries to do the best and teach us what she can. She helps me and every student who asks."

"The books are too old."

"I like math class but not homework."

"Math is cool."

"My teacher is a very good teacher and very helpful. The way she explains it makes me understand it better."

"I like the teacher. She is kind and helps you understand the math better by using those activities we have been doing."

"We don't have much homework because we do a lot of things together in class."

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