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A study on the differences of teaching mathematics and science separately and integrated

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A STUDY ON THE DIFFERENCES OF TEACHING MATHEMATICS AND SCIENCE SEPARATELY AND INTEGRATED

by
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A THESIS

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ABSTRACT

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A Study on the Differences
of Teaching Mathematics
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Dr. Molinari
Masters in Elementary Education

This study determined if teaching science and mathematics with an integrated approach would increase students' achievement. It also determined whether males or females achieved higher in science and mathematics when taught with the integrated approach, as compared to teaching the two disciplines separately. It determined whether the attitudes of the fourth grade students improved when mathematics and science were taught with an integrated approach.

The group participating in this study consisted of one fourth grade class. The total population of the study was sixteen fourth grade, heterogeneously grouped students. The class consisted of twelve female and four male students.

For one month, mathematics and science were taught as separate disciplines. For another month, mathematics and science were taught as an integrated unit. The mean scores were calculated each month. Each student was given an attitude survey to determine how they felt about mathematics and science.

An analysis of the data was completed in order to accept or reject the four stated hypotheses. t-Tests were performed to determine if any significant differences existed between the mean scores. After analyzing the results of these tests, it was found that there were no significant differences in achievement levels, but there were significant differences in student attitudes.

MINI-ABSTRACT

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This study determined if teaching science and mathematics with an integrated approach would increase students' achievement and whether males or females achieved higher in science and mathematics. It determined whether the attitudes of the fourth grade students improved when mathematics and science were taught with the integrated approach. It was found that student achievement did not increase significantly, but student attitudes did increase a significant amount.

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TABLE OF CONTENTS

CHAPTER PAGE

List of Tables and Charts

Charts | Page

Chapter 1

The Problem

Significance of the Study

Large numbers of young Americans are not equipped to work in, contribute to, profit from and enjoy our technological society. Too many students leave elementary and secondary schools with an inadequate background in mathematics, science and technology. These students lack adequate knowledge to acquire the training, skills and understandings that are needed today and will be needed even more in the 21st century.(Barba, 1995)

A stated goal of Goals 2000 is that United States students will be "first in the world in mathematics and science achievement."("The National Education Goals," 1996, p. 1) In order to accomplish this goal, schools need to reassess their science and mathematics curriculums. Many professional organizations are setting standards to improve the teaching of science and mathematics. The National Council of Teachers of Mathematics (N.C.T.M.) have developed Curriculum and Evaluation Standards as well as Professional Teaching Standards. Project 2061 and Science For All Americans have set standards for science. The National Science Teachers Association is working to develop an integrated, theme-based curriculum in science that involves all students,

(Fennimore and Cook,1993) Setting standards is the beginning of reform in science and mathematics.

The N.C.T.M. urges schools "to prepare mathematically literate citizens who can function efficiently in our society and contribute to the American democratic process."(Underhill, Abdi, and Peters, 1994, p. 26) As stated in the N.C.T.M. standards, "Students should have many opportunities to observe the interaction of mathematics with other school subjects and with everyday society."(Haigh and Rehfeld, 1995, p. 240) Mathematics should not be seen as a separate discipline, but rather, as a way to make sense out of the world.

Science For All Americans and Project 2061 provide us with standards for teaching science. The standards include science, mathematics, and technology. Project 2061 outlines the knowledge, skills and attitudes that all students should acquire. It emphasizes that there should be less coverage of factual material and to make more time for students to develop better understandings of the key concepts. One of the benchmarks states, "The student should know that scientific problems have sometimes led to development of new mathematics."(Aldgren and Rutherford, 1993, p. 21) We can see that a connection between science and mathematics is being emphasized, thus showing the importance of integration.

Children should be actively involved in the learning process. Constructivists believe the teaching and learning of science and mathematics should rely on the "hands-on" approach, experiment, discussion, cooperation, and participation.(Fisher, 1992) When science and mathematics are integrated, the two disciplines become relevant and meaningful to the learner. Mathematics, when integrated with science, gives students the opportunity to apply the discipline to real situations that relate to the student's world.

The inclusion of science in the mathematics curriculum and mathematics in the

science curriculum would provide continuity for students. By integrating mathematics and science, students would see more relevancy and applicability to their world. When science and mathematics are taught as separate disciplines, the relevancy of each are touched upon only briefly, if at all. In the past, content coverage, rather than contextual understanding has been valued in mathematics and science. For these reasons, students never saw the connection to real life. When we integrate science and mathematics, the disciplines can be seen as relevant and meaningful to the learner. Students can apply the discipline to real life situations that are relevant to their world, from their own perspective. (Davison, Miller, Metheny, 1995)

An integrated approach to science and mathematics would assist students in making connections between "school learning" and the "real world." As Rutherford and Ahlgren (1988) state, "science and mathematics have had a long and successful relationship. On the one hand, science continually provides mathematics with challenges, while on the other hand, mathematics was developed as a suitable way to analyze scientific problems."(Barba, 1995, p. 280) The integration of science and mathematics will empower students and help them make connections which can be applied to everyday life. After all, many real life problems require both mathematical and scientific skills.

The integration of mathematics and science is not a new idea. In the 1840s, Fredich Froebel pioneered the use of manipulative materials to teach mathematical concepts and scientific principles through a thematic, inquiry-based approach to learning. After Froebel, in the 1900s, the Central Association of Science and Mathematics Teachers formed in the United States. The purpose of this association was to establish a closer relationship between mathematics and science teachers. In the 1960s, science curriculum projects were written using an integrated mathematics and science inquiry-based approach to learning. Science: A Process Approach, Science Curriculum Improvement Study, and Elementary Science Study were three

of these projects. Recently, mathematics and science curriculum writers have produced the *Activities that Integrate Mathematics and Science* (AIMS), Unified Science and Mathematics for Elementary School (USMES), and Great Explorations in Mathematics and Science (GEMS) materials.(Barba, 1995) These materials are used today by some elementary schools.

There are benefits to the integration of science and mathematics. There are many reasons why teachers should integrate the disciplines. "Mathematics can enable students to achieve deeper understandings of science concepts by providing ways to quantify and explain science relationships."(Haigh and Rehfeld, 1995, p. 241) Many national organizations recognize the importance of the integration of mathematics and science teaching and learning. The integration of the disciplines offers greater opportunity to motivate students and create positive attitudes toward mathematics and science. When students see a relationship between what they are learning and their personal lives, their interest in learning increases. The integration of mathematics and science increases students' achievement in both disciplines. (Haigh and Rehfeld, 1995) The integration of mathematics and science can be readily achieved through the use of current technology and curriculum resources. Since the pedagogy of the two disciplines are similar, mathematics and science are intertwined. In order to have competent students, there is a need to provide science and mathematics career knowledge and real world connections for both disciplines at the elementary school level.

The Carnegie Commission on Science states:

> Inadequacies in precollege mathematics and science education are a chronic and serious threat to our nation's future. The national interest is strongly bound up in the ability of Americans to compete technically. All young people, including the noncollege-bound, the disadvantaged, and young women, must be given the opportunity to become competent in mathematics and science.(Fisher, 1992, p. 51)

Statement of the Problem

Could it be that the students in fourth grade at Seventh Avenue School in Haddon Heights will demonstrate an increase in achievement levels when mathematics and science instruction are integrated, as compared to when they are taught as separate disciplines?

Purpose of the Study

There are three purposes to this study. This study will determine if teaching science and mathematics with an integrated approach will increase students' achievement. Second, this study will determine whether males or females achieve higher in science and mathematics when taught with the integrated approach, as compared to teaching the two disciplines separately. Third, it will determine whether the attitudes of the fourth grade students improve when mathematics and science are taught with an integrated approach.

Statement of the Hypotheses

The following hypotheses were presented for investigation:

1. There will be no significant differences in the achievement levels in the fourth grade students in Seventh Avenue School in Haddon Heights when mathematics and science instruction are integrated as opposed to being taught as separate disciplines.

2. There will be no significant differences in the achievement levels of males and females in the fourth grade when science and mathematics are taught as separate disciplines.

3. There will be no significant differences in the achievement levels of males and females in the fourth grade using the integrated approach to science and mathematics.

4. There will be no significant differences in the attitudes of the fourth grade students when taught with the integrated approach or when taught the two disciplines separately.

Methods and Procedures of the Study

An experimental design model was employed using sixteen fourth graders in the Haddon Heights School District. When science and mathematics were taught separately, a test was given on each objective after it was taught. The mean score was calculated for each student and the class. When science and mathematics were integrated, a test was given on each objective after it was taught. Again, the mean score was calculated for each student and the class. The means of the two months were compared for differences using a t-Test.

Limitations of the Study

The following are limitations of the study:

1. This research was limited to one fourth grade class in Seventh Avenue School in Haddon Heights as of January 1, 1997.

2. The length of the study was restricted to eight weeks.

3. The class is made up of twelve females and four males.

4. Different units were taught during each four week period, thus the objectives were not exactly the same.

Definition of Terms

Manipulative Materials - Objects or things that the student is able to feel, touch, handle, and move. They may be real objects or objects used to represent ideas.

"Hands-on" Approach - Manipulating with concrete materials.

N.C.T.M. - The National Council of Teachers of Mathematics set mathematics standards.

N.S.T.A. - The National Science Teachers of America are working to develop integrated, theme-based curriculums in science that involve all students.

AIMS - Activities that Integrate Mathematics and Science that assist in the integration of the two disciplines.

Organization of the Study

Chapter I includes an overview of the entire study. It presents the significance of the study, the statement of the problem, the purpose of the study and the specific hypotheses tested. It also includes the methods and procedures of the study, the limitations of the study, definition of terms, and the organization of the thesis.

Chapter II presents a review of the literature relevant to this study. The review includes an introduction and a presentation of research related to the integration of mathematics and science. It includes what the organizations that are active in this approach to teaching are doing to implement their ideas.

Chapter III provides a description of the design of the study. This includes the setting of the study, a description of the subjects used and the procedures for the study. The instruments used with the study and a statement about their reliability and validity is included also. The type of data collected and the methods used to analyze the data is explained.

Chapter IV presents the data collected from the tests given in January and February on each objective taught. It presents the data related to the hypotheses. It includes the analysis of the methods used in the study. It also shows the significance of each of the stated hypotheses.

Chapter V summarizes the results of the study. It states a conclusion and implications using the information gathered in the previous chapters. It also includes recommendations for future study.

Chapter II

Review of the Literature

Introduction

Something must be done to change students' views of science and mathematics. Fisher states, "In American school districts the teaching of science has virtually disappeared from elementary education. By the time students reach high school, few find science fun. A low percentage of students possess in-depth scientific knowledge. The outlook of mathematics isn't much better. By eighth grade, students have generally mastered no more than basic arithmetic. Students are weak in reasoning and problem solving skills." (Fisher, 1992) Educators need to find a solution to this dilemma.

The literature review in this chapter will explain the learning theories of several psychologists. It will report the benefits of the integration of mathematics and science. This study will include reform efforts in the schools to change the mathematics and science curriculums and the obstacles that must be overcome.

The resources used in this review were collected from the Savitz Library at Rowan College in Glassboro, NJ, various sites on the Internet, educational magazines, professional journals, and in-service workshops. The Core Curriculum Standards for New Jersey and the National Standards for Science and Mathematics at the fourth grade level were used throughout this study.

Learning Theory

Constructivism is the leading theoretical position in education that believes that children learn science and mathematics from the moment they become aware of their environment. Children build models of the real world through every day experiences. These models help them understand what they have seen and heard and to predict what may happen next. Constructivists believe what the learner knows is of central importance. (Treagust, Duit and Fraser, 1996) They believe that students actively construct their own knowledge whenever they learn something.

From a constructivist point of view, there are five basic assumptions shared by mathematics and science educators:

1) More emphasis will be given to the applicability of science and mathematics knowledge in which students are interested. Mathematics and science of our daily lives will become appropriate content for building connections between prior knowledge and scientific or mathematical content.

2) Mathematics and science knowledge is tentative human construction and not eternal truth.

3) More elaborate and complex mathematical and scientific ideas must be demonstrated to allow deeper and broader explanations if they are to become important to students.

4) The approach must be student centered. The classroom climate should support and encourage the exchange of ideas. Students must become aware of their own thinking processes.

5) Norms, routines and patterns of classroom interactions form an influence on the effectiveness of reform efforts in the integration of science and mathematics. (Treagust, et al., 1996) These assumptions must be understood in order to reform the science and

mathematics curriculums.

According to Piaget, children from ages seven to eleven are in the concrete stage of development. In this stage, the child is able to solve concrete or hands-on problems in a logical fashion. Piaget also said that all knowledge is constructed by direct physical contact with objects or events. (Charbonnean and Reider, 1995) Therefore, teachers must continue to supply manipulative materials to students to make learning meaningful.

Many schools are stressing that teachers teach to multiple intelligences. These intelligences, as termed by Gardner, are logical-mathematical, interpersonal, intrapersonal, musical, spatial, bodily-kinesthetic, and linguistic. According to Gardner, teachers need to teach for more thorough understanding. Gardner believes children learn in different ways and according to the strengths of certain intelligences.(Charbonneau and Reider, 1995) Of course, different children have strengths and weaknesses in different intelligences. By integrating mathematics and science, teachers would be teaching to more of the intelligences and allow for the different ways in which children learn.

Dewey's approach to education was to attempt to connect subject-matter knowledge with the child's experience. Dewey, in Experience and Education, (1938, p.88) states that "it is a cardinal principle of education that the beginning of instruction shall be made with the experience learners already have; that this experience and the capacities that have been developed during its course provide the starting point for all further learning." (Charbonneau and Reider, 1995, p. 4) Dewey's insights from so many years ago still pertain to how a child learns today.

Integration of Science and Mathematics

Integration deals with the extent to which teachers use examples, data, and information from a variety of disciplines and cultures to illustrate the key concepts,

principles, generalizations and theories of the discipline. There are five types of integration: 1) discipline specific, 2) content, 3) process, 4) methodological, and 5) thematic.(Davison, et al., 1995) Each type integrates the disciplines in a different way.

Discipline specific integration involves an activity that includes two or more different branches of mathematics or science. This does not necessarily integrate the two disciplines, but some branches of mathematics and some branches of science are interrelated and may be integrated.(Davison, et al., 1995) For example, when teaching about squares in mathematics, you may also teach about parallel lines, perpendicular lines and angles. It does not integrate science but it does integrate several mathematical concepts.

Process integration uses real life activities in the classroom. Students experience the processes of science and perform the needed mathematics. Students conduct experiments, collect data, analyze data, and report results. They use skills like problem solving, reasoning, estimating, observing and classifying, all of which are included in the N.C.T.M. standards. (Davison, et al., 1995) The AIMS activities, discussed later, and used as a unit in this study are an example of process integration.

Methodological integration is not heard of much in literature today. Science methodology is integrated with the teaching of mathematics in this approach. Students will investigate issues in both science and mathematics using strategies such as inquiry, discovery and exploration. This might be termed as experimental science.(Davison, et al., 1995)

Thematic integration is probably the most well known, especially to elementary teachers. By using a theme, teachers design a unit around that subject. Thematic teaching includes all disciplines, not only mathematics and science.(Davison, et al., 1995) An example of a theme might be a unit on sharks to develop mathematics and science concepts.

When using content specific integration, the teacher uses an objective from the mathematics curriculum and an objective from the science curriculum. An activity that incorporates both objectives is performed. This type of integration weaves together the existing programs in science and mathematics.(Davison, et al.,1995) For example, if you teach about dinosaurs in science, the measurement of dinosaurs can be taught from mathematics.

The AIMS projects are units that were developed to integrate mathematics, science, language arts and social studies. The topics of the AIMS projects deal with concerns of the real world. The activities help develop positive attitudes towards the study of mathematics and science and are of high interest to children. The lessons include hands-on investigations, are student-centered, promote inquiry, higher order thinking processes, and reasoning. The students are the focus of the activities. The teacher acts as a resource and assesses the knowledge, skills, processes and behaviors of the students. (Berlin and Hillen, 1994) Students have opportunities to develop positive attitudes, realistic beliefs, and to become confident in their ability to do mathematics and science.

The AIMS project has four major objectives. The first objective is to improve the students' understanding of mathematics and science and how they are related, while at the same time developing a strong positive attitude toward the two disciplines. The next objective is to train teachers to assume leadership roles in the districts by providing staff development in mathematics and science. Another objective is to assist classroom teachers in changing the way they teach mathematics and science by using a hands-on, student centered approach that promotes thinking and understanding. The last objective is to provide sound integrated mathematics and science curriculum experiences which are consistent with the recommendations of the N.C.T.M. Standards and Project 2061.

The goal of the AIMS project is to provide opportunities to acquire fundamental

concepts and procedures, opportunities to discover, inquire, reflect, construct and validate knowledge of some purposeful, meaningful activity.(Berlin and Hillen, 1994) AIMS uses real life problems to learn about mathematics and science. An AIMS project unit will be used in this study.

The scientific and mathematics endeavor should include an understanding of the union of mathematics and science. Mathematics is a science which provides the language of science with a powerful analytical tool. Science and mathematics have roots going back into history and into every part of the world. Mathematics is the science of abstract patterns and relationships. Mathematics is a creative process rather than one of using memorized rules to calculate answers. Science and mathematics deal with problems that originate in the everyday world.("Science For All Americans Summary," 1995) They are related to each other, and therefore should be related when they are taught to students. In 1990, Rutherford and Ahlgren state:

> The alliance between science and mathematics has a long history, dating back centuries. Science provides mathematics with interesting problems to investigate, and mathematics provides science with powerful tools to use in analyzing data.... Science and mathematics are both trying to discover general patterns and relationships, and in this sense they are part of the same endeavor. (Berlin and White, 1992, p. 340)

This quote tells us that mathematics and science are related, and help us to solve real world problems.

At the Wingspread Conference, educators gathered to discuss the integration of science and mathematics. Many benefits of integration were discovered. It provides opportunities for out of school resource persons to become involved in the schools. Integration stimulates group interaction and social development. It also bridges an understanding between concrete and abstract representations for students. Integration of the disciplines puts an emphasis on information use rather than the acquisition of

information. Students have opportunities to put ideas together and gain a deeper understanding of science and mathematics. Integration encourages relevant, exciting science and mathematics in schools.(Berlin and White, 1992) This quote from the conference sums up what integration is about, "Integration infuses mathematical methods in science and scientific methods into mathematics such that it becomes indistinguishable as to whether it is mathematics or science." (Berlin and White, 1992, p. 341) The integration of science and mathematics helps students realize that mathematics and science are everywhere.

The students are the most important people to consider when bringing about change. Research has shown that when mathematics and science are integrated, students' attitudes towards the disciplines improve significantly. Integration also improves students' problem solving abilities in both science and mathematics. It is effective in improving students' mathematical graphing skills and science process acquisition.(Barba, 1995) Students benefit from seeing how mathematics and science are involved in acquiring new knowledge. Students are able to find solutions to real world problems through this integrated approach to learning. Integration may encourage support and confidence in the students' ability to do science and mathematics.(Mitchell, Miller and Paine, 1995) Since integration is so beneficial to students, teachers must make an effort to change the way they are teaching mathematics and science. The National Research Council (1990) states:

> Since mathematics is both the language of science and a science of patterns, the special links between mathematics and science are far more than just those between theory and application. The methodology of mathematical inquiry shares with the scientific method a focus on exploration, investigation, conjecture, evidence, and reasoning. Firmer school ties between science and mathematics should especially help students' grasp of both fields.(Berlin and White, 1992, p. 340)

Reform

Recent reform in mathematics and science education calls for the active involvement of students in instruction related to real life. To reform instruction, we have to rethink all levels of the educational system. We should be focused on supporting classrooms that are devoted to active, meaningful learning. We must get support from principals, teachers, parents and the community, administration, and political structures.(Fennimore and Cook, 1993) With support, teachers can institute changes of the science and mathematics curriculums.

Many teaching and learning changes must take place to reform mathematics and science instruction. First, we must recognize that the current teaching methods are not based on current research about learning. Teachers must be committed to learning new ways of teaching and to try new ways of teaching and learning approaches. New modes of assessment of learning must be developed. There must be an awareness of the need for the ongoing training of teachers. The follow-up of teacher training must be comprehensive. ("A Model of Change in Science and Mathematics Education," 1993) Professional development plays an important role in implementing a new practice.

The National Science Foundation reaffirmed the importance of attending to the growing need for mathematically and scientifically literate United States citizens. Systemic reform is the ongoing process of changing the way individuals view learning and teaching within each classroom and beyond, to schools, to community, to administrative entities.(Fennimore and Cook, 1993) Through systemic reform, it is hoped that the educational system can be transformed to make lasting change.

Systemic change occurs when we reformulate the goals of learning. The curriculum must reinforce the new vision. Instruction must promote inquiry, purposeful dialogue, and problem-focused collaboration. (Fennimore and Cook, 1993) Assessment

needs to focus on higher order thinking, as in Bloom's Taxonomy. When we alter our goals for instruction and assessment, systemic change may occur.

Goals 2000 has set objectives to be reached by the year 2000 for all United States students. It is expected that our students will be "first in the world in mathematics and science achievement."("Teachers and Goals 2000: Leading the Journey Toward High Standards for all Students," 1995, p. 1) The objectives for this goal include:

1) mathematics and science education, including the metric system, will be strengthened throughout the system, especially in the earlier grades.

2) The number of teachers with a substantive background in mathematics and science will increase by fifty percent.

3) The number of United States undergraduate and graduate students, especially women and minorities, who complete degrees in mathematics, science and engineering will increase significantly.("Teachers and Goals 2000: Leading the Journey Toward High Standards for all Students," 1995) By the year 2000, it is hoped that students develop a functional level of scientific and mathematical literacy, the motivation to excel in science and mathematics, and the initiative to select science and mathematics related careers.

Many states have set their own goals, such as the goals set by Maine. The Maine Mathematics and Science Alliance have developed their own goals. Their mission statement follows: "We seek a state able to sustain an effective learning environment that supports increased aspiration and improved performance in mathematics and science for all students and all teachers."("The Maine Mathematics and Science Alliance," 1995, p.1) The goals of the alliance are:

1) All students should demonstrate the knowledge and skills in science and mathematics to meet or exceed national standards.

2) Aspirations and expectations for learning and achieving in science and

mathematics for all students will be high.

3) Student opportunities for learning science and mathematics will be equitable.("The Maine Mathematics and Science Alliance," 1995) Maine is one of he leading states in science and mathematics reform.

Some school districts have set their own goals that follow Goals 2000. The Haddon Heights, Barrington, and Lawnside districts are working together in an effort to reform science and mathematics instruction. The following goals are some examples of the reform efforts in the three districts. Goal 1, Objective 1.1 states: "To use the local improvement panel's recommendations to increase the academic achievement of our students in the areas of mathematics, science and technology as determined by the needs assessment survey within the three districts." ("Goals 2000: Educate America Act," 1996) Goal 2 states: "By the year 2000, all students will leave grades 4, 8, and 12 having demonstrated competency over challenging subject matter including mathematics, science, and technology so that they may be prepared for further learning and productive employment in our Nation's modern economy." ("Goals 2000: Educate America Act," 1996) Goal 4, Objective 4.1 states: "To infuse lessons involving career planning, and decision making, critical thinking and problem solving, the practical application of basic skills, and effective communication skills into mathematics and science lessons as measured by revised curricula and instructional observations of the implemented lessons." ("Goals 2000: Educate America Act," 1996) Many more goals are included in an effort to improve the learning and teaching of mathematics and science.

Science and mathematics organizations have also set standards for the learning and teaching of science and mathematics. The National Council of Teachers of Mathematics (N.C.T.M.) standards include Curriculum and Evaluation Standards for School Mathematics and Professional Teaching Standards. The N.C.T.M. wants schools to prepare students mathematically to function efficiently in our society. Many

science organizations have developed standards to improve the teaching of science. Science For All Americans and Project 2061 emphasize literacy in science for all Americans. These organizations are leading the efforts to reform science and mathematics education.

The N.C.T.M. is urging schools to prepare students to be mathematically literate in order to function in our society. The goal of the N.C.T.M. and the National Research Council is to develop in students a functional level of scientific and mathematical literacy. Student should excel in science and math and select careers related to the two disciplines.(Berlin and White, 1994) The N.C.T.M. standard on mathematical connections emphasizes the importance of the connections among mathematical topics and other disciplines. Students should be able to observe mathematics interacting with other school subjects and society.(Haigh and Rehfeld, 1995) Another N.C.T.M. standard states that students should be able to "apply mathematical thinking and modeling to solve problems that arise in other disciplines."(Davison, et al., 1995, p. 229) The N.C.T.M. has recognized other subjects, including science, as part of their standards.

In Science for All Americans, science for all means that all people, including women, girls, all racial and ethnic groups, the physically and educationally challenged, and those with limited English proficiency, should become scientifically literate. This requires that the curriculum, teaching, and assessment standards, take into account the diversity, interests, motivation, experience, and understanding of all students.(Hoffman and Stage, 1993) These standards should highlight and promote the best practices of teaching science.

Science For All Americans and Project 2016 have recommendations that should be met by all students. Students should be familiar with the natural world, and recognize its diversity and unity. They should understand the key concepts and principles of science. Students should be aware of important ways in which science,

mathematics and technology depend upon one another. Science, mathematics and technology are human enterprises, and students should know their strengths and limitations. Students should develop scientific ways of thinking. They should use their scientific knowledge and ways of thinking for individual and social purposes.("Science For All Americans Summary," 1995) With these recommendations, curriculums and instruction need to be reformed to best prepare our students.

The National Committee on Science Education Standards and Assessment met in May of 1992. They met to develop standards for school science. The committee specified criteria to guide the future development of science education. The curriculum standards of the committee defined:

1) the nature of school science experiences effective in producing valued science learning,

2) the scientific information (facts, concepts, theories) that all students are expected to attain as a result of their science experiences and

3) the attitudes and inclination to apply scientific principles and ways of thinking outside the formal education system.(Hoffman and Stage, 1993)

The standards were to provide a vision of excellence to guide the science educational system in productive and socially responsible ways.

Standards have also been set for teachers and the teaching of science and mathematics. Teachers need to acquire the skills and knowledge to provide students with school experiences to achieve the science and mathematics learning outcomes. They need professional development to fulfill their roles as science and mathematics teachers. (Hoffman and Stage, 1993) Teachers need a support system and resources for the effective teaching of science.

Many teachers fall below the minimum standards themselves for teaching

mathematics and science. Much teaching of mathematics and science is still done where the teacher gives students information to memorize and then regurgitate. Teachers need to expand their basic understanding of mathematics and science and acquire new skills and teaching techniques. They need retooling to explore concepts and learn content through cooperative learning and hands-on, inquiry-based activities to take back to the classroom. (Monteagudo, 1995) These activities provide teachers with the understanding and learning needed to connect their classroom study of mathematics and science to the standards.

When integrating science and mathematics, there are changes seen in the teacher. Integration improves teachers' attitudes toward teaching mathematics and science. The teacher's ability to articulate the curriculum improves. Higher level thinking skills are taught more often. Teachers use alternative assessment devices more. Integration promotes the use of technology in the mathematics and science curriculums. Career awareness is incorporated into instruction. (Barba, 1995) Most importantly, integration increases teachers' motivation to teach mathematics and science.

Since teachers will interpret the new standards in mathematics and science, there must be a serious commitment made to teacher development. Teachers will decide how the new curriculum is to be realized and how instructional materials will be used. The teacher needs to be more involved in school wide decisions. Teacher development is the key to the school-wide renewal of mathematics and science.

Of course, there are many obstacles to reform. "Progress has been hampered," says Douglas Lapp, director of the National Science Resource Center, "because efforts in education have been driven by crisis." (Fisher, 1992, p.52) The funding and leadership have not been steady. It seems impossible to have continuous, successful programs in science and mathematics teacher training. It is difficult to provide

classrooms with up-to-date equipment and computers.(Fisher, 1992) Efforts that have been made to restructure the mathematics and science curriculums seem to have little effect on the conventional uses of the textbook and the methods of delivery. (Davison, et al., 1995) The attitudes of the school and the community are difficult to change when trying to implement new programs. Even though the changes needed may not be easy, we must move forward and do what is best for our students.

Chapter 3

Design of the Study

Introduction

The purpose of this study is to determine if teaching science and mathematics with an integrated approach will increase students' achievement levels. This study will also determine whether the attitudes of the fourth grade students improve when taught with the integrated approach. In order to discover any significant differences, the students' achievement levels were measured by tests of the specific objectives taught in science and mathematics. An attitude survey was given to measure any differences in attitudes when taught with an integrated approach as compared to being taught the subjects separately.

Setting

Haddon Heights is in Southern New Jersey. It is a small, residential community with few businesses. Haddon Heights can be described as a "hometown," where many families who reside there live in homes previously owned by other family members, such as parents or grandparents. Many of the parents, whose children attend the public school system, have themselves attended the same school system.

The Haddon Heights Public School District has four schools, three elementary schools (K - 6), and one High School (9 - 12) that includes a Junior School (7 - 8). The

High School includes students from Barrington and Lawnside, as well as Haddon Heights. The Haddon Heights High School dates back to 1924, while the oldest elementary school, Seventh Avenue, was built in 1914. The elementary schools in Haddon Heights are neighborhood schools. There is no busing of students, except for special education, as they are close enough to their neighborhood school to walk. Two of the elementary schools have one grade level each, while the third school frequently has two of some grade levels, as needed according to the population. The Glenview School is the only elementary school that houses separate special education classrooms.

There were 1,321 students enrolled in the Haddon Heights School District as of October 15, 1996. The racial composition of the students was 1,140 white, 150 black, 14 Hispanic, 1 American Indian and 16 Asian. In the Seventh Avenue School, where my study took place, 98% of the students speak English, with 1% speaking Spanish and 1% speaking Turkish. The teaching staff in the Haddon Heights Public School District numbered 116 members as of October 15, 1996.

Description of the Population and Sample

The Seventh Avenue Elementary School in Haddon Heights has 144 students. There is one grade of each level from kindergarten to grade six. The group which was the subject of this study consisted of one fourth grade class from the Seventh Avenue School. The total population of the study was sixteen fourth grade, heterogeneously grouped students. The students are all of average to high ability. Due to the small numbers in the class, its members get much individual attention. The class consisted of twelve female and four male students. Fourteen of the students have been in the same class together since kindergarten. Two students came to Seventh Avenue in third grade.

Description of the Instrument

This study lasted for a two month period. For the month of January, the objectives in science and mathematics were tested separately. The students were administered a posttest after each objective was taught in mathematics and science. Each students' mean score was determined to assess their achievement in each subject separately. During the second month, students were tested on the objectives of the integrated unit being taught. The students were administered a posttest after each objective in the integrated unit. Each students' mean score was determined to assess their achievement in mathematics and science for the integrated unit. A comparison of the mean test scores of the students' achievement was used to help assess any differences in student achievement from January to February.

In January, mathematics and science were taught separately. In mathematics, the tests used came from the Open Court mathematics program. I consulted with the mathematics specialist in the district, Mrs. Kelly Johnson. Mrs. Johnson and myself determined that each test supports the National Standards for Mathematics and follows the district curriculum specifications. The students were first tested with a review test from the Open Court text book and then tested with the similar mastery objective test that comes with the series. The students performed similarly on both evaluations. In science, a unit was taught on deserts. Each objective covered in the unit was tested with a teacher made test. The questions on each test followed the National Standards for Science and the New Jersey Core Curriculum Content Standards, as well as the current district curriculum. Each test was given twice, both the same format, but with different questions. The students achieved similar scores on both tests. I also compared the scores with the students' usual performance in class, their participation and the projects they completed for the unit. The achievement of the students on the tests was equal to their

usual performance, participation and the quality of their projects.

For the month of February, a unit on nutrition was taught. The unit taught was from the AIMS project. Each lesson from the unit correlates to the National Mathematics and Science Standards. The unit also supports the curriculum of the district in mathematics and science. Each objective was tested and retested to determine the reliability of the tests. The tests were of the same format and length with different questions. Students achieved comparable scores for both tests.

Students were given a survey at the beginning and end of each month to determine any differences in their attitudes toward the learning of mathematics and science separately or integrated. The word attitude used in this study is defined as a learned, predisposition to react in a consistent way toward an idea. The survey followed the Likert-type attitude scale. The survey was composed of statements to which the students made five responses: yes, almost always, sometimes, seldom, or no. The statements were averaged, and the score was rated from one to five, with five being the most favorable. The attitude surveys were evaluated and the scores of the two months were compared using a t-Test to determine any differences in students' attitudes toward mathematics and science learning.

Relationship of the Instrument to the Null Hypothesis

The general hypothesis of this study states that there will be no significant difference in the achievement levels of the fourth grade students when mathematics and science are integrated as compared to being taught as separate disciplines. The tests administered during each month were scored on a scale of 0 - 100. Each students' mean score was calculated for science and mathematics. At the end of February, the scores of each individual were compared to see if there were any significant differences in the achievement levels of mathematics and science for the two months. The same instrument

was used to compare any differences in the achievement of males to females in the class.

A second instrument, an attitude survey, was used to test the hypothesis that stated there would be no significant difference in students' attitudes when taught science and mathematics separately or integrated. The survey was rated on a scale of 1 to 5. The average was calculated for each student. At the end of the two months, the attitudes of the students were compared to discover any differences in their feelings toward science and mathematics.

Time Period and Procedure of Data Collection

An in-depth review of current literature was used as a basis of gaining insight into the teaching technique of integrating science and mathematics. The research on the integration of science and mathematics indicates that there are many advantages to teaching mathematics and science with an integrated approach. The purpose of this study is to determine if there are any differences in student achievement levels when mathematics and science are taught with the integrated approach.

During the month of January, mathematics and science were taught as separate disciplines. The mathematics lessons were taught from the Open Court mathematics program. In mathematics, the concepts taught were functions, graphing functions, basic facts, multiplying and estimating. In science, a unit on deserts was taught. The concepts covered included classifying, comparing and contrasting of desert landforms, plants, and animals. Each objective was tested after being taught. The mean scores of the students were calculated for mathematics and science. Each student was given an attitude survey to determine how they felt about mathematics and science.

For the month of February, mathematics and science were taught as an integrated

unit using a nutrition unit from the AIMS project. The concepts taught were reading graphs, determining ranges, estimating, classifying, and comparing and contrasting foods. Each objective was tested for mathematics and science understanding. The mean scores of the students were calculated for the integrated mathematics and science unit. At the end of the month, each student was given an attitude survey to determine how they felt about mathematics and science.

The two units taught in January and February were of equal levels of difficulty. Four teachers, including myself, evaluated each unit to establish that they were of equal levels of difficulty. The mathematics specialist and myself evaluated the two mathematics units taught over the two month period. Both units followed the New Jersey Core Curriculum Content Standards and the National Standards for Mathematics. Both units included problem solving, computation, use of calculators, and interpreting data. The units included difficult and easy questions, as well as those of moderate difficulty. Together, we concluded that the units were of equal levels of difficulty. The fifth and sixth grade teachers and myself evaluated the two science units being taught in January and February. Both units followed the Core Curriculum Standards for Science and the National Science Standards. Both units included higher level thinking skills and critical thinking. The units included difficult, moderate and easy levels of questioning. Both the fifth and sixth grade teachers agreed that the units were of equal levels of difficulty.

Each objective taught in science and mathematics was tested during the two months. The tests were scored on a scale of 0 - 100. A mean score was calculated for each student for all of the tests in the two month period. At the end of each month, each student's scores were averaged. A comparison of the scores was made between each student's final average for each month.

An attitude survey was used to test whether the students felt differently toward science and mathematics over the two month time period. The survey was rated on a

scale of 1 to 5. The scores of each student were averaged to determine their attitude of science and mathematics. The surveys were completed at the end of each month and were compared for any differences in attitudes towards science and mathematics over the two month period.

Summary

In Chapter Three, the population, sample, and instrument of the study were outlined and discussed. Comparisons of the mean test scores from tested objectives were used to assess the differences in student achievement levels in mathematics and science when taught separately and integrated. Analysis of the scores would determine the validity of the hypotheses central to this study. Students were surveyed to determine any differences in their attitudes toward science and mathematics learning.

Chapter 4
Analysis of the Data
Introduction

This study gathered information to determine if there were significant differences in the achievement levels of fourth grade students when taught integrated mathematics and science as compared to being taught the subjects separately. The fourth grade class at the Seventh Avenue School in Haddon Heights were taught mathematics and science for one month as separate subjects and for one month using the integrated approach. This study also examined any differences in male and female achievement levels and any differences in attitudes towards mathematics and science when taught with the two approaches. The methods of measuring achievement were tests on the specific objectives of the lessons and an attitude survey. The tests for mathematics for January were supplied by the Open Court mathematics series. The science tests were teacher-made following guidelines from Ranger Rick's Nature Scopes. The mathematics and science tests for February were teacher-made following guidelines from an AIMS unit. The hypothesis stated that there would be no significant differences in achievement levels or attitudes when the subjects were taught separately or integrated.

Tests of the Hypotheses and Results

The data presented has been statistically analyzed using a t-Test to determine any differences in the achievement levels of the fourth grade students when taught mathematics and science with the integrated and separate approaches. The hypotheses being tested were:

1.) There will be no significant differences in the achievement levels of the fourth grade students in Seventh Avenue School in Haddon Heights when mathematics and science instruction are integrated as compared to being taught as separate disciplines.

2.) There will be no significant differences in the achievement levels of males and females in the fourth grade when science and mathematics are taught as separate disciplines.

3.) There will be no significant differences in the achievement levels of males and females in the fourth grade using the integrated approach to science and mathematics.

4.) There will be no significant differences in the attitudes of the fourth grade students when taught with the integrated approach or when taught the two disciplines separately.

Presentation and Statistical Analysis of the Data Related to Hypothesis 1

Hypothesis 1 states that there will be no significant differences in the achievement levels in the fourth grade students in Seventh Avenue School in Haddon Heights when mathematics and science instruction are integrated as compared to being taught as separate disciplines. Table 1 summarizes the scores achieved during the month of

January when the students were taught mathematics and science as separate subjects. The mean of each test given was calculated with the scores ranging from 82.81% to 96.81%. The combined mathematics and science averages ranged from 83.43% to 97.14%. The class average for the month was 91.66% with a standard deviation of 4.19.

Table 1

Tests Scores and Mean Scores for the Fourth Grade Students When Mathematics and Science Were Taught as Separate Disciplines for the Month of January

Name								Average
Amy	73	100	96	92	92	92	86	90.14
Meghan	93	90	93	93	94	100	98	94.14
Robin	86	92	97	89	95	97	93	92.71
Katie	83	98	94	91	92	90	100	92.57
Julia	55	85	85	89	93	100	99	84.71
Andrew	93	93	93	99	96	99	93	93.71
Kerri	100	100	91	99	85	100	86	86.86
Heather	60	93	80	91	78	96	92	83.43
April	83	94	98	88	85	97	93	92.57
Megan	93	99	100	99	97	97	93	86.86
Kate	86	85	71	97	97	86	93	88.71
Jonathan	100	100	100	89	92	100	79	96.71
Ryan	77	88	92	99	92	97	100	92.17
Christina	100	100	92	99	100	100	89	97.14
Sarah	73	85	85	84	91	93	100	88.71
Scott	60	85	92	91	91	99	86	86.41
Sum of Scores	1325	1477	1468	1609	1470	1545	1485	1486.55
Mean	82.81	92.31	91.81	94.31	91.88	96.61	91.56	91.66
Sum of SS	113089	136987	135627	142593	135536	150155	134751	134685.95
Sum of Squares	3362.44	641.44	754.44	275.44	479.75	182.44	611.81	262.89
S.D. for Population	14.5	6.33	6.87	4.16	5.48	3.47	6.18	4.05
S.D. for Sample	14.97	6.54	7.09	4.29	5.66	3.53	6.39	4.18

Table 2 summarizes the scores achieved during the month of February when the students were taught integrated mathematics and science. The mean of each test given was calculated with a range from 90.31% to 97.63%. The students' combined mathematics and science averages ranged from 82.8% to 98.6%. The class average for the month was 92.61% with a standard deviation of 5.03.

Table 2

Tests Scores and Mean Scores for the Fourth Grade Students When Mathematics and Science Were Taught as an Integrated Unit for the Month of February

Name						Average
Amy	89	97	90	84	93	90.6
Meghan	93	98	100	93	89	94.6
Robin	93	94	100	94	88	93.8
Katie	100	100	100	95	92	97.4
Julia	92	88	90	92	89	90.2
Andrew	95	100	100	88	89	94.4
Kerri	96	100	100	88	92	95.2
Heather	94	94	70	75	87	84
April	87	96	80	85	84	86.4
Megan	97	100	100	100	96	98.6
Kate	94	100	78	85	86	88.6
Jonathan	100	97	99	100	94	98
Ryan	93	98	90	92	94	93.4
Christina	100	100	90	95	92	95.4
Sarah	100	100	98	100	94	98.4
Scott	73	100	75	80	86	82.8
Sum of Scores	1496	1562	1460	1446	1445	1481.8
Mean	93.5	97.63	91.25	90.38	90.31	92.61
Sum of S.S.	140552	152658	134814	131482	130689	137613.2
Sum of Squares	676	167.75	1589	799.75	187.44	379.94
S. D. for Population	6.5	3.24	9.97	7.07	3.42	4.87
S.D. for Sample	6.71	3.34	10.29	7.3	3.53	5.03

Chart 1 shows the comparison of individual means for January and February. In January, mathematics and science were taught as separate disciplines. In February, mathematics and science were taught as an integrated unit. The means for most individuals were slightly higher for the integrated unit, as shown in this graph.

Chart 1

Comparison of the Individual Means When Mathematics and Science Were Taught Separately in January and Integrated in February

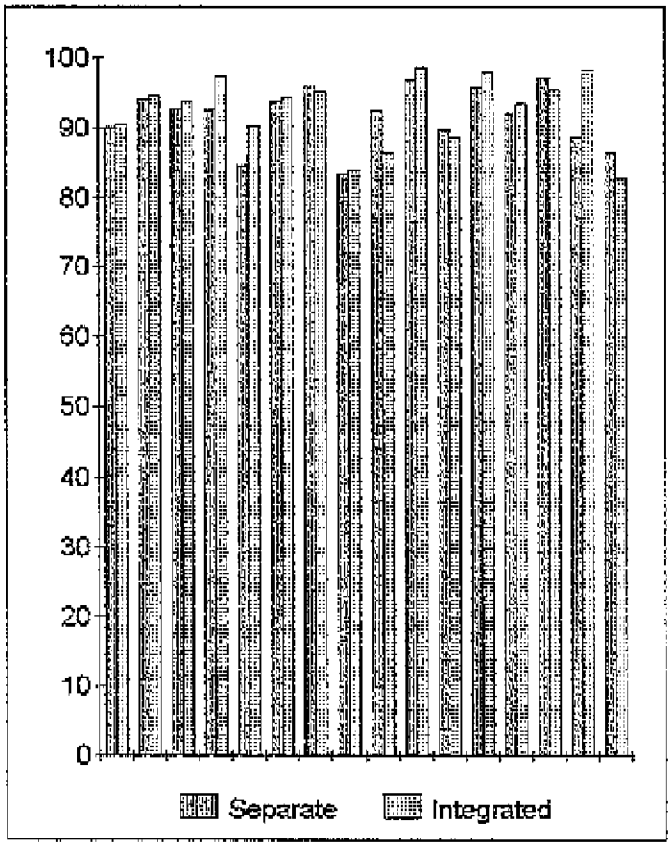
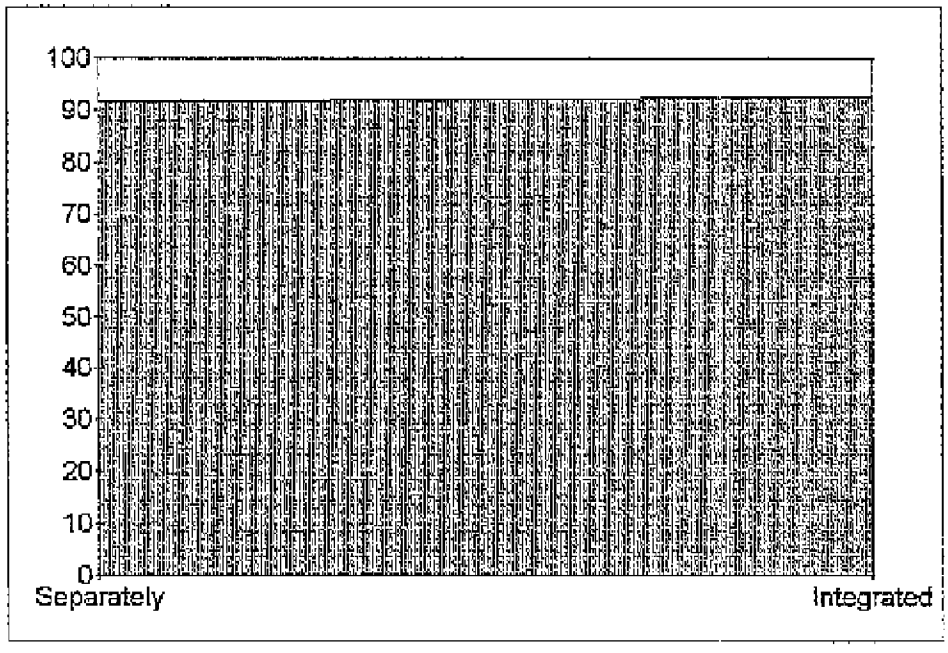


Chart 2 shows the comparison of the class means for January and February. In January, mathematics and science were taught as separate disciplines. In February, mathematics and science were taught as an integrated unit. The class mean for the month of February, when mathematics and science were taught as an integrated unit are slightly higher than the January scores. January's mean was 91.66 and February's mean was 92.61.

Chart 2

Comparison of the Class Means When
Mathematics and Science Were Taught Separately
in January and Integrated in February



The t-value calculated, as shown in Table 3, was -0.58 with 30 degrees of freedom. The absolute value of the t-value, 0.58, falls between the positive and negative critical value of 2.042. Although there is a slight increase in achievement levels shown from January to February, Hypothesis 1 can be accepted as there were no significant differences in the achievement levels from January to February when mathematics and science were taught separately or integrated. The increase could signify a trend and could be investigated further.

Table 3

Results from a t-Test for Independent Samples Comparing the Mean Scores of the Fourth Grade Students When Mathematics and Science Were Taught Separately in January and as an Integrated Unit in February

Statistic	Value
Number of scores in group one - January	16
Sum of scores in group one	1466.55
Mean of group one	91.66
Sum of squared scores in group one	134685.95
SS of group one	262.89
Number of scores in group two - February	16
Sum of scores in group two	1481.8
Mean of group two	92.61
Sum of squared scores in group two	137613.17
SS of group two	379.94
t-value	-0.58
Degrees of freedom(d)	30

Presentation and Statistical Analysis of the Data Related to Hypothesis 2

Hypothesis 2 states that there will be no significant differences in the achievement levels of males and females in the fourth grade when science and mathematics are taught as separate disciplines. Table 4 shows the mean scores and the t-value of the male fourth grade students compared to the female fourth grade students for the month of January.

Table 4

Results of a t-Test for Independent Samples Comparing the Mean Scores of the Male Students to the Female Students When Mathematics and Science Were Taught Separately in January

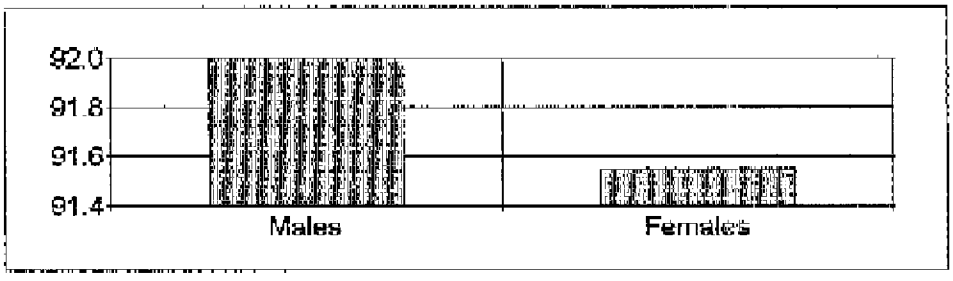
Statistic	Value
Number of scores in group one - males	4
Sum of scores in group one	368
Mean of group one	92
Sum of squared scores in group one	33903.96
SS of group one	47.96
Number of scores in group two - females	12
Sum of scores in group two	1098.55
Mean of group two	91.55
Sum of squared scores in group two	100781.98
SS of group two	214.3
t-value	0.18
Degrees of freedom(d)	14

The t-value, shown in Table 4, was calculated at 0.18 with 14 degrees of freedom. The t-value falls between the positive and negative critical value of 2.624. Therefore, Hypothesis 2 can be accepted as there are no significant differences between male and female achievement when mathematics and science are taught separately.

Chart 3 shows the comparison of the males' group mean scores and the females' group mean scores for January. The mean scores of the males group is slightly higher than the mean scores of the female group when mathematics and science were taught separately.

Chart 3

Comparison of the Mean Scores of the Male Group to the Female Group When Mathematics and Science Were Taught Separately in January



Presentation and Statistical Analysis of the Data Related to Hypothesis 3

Hypothesis 3 states that there will be no significant differences in the achievement levels of males and females in the fourth grade using the integrated approach to science and mathematics. Table 5 shows the mean scores and t-value of the male fourth grade students compared to the female fourth grade students for the month of February.

Table 5

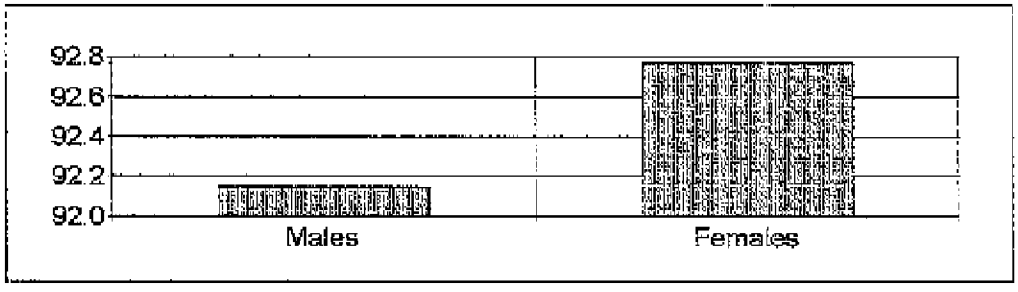
Results of a t-Test for Independent Samples Comparing the Mean Scores of the Male Students to the Female Students When Mathematics and Science Were Taught as an Integrated Unit in February

Statistic	Value
Number of scores in group one - males	4
Sum of scores in group one	368.6
Mean of group one	92.15
Sum of squared scores in group one	34094.76
SS of group one	128.28
Number of scores in group two - females	12
Sum of scores in group two	1113.2
Mean of group two	92.77
Sum of squared scores in group two	103518.41
SS of group two	250.59
t-value	-0.21
Degrees of freedom(d)	14

Chart 4 shows the comparison of the male groups' mean scores and the females' group mean scores for February. The mean scores of the female group is slightly higher than the mean scores of the male group when mathematics and science were taught as an integrated unit. Though there were no significant differences in the achievement levels, this could be studied further to see if there is a trend.

Chart 4

Comparison of the Mean Scores of the Male Group to the Female Group When Mathematics and Science Were Taught as an Integrated Unit in February



For February, the t-value, shown in Table 5, was calculated at -0.21 with 14 degrees of freedom. The t-value falls between the positive and negative critical value of 2.624. Therefore, Hypothesis 3 can be accepted as there are no significant differences between male and female achievement when mathematics and science are taught with the integrated approach.

Presentation and Statistical Analysis of the Data Related to Hypothesis 4

Hypothesis 4 states that there will be no significant differences in the attitudes of the fourth grade students when taught with the integrated approach or when taught the two disciplines separately. Table 6 shows the results of the combined mathematics and science attitude survey scores. The survey was based on a Likert-type 1 to 5 scale and then averaged for each student. As seen in Table 6, most attitudes did increase when the students were taught with the integrated approach to mathematics and science.

Table 6

Results of the Attitude Survey Given When Mathematics and Science Were Taught Separately and When the Disciplines Were Integrated

	Separately	Integrated
	Math and Science	Math and Science
Name		
Amy	3.4	4
Meghan	3.8	4.3
Robin	4.3	4
Katie	3.9	4.2
Julia	4.3	4.6
Andrew	4.2	4.3
Kerri	4.3	4.7
Heather	3.45	3.8
April	4.2	4.1
Megan	4.35	4.5
Kate	4.1	4.2
Jonathan	3.5	4.1
Ryan	4.5	4.4
Christina	4.37	4.8
Sarah	4.27	4.2
Scott	3.5	3.9

Table 7

Results of the t-Test for Independent Samples
for the Attitude Survey Given When Mathematics and
Science Were Taught Separately and Integrated

Statistic	Value
Number of scores in group one - Separately	16
Sum of scores in group one	64.44
Mean of group one	4.03
Sum of squared scores in group one	261.67
SS of group one	2.14
Number of scores in group two - Integrated	16
Sum of scores in group two	68.1
Mean of group two	4.26
Sum of squared scores in group two	291.07
SS of group two	1.22
t-value	-1.93
Degrees of freedom(d)	30

The t-value calculated from Table 7 was -1.93 with 30 degrees of freedom. The absolute value of this t-value, 1.93, falls outside the positive and negative critical value of 1.697. Out of 16 scores, there was an increase in 12 individual scores. Therefore, Hypothesis 4 is rejected that there are no significant differences in attitudes when mathematics and science are taught separately or integrated. The increase in positive attitudes might account for the slightly higher achievement levels in February.

Summary

This chapter presented the data collected from tests and an attitude survey given to a fourth grade class. The data was collected over a two month period, from January to February. The students were taught mathematics and science as separate subjects for one month and integrated for another month.

An analysis of the data was done in order to accept or reject the four stated hypotheses. t-Tests were performed to determine if any significant differences existed between the mean scores. Although there was a slight increase in achievement from January to February, after analyzing the results of these tests, it was found that Hypotheses 1, 2, and 3 were accepted. After analyzing the t-Test comparing the students' attitudes for the two months, Hypothesis 4 was rejected.

Chapter 5

Conclusions and Recommendations

Summary of the Problem

The purpose of this study was to determine if there were any differences in fourth grade student achievement levels when students were taught mathematics and science as separate disciplines or when the subjects were taught in an integrated manner. This study attempted to determine whether there were any differences in male and female achievement levels when taught the disciplines separately or integrated. This study also attempted to determine any differences in the attitudes of the fourth grade students when taught with the two different teaching methods.

Summary of the Method of Investigation

A heterogeneous fourth grade class was selected for this study, resulting in a total of 16 students participating. For the month of January, science and mathematics were taught to the students as separate disciplines. For the month of February, science and mathematics were taught with an integrated approach using an AIMS unit. The two units were designed and analyzed so that the levels of difficulty of the units were similar. The students were tested on each objective taught, and the means of the students for each

month were compared. The students also completed an attitude survey to determine if there were any differences in attitudes over the two month period. An analysis was completed using t-Tests to determine any differences in the achievement levels or attitudes of the students. The results from the t-Tests were studied and compared.

Summary of the Findings and Conclusions

Hypothesis 1, which states that there will be no significant differences in the achievement levels of the fourth grade students in Seventh Avenue School in Haddon Heights when mathematics and science instruction are integrated as compared to being taught as separate disciplines was analyzed using a t-Test. The t-value was calculated as -0.58 with 30 degrees of freedom. This value falls between the positive and negative critical value of 2.042. Even though the students showed a slight increase in scores from January to February, Hypothesis 1 is accepted as there were no significant differences in achievement levels when science and mathematics were taught separately or integrated.

Hypothesis 2, which states that there will be no significant differences in the achievement levels of males and females in the fourth grade when science and mathematics are taught as separate disciplines was analyzed using a t-Test. The t-value was calculated as 0.18 with 14 degrees of freedom. The critical value determined was 2.624. Since the t-value of 0.18 falls between the positive and negative critical value, Hypothesis 2 can be accepted as there were no significant differences in achievement levels between males and females when taught mathematics and science as separate disciplines.

Hypothesis 3, which states that there will be no significant differences in the achievement levels of males and females in the fourth grade using the integrated approach to science and mathematics was analyzed using a t-Test. The t-value was calculated as

-0.21 with 14 degrees of freedom. The critical value was determined at 2.624. Since the *t*-value falls between the positive and negative critical value, Hypothesis 3 can be accepted as there were no significant differences in the achievement levels in males and females when science and mathematics were taught using the integrated approach.

Hypothesis 4, which states that there will be no significant differences in the attitudes of the fourth grade students when taught with the integrated approach or when taught the two disciplines separately was also analyzed using a t-Test. The results show a t-value of -1.93 with 30 degrees of freedom. The critical value determined was 1.697. Since 1.93 falls outside of the positive and negative critical value, Hypothesis 4 can be rejected that there are no significant differences in the attitudes of the fourth grade students when taught with the integrated approach or when taught the two disciplines separately. The attitudes increased in February when mathematics and science were taught as an integrated unit.

Implications

The acceptance of Hypothesis 1 says that there were no significant differences in achievement when students were taught mathematics and science separately or integrated. The literature reviewed for this study does not agree with that finding. This could be because of the small class size. With the amount of individual attention that the students receive in this small class, they rarely fall behind. When comparing Table 1 and Table 2 in Chapter 4, the individual scores of the students did increase, as seen in Chart 1. Even though the scores increased from January to February, it was not significant enough to show any differences when using a t-Test.

The acceptance of Hypothesis 2 says that there were no significant differences in the achievement of males and females when taught mathematics and science as separate

disciplines. The mean for the month of January for males was 92.0 and for females was 91.55. The mean for the males was slightly higher than the females when science and mathematics were taught as separate disciplines. Another study with a class of males and females more evenly distributed may come up with a different result.

The acceptance of Hypothesis 3 says that there were no significant differences in the achievement of males and females when taught mathematics and science with the integrated approach. This does not support the literature reviewed for this study. For the month of February, the mean for males was 92.15 and for females was 92.77. The mean for the females was slightly higher than the males for the month when science and mathematics were taught with the integrated approach. Again, class size and the fact that there were only 4 males and 12 females used for this study could be the reason for this finding. The differences were so small that more testing would need to be completed on a class with a more even distribution of males and females.

Hypothesis 4 was rejected as there were no significant differences in attitudes when mathematics and science were taught separately or integrated. Table 7, in Chapter 4, shows the results of the t-Test from the attitude survey for January and February. The results show a significant increase in attitudes when the students were taught science and mathematics with the integrated approach. This could also be due to the interest level of the unit. Although the students were interested in the units taught in January when the disciplines were taught separately, they were clearly very excited about the food unit taught in February when the two disciplines were integrated. The increase in attitudes could account for the slight increase in achievement levels.

The study showed that the female means and attitudes increased when science and mathematics were taught in the integrated manner. Though the increase in the mean was minimal, this trend could be further studied. A study could be conducted across grade levels focusing on female achievement to determine whether the integrated approach is

more beneficial to female students.

Recommendations for Future Study

Based on the findings from this study, the following are recommendations for future study:

1. This study could be conducted for a longer period of time.
2. This study could be conducted comparing two or more separate classes at the same grade level.
3. A larger and more diverse sample of students could be used to make this study more valid and reliable.
4. A study could be conducted to further research the increase in achievement levels and attitudes of the female students.
5. This study could be conducted across grade levels to compare differences at different stages of child development.

APPENDIX A

TESTS GIVEN FOR MATHEMATICS AND SCIENCE DURING THE MONTH OF JANUARY WHEN THE DISCIPLINES WERE TAUGHT SEPARATELY

Test continued on next page

Name _____

Use inverse operations to find the values of x in the ordered pairs. (The first one has been done for you.)

1. $x \xrightarrow{-4} y$ $\quad$ $\overset{4}{(x, 0)}$, $(x, 7)$, $(x, 19)$, $(x, 56)$, $(x, 97)$

2. $x \xrightarrow{\div 7} y$ $\quad$ $(x, 3)$, $(x, 7)$, $(x, 8)$, $(x, 9)$, $(x, 5)$

3. $x \xrightarrow{\times 3} y$ $\quad$ $(x, 27)$, $(x, 18)$, $(x, 21)$, $(x, 15)$, $(x, 9)$

Complete these charts.

4. $x \xrightarrow{+6} y$

x	y
4	10
	12
8	
15	
	54

5. $x \xrightarrow{\times 5} y$

x	y
	5
3	15
7	
	45
	0

6. $x \xrightarrow{\div 4} y$

x	y
	0
4	
36	
16	
	7

Name _____

Complete these charts.

7. $x \xrightarrow{+5} y$

x	y
0	
5	
	23
106	
	132

8. $x \xrightarrow{\times 10} y$

x	y
	50
	100
	60
	200
	70

9. $x \xrightarrow{\div 8} y$

x	y
	7
	9
	8
80	
24	

10. $x \xrightarrow{-10} y$

x	y
	50
	100
	60
	200
	70

11. $x \xrightarrow{\div 3} y$

x	y
	0
	4
30	
	9
15	

12. $x \xrightarrow{\times 2} y$

x	y
5	
0	
	16
	18
	20

Find the function rules before you complete these charts.

13. $x \xrightarrow{\quad} y$

x	y
3	
	24
8	12
	83
36	40

14. $x \xrightarrow{\quad} y$

x	y
11	0
57	
9	0
98	
163	

15. $x \xrightarrow{\quad} y$

x	y
50	
5	5
1	
9	
356	356

Name _____

Test continued on next page

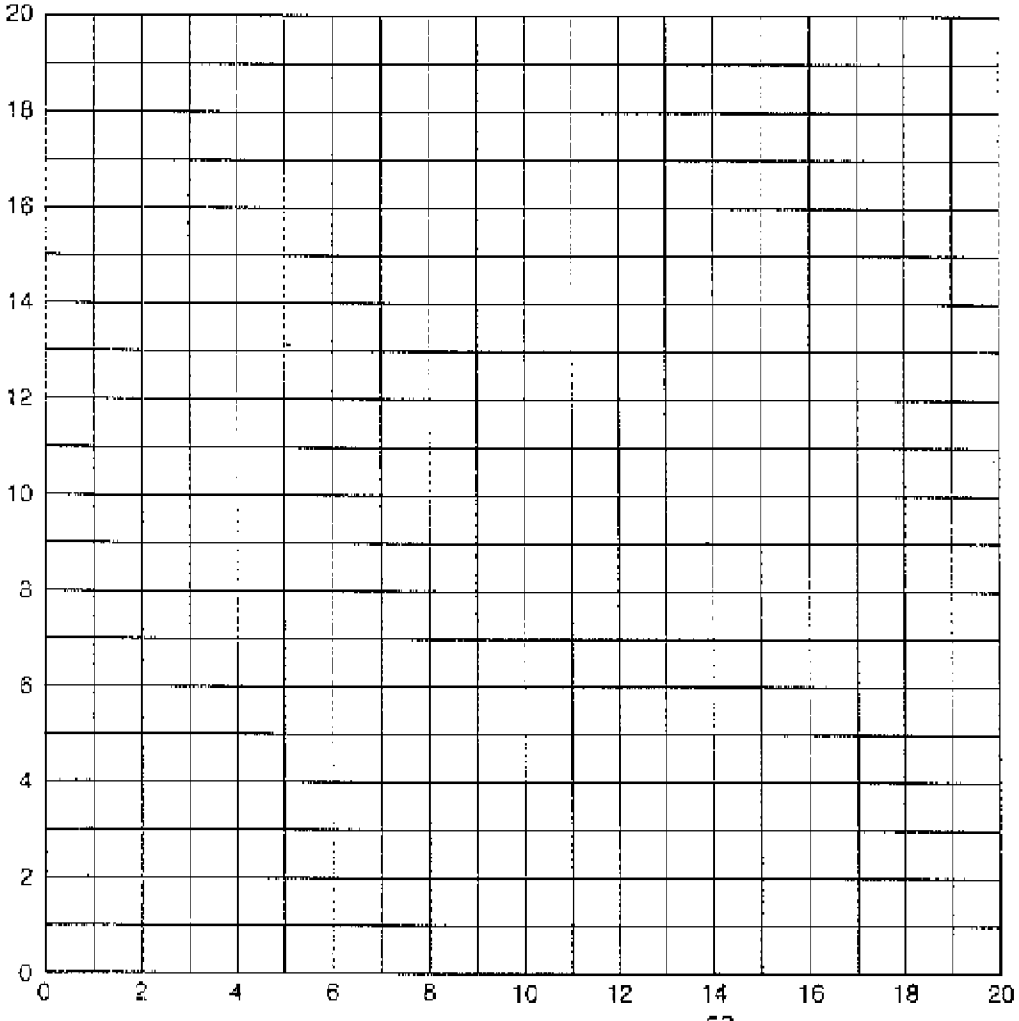
Use inverse operations to replace each x with the correct number. (The first one has been done for you.) Then make a graph for each set of ordered pairs.

1. x —(×3)→ y $\quad$ (1, 3), (3, 9), (6, 18), (0, 0), (5, 15)

2. x —(+9)→ y $\quad$ (x, 9), (x, 12), (x, 18), (x, 16), (x, 14)

3. x —(−7)→ y $\quad$ (x, 3), (x, 7), (x, 0), (x, 12), (x, 10)

4. x —(÷2)→ y $\quad$ (x, 9), (x, 0), (x, 6), (x, 1), (x, 5)



Name _____ Test continued on next page

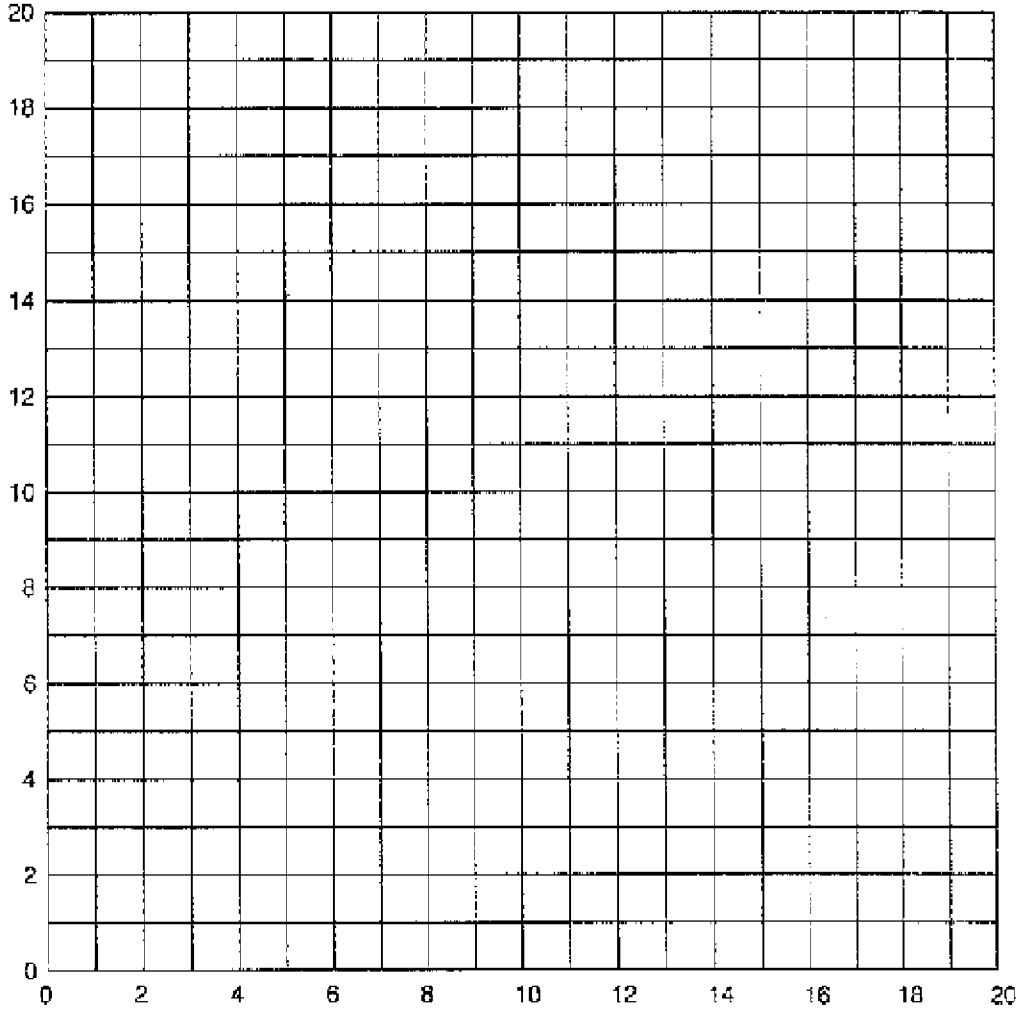
Use inverse operations to replace each x with the correct number. (The first one has been done for you.) Then make a graph for each set of ordered pairs.

1. $x \xrightarrow{\times 3} n \xrightarrow{+2} y$ **0** $(x, 2), (x, 11), (x, 17), (x, 14)$

2. $x \xrightarrow{-7} n \xrightarrow{\times 5} y$ $(x, 0), (x, 15), (x, 5), (x, 10)$

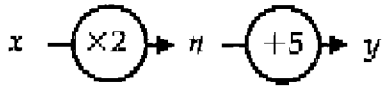
3. $x \xrightarrow{+8} n \xrightarrow{\div 2} y$ $(x, 4), (x, 6), (x, 9), (x, 13)$

4. $x \xrightarrow{\div 3} n \xrightarrow{+2} y$ $(x, 8), (x, 6), (x, 4), (x, 3)$



Name _____

Do these problems.



1. a. Pick a number between 0 and 10 for the value of x. Make an ordered pair of the number you used for x and the value of y.

_____

b. Find 2 more ordered pairs for the same function.

_____ _____

c. Graph the 3 ordered pairs you have found.

d. Look at your graph. Pick a point that has 4 as its first (sideways) coordinate and is on the same line as the other 3 points. What is the second coordinate of the point you picked?

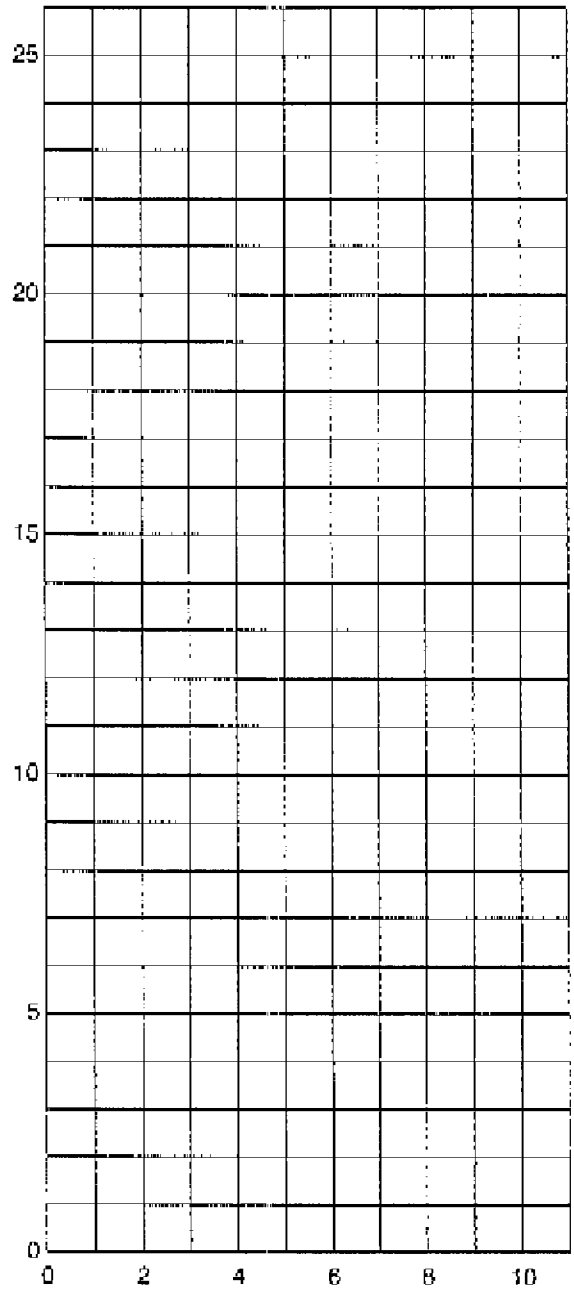
_____

e. Look at your graph. Pick a point that has 17 as its second (up-and-down) coordinate and is on the same line as the other points. What is the first coordinate of the point you picked?

_____

f. Replace x and y in these ordered pairs with the correct numbers:

$(4, y), (x, 17)$



Name _____ Test continued on next page

Solve. Watch the signs.

1. $28 \div \_\_\_\_ = 7$
2. $\_\_\_\_ - 3 = 9$
3. $8 \times 7 = \_\_\_\_$
4. $\_\_\_\_ + 8 = 17$
5. $\_\_\_\_ \div 4 = 9$
6. $\_\_\_\_ = 5 + 8$
7. $24 = \_\_\_\_ \times 6$
8. $15 - 9 = \_\_\_\_$
9. $\_\_\_\_ \div 6 = 9$
10. $\_\_\_\_ \times 8 = 24$
11. $9 + \_\_\_\_ = 13$
12. $\_\_\_\_ - 9 = 2$
13. $\_\_\_\_ + 6 = 14$
14. $6 \times 7 = \_\_\_\_$
15. $\_\_\_\_ = 81 \div 9$
16. $16 - \_\_\_\_ = 9$
17. $3 + 8 = \_\_\_\_$
18. $8 \times \_\_\_\_ = 64$
19. $\_\_\_\_ \div 5 = 7$
20. $6 + 7 = \_\_\_\_$
21. $18 - 9 = \_\_\_\_$
22. $\_\_\_\_ = 7 \times 5$
23. $49 \div \_\_\_\_ = 7$
24. $8 + 4 = \_\_\_\_$
25. $12 - \_\_\_\_ = 8$
26. $\_\_\_\_ \times 8 = 32$
27. $18 \div 9 = \_\_\_\_$
28. $\_\_\_\_ + 6 = 13$
29. $14 - \_\_\_\_ = 10$
30. $6 \times 5 = \_\_\_\_$
31. $\_\_\_\_ \div 9 = 6$
32. $6 + \_\_\_\_ = 19$
33. $\_\_\_\_ = 4 \times 4$
34. $\_\_\_\_ = 48 \div 6$
35. $\_\_\_\_ \times 6 = 36$
36. $19 + \_\_\_\_ = 23$

37. $\begin{array}{r} 9 \\ \times\ 6 \\ \hline \end{array}$
38. $\begin{array}{r} 16 \\ -\ 7 \\ \hline \end{array}$
39. $\begin{array}{r} 8 \\ +\ 3 \\ \hline \end{array}$
40. $7\overline{)42}$
41. $\begin{array}{r} 5 \\ \times\ 4 \\ \hline \end{array}$

42. $\begin{array}{r} 4 \\ +\ 9 \\ \hline \end{array}$
43. $\begin{array}{r} 16 \\ -\ 8 \\ \hline \end{array}$
44. $9\overline{)54}$
45. $\begin{array}{r} 9 \\ +\ 8 \\ \hline \end{array}$
46. $\begin{array}{r} 20 \\ -\ 14 \\ \hline \end{array}$

47. $\begin{array}{r} 15 \\ -\ 8 \\ \hline \end{array}$
48. $\begin{array}{r} 3 \\ +\ 9 \\ \hline \end{array}$
49. $\begin{array}{r} 13 \\ -\ 4 \\ \hline \end{array}$
50. $8\overline{)64}$

Name _____

Solve. Watch the signs.

1. $23 - \_\_\_\_ = 5$
2. $36 \div \_\_\_\_ = 9$
3. $8 \times 6 = \_\_\_\_$
4. $16 \div \_\_\_\_ = 4$
5. $\_\_\_\_ - 13 = 6$
6. $\_\_\_\_ \times 6 = 54$
7. $35 \div 7 = \_\_\_\_$
8. $5 + \_\_\_\_ = 15$
9. $\_\_\_\_ - 6 = 7$
10. $\_\_\_\_ \times 2 = 18$
11. $32 \div \_\_\_\_ = 4$
12. $\_\_\_\_ \div 4 = 12$
13. $12 - 8 = \_\_\_\_$
14. $7 \times 7 = \_\_\_\_$
15. $\_\_\_\_ = 6 \times 5$
16. $\_\_\_\_ + 9 = 18$
17. $16 - 8 = \_\_\_\_$
18. $\_\_\_\_ \times 7 = 35$
19. $64 \div 8 = \_\_\_\_$
20. $11 - 3 = \_\_\_\_$
21. $\_\_\_\_ + 9 = 16$
22. $9 \times \_\_\_\_ = 81$
23. $42 \div \_\_\_\_ = 6$
24. $14 - \_\_\_\_ = 6$
25. $9 + 2 = \_\_\_\_$
26. $\_\_\_\_ - 9 = 4$
27. $24 \div 3 = \_\_\_\_$
28. $9 \times 6 = \_\_\_\_$
29. $9 + \_\_\_\_ = 15$
30. $24 \div \_\_\_\_ = 6$
31. $8 + \_\_\_\_ = 13$
32. $\_\_\_\_ \times 9 = 36$
33. $17 - \_\_\_\_ = 8$
34. $56 \div \_\_\_\_ = 8$
35. $9 + \_\_\_\_ = 12$
36. $\_\_\_\_ \times 7 = 28$

37. 7×6
38. $11 - 2$
39. $19 - 7$
40. $9\overline{)36}$
41. 9×9

42. $13 - 9$
43. $8 + 8$
44. $7\overline{)49}$
45. $9 + 7$
46. $20 - 16$

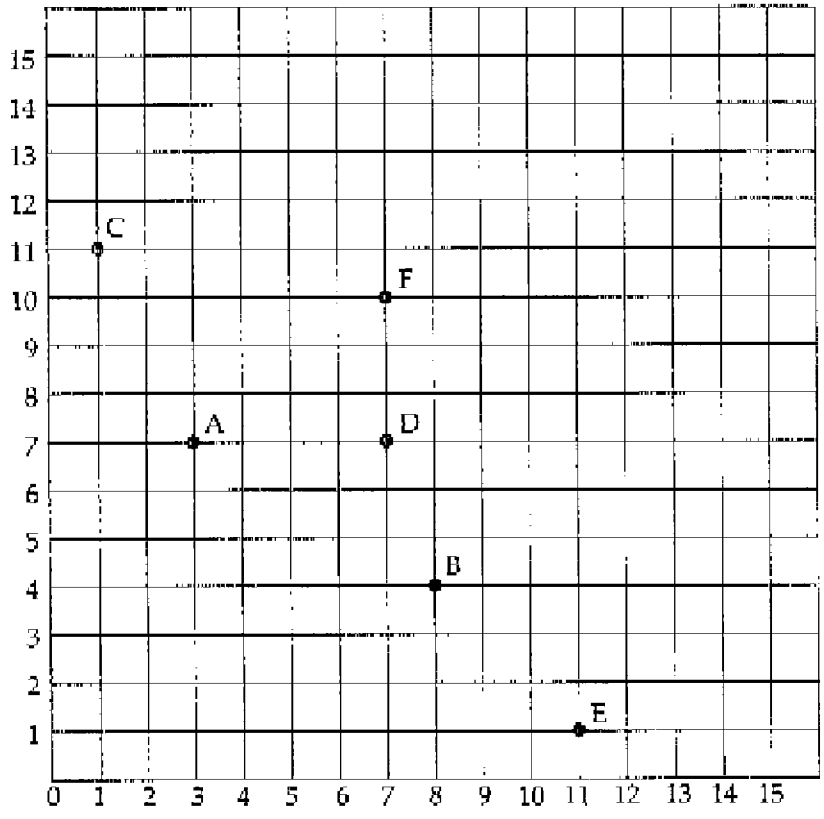
47. $15 - 7$
48. $8 + 4$
49. $16 - 7$
50. $8\overline{)56}$

Test continued on next page

Name _____

Look at the graph. What are the coordinates of these points?

1. A _____
2. B _____
3. C _____
4. D _____
5. E _____
6. F _____



Find the value of x or y.

7. 4 → (+4) → y $y =$ ____

8. 7 → (−2) → y $y =$ ____

9. x → (−7) → 2 $x =$ ____

Test continued on next page

Name _____

10. 13 → (−6) → n → (×4) → y $n =$ _____ $y =$ _____

11. 9 → (÷3) → n → (+6) → y $n =$ _____ $y =$ _____

12. x → (+3) → n → (+7) → 16 $x =$ _____ $n =$ _____

What is a possible function rule for each of these?

13.

x → ? → y	
x	y
4	8
5	10
2	4
1	2

14.

x → ? → y	
x	y
7	14
4	11
20	27
14	21

Solve for n.

15. $42 \div 6 = n$ ____

16. $n \times 5 = 45$ ____

17. $n \div 7 = 3$ ____

18. $19 - n = 11$ ____

19. $n \times 6 = 18$ ____

20. $5 \times 5 = n$ ____

Add or subtract. Watch the signs.

21. $\begin{array}{r} 847 \\ +\ 454 \\ \hline \end{array}$

22. $\begin{array}{r} 741 \\ -\ 99 \\ \hline \end{array}$

23. $\begin{array}{r} 515{,}806 \\ -\ 33{,}907 \\ \hline \end{array}$

24. $\begin{array}{r} 74{,}318 \\ +\ 37{,}782 \\ \hline \end{array}$

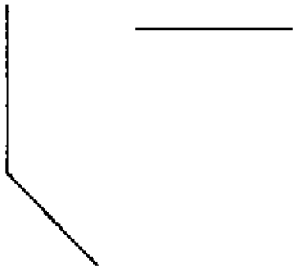
25. If Mark saves $7 a week, how much will he save in 7 weeks? _____

26. Jesse lives 3 kilometers from school. Megan lives 1 kilometer from Jesse. How far does Megan live away from school? _____

27. Tricia's 20th birthday was in 1988. What year was her 10th birthday? _____

Name _____

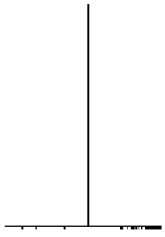
Tell whether each angle is a right angle.

28. 

29. 

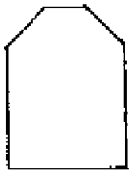
For each pair of lines, tell whether the lines are parallel, perpendicular, or neither.

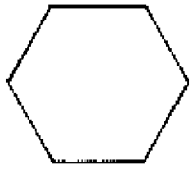
30. 

31. 

32. 

How many lines of symmetry can be drawn in each figure?

33. 

34. 

Name_____

Date_____

Science- Desert test

1. Name three things that make a desert a desert.

_____

_____

2. How much rainfall do deserts get?

_____

_____

3. How many major deserts are there?

_____

_____

4. What is a hot desert? Give an example of a hot desert.

_____

_____

_____

5. What is a cold desert? Give an example of a cold desert.

_____

_____

_____

6. Name two things the wind does to change deserts.

_____

_____

7. Name two things water does to change deserts.

_____

_____

_____

Name_____ #

Date_____

Science-Desert plants quiz

Use the following words to fill in the blanks. Use capitals where needed.

colorful	smaller	roll up
animals	drought	moisture
growing	taproots	hairs
dry	bloom	chemicals
sleep		

1. Desert plants have _____openings on their leaves.

2. Plants _____ their leaves during the day.

3. Desert plants lose their leaves during a _____.

4. _____on leaves reduce _____ loss by breaking the force of the wind.

5. Spines on stems protect plants from_____.

6. _____ grow more than 100 feet long.

7. Some plants give off _____ to keep other plants from _____ nearby.

8. Some seeds _____during _____ spells.

9. When plants _____, the desert changes into _____ fields.

Name _____

Date _____

Science-Deserts-Unit Questions

1. Name two characteristics that all deserts have in common.
2. Are all deserts hot? Explain your answer.
3. Name two cold deserts.
4. How do wind and water create desert landforms?
5. What is the difference between a hot desert and a cold desert?
6. What do camels store in their humps?
7. Name three ways animals escape desert heat.
8. What are the two largest deserts in North America?
9. Name two things people do that hurt deserts.
10. Describe four ways plants have adapted to living in the desert.
11. What is the largest desert in the world?
12. What happens when desert lands are over-irrigated?
13. How is a playa formed?
14. How are mesas formed?
15. What is an oasis?

APPENDIX B

TESTS GIVEN FOR MATHEMATICS AND SCIENCE DURING THE MONTH OF FEBRUARY WHEN THE DISCIPLINES WERE INTEGRATED

Test continued on next page.

Name _____

Date _____

Science - Food Quiz

Answer the following questions in complete sentences.

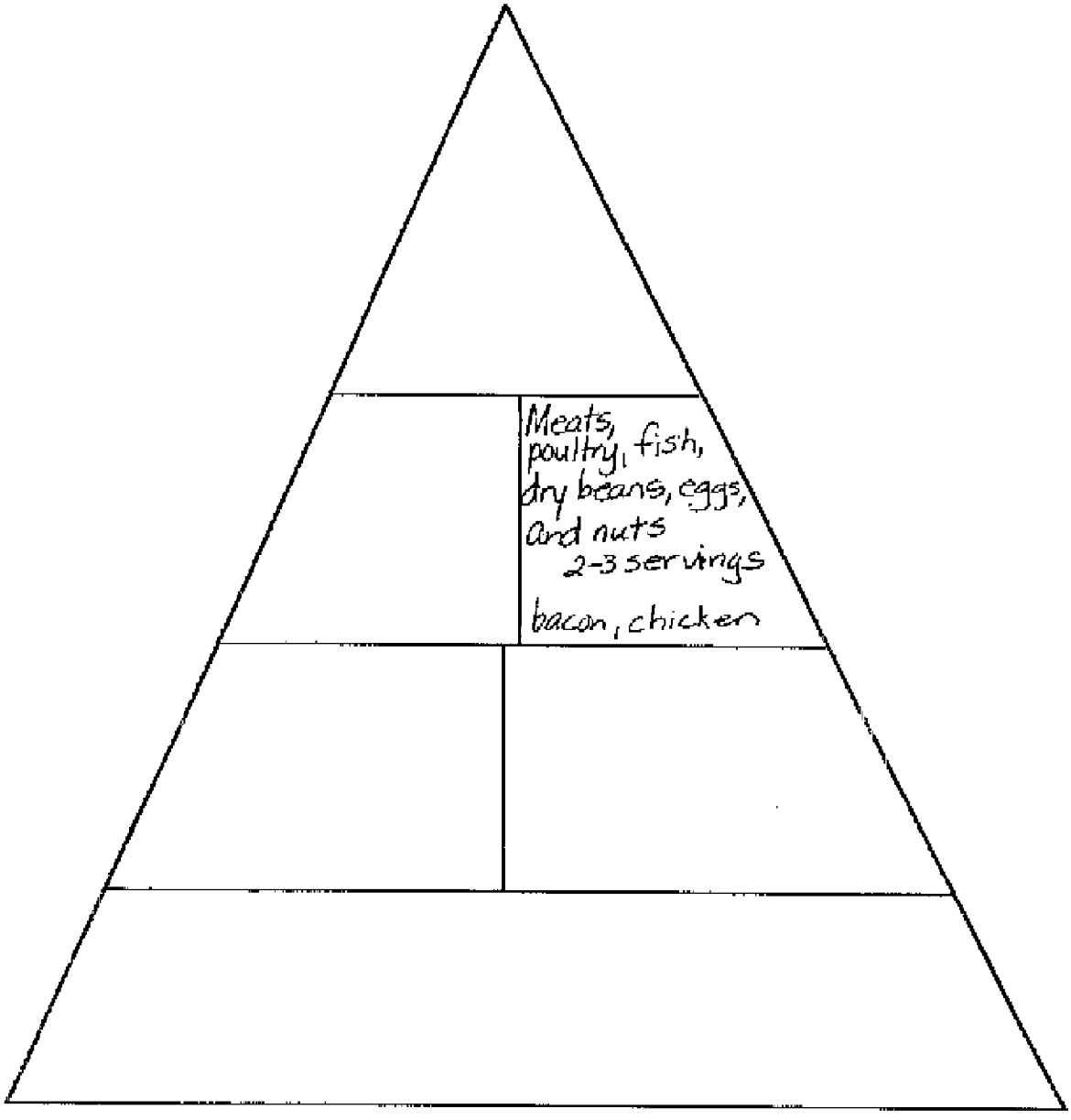
1. Why do you need breakfast? Tell two reasons in your answer.

2. Why is food important to people? (Do not use the same answer from number one.)

3. How does lack of food affect you?

4. What is in food that helps us be healthy?

5. Complete the food pyramid. Label each section with the group name and tell how many servings you should have from each group. List two examples of food from each group.



Test continued on next page.

Name _____

Date _____

Science - Fair Shares

Solve the following problems. Show all of your work. Put any pieces in fraction form.

1. You have 67 pieces of candy. How do you split it fairly between four people?

Each person would get _____.

2. You have 102 pieces of candy. How do you split it fairly between four people?

Each person would get _____.

3. You have 73 pieces of candy. How do you split it fairly between four people?

Each person would get _____.

4. You have 25 pieces of candy. How do you split it fairly between four people?

Each person would get _____.

5. You have 17 pieces of candy. How do you split it fairly between four people?

Each person would get _____.

6. You have 59 pieces of candy. How do you split it fairly between four people?

Each person would get _____.

7. You have 82 pieces of candy. How do you split it fairly between four people?

Each person would get _____.

8. You have 123 pieces of candy. How do you split it fairly between four people?

Each person would get _____.

9. You have 111 pieces of candy. How do you split it fairly between four people?

Each person would get _____.

10. You have 96 pieces of candy. How do you split it fairly between four people?

Each person would get _____.

Test continued on next page.

Name _____

Date _____

Science - Apple Experiment

As we experiment, answer the following questions in complete sentences.

1. How did the mass of the apples change after four days?

2. What did the apples lose? Where did it go?

3. Did any of the apples gain mass from one day to the next? Why?

4. Did the chopped apple lose more moisture than the peeled apple? Why?

5. Why did the unpeeled apple lose so little moisture?

6. What other fruits might have similar results? Why?

7. How is the moisture in foods, such as apples, important to our bodies?

Test continued on next page.

Name _____

Date _____

Science - Blue-Ribbon Lunch

1. What is a blue-ribbon lunch? List how many servings you should have from each food group.

_____

_____

_____

_____

_____

2. On the following menu, list the foods for a blue-ribbon lunch and put the serving numbers in the correct boxes.

Menu for Blue-Ribbon Lunch	Bread	Vegetable	Fruit	Milk	Meat	Sweets

3. On the following menu, list the foods for a bad lunch and put the serving numbers in the correct boxes.

Menu for bad lunch	Bread	Vegetable	Fruit	Milk	Meat	Sweets

4. On the following menu, list everything you had for lunch today and put the serving numbers in the correct boxes.

Menu for today's lunch	Bread	Vegetable	Fruit	Milk	Meat	Sweets

5. List any changes you can make in your lunch from today to make it a blue-ribbon lunch.

APPENDIX C

ATTITUDE SURVEYS FOR JANUARY AND FEBRUARY

Date - January 31, 1997					
Name					
Math	Yes		Sometimes		No
	5	4	3	2	1
I liked solving functions.					
I liked solving basic fact problems.					
I liked graphing.					
I liked estimating.					
I liked solving word problems.					
I liked multiplying by factors of ten.					
I liked working with a partner.					
I liked working with a group.					
Science	Yes		Sometimes		No
	5	4	3	2	1
I liked learning about desert landforms.					
I liked learning about desert animals.					
I liked learning about desert plants.					
I liked writing the coyote story.					
I liked writing the plant report.					
I liked writing the animal report.					
I liked making a desert scene.					
I liked working with a partner.					
I liked working with a group.					
I liked telling the class what I knew about deserts.					

February 28, 1997					
Name					
Math	Yes		Sometimes		No
	5	4	3	2	1
I liked measuring mass.					
I liked learning fractions.					
I liked graphing.					
I liked estimating.					
I liked solving word problems.					
I liked finding percentages.					
I liked working with a partner.					
I liked working with a group.					
I liked finding averages.					
Science	Yes		Sometimes		No
	5	4	3	2	1
I liked learning about the food pyramid.					
I liked learning why we need food.					
I liked learning about the fat content in food.					
I liked making the food pyramid.					
I liked comparing food packaging.					
I liked the apple experiments.					
I liked collecting and recording data.					
I liked working with a partner.					
I liked working with a group.					

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HIGH SCHOOL:	Audubon High School Audubon, New Jersey Graduated 1983
COLLEGE:	Glassboro State College Glassboro, New Jersey B. A. 1986
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