PERCEPTIONS OF MIDDLE SCHOOL MATHEMATICS, SCHOOL SCIENCE, AND TECHNOLOGY EDUCATION TEACHERS REGARDING SELECTED ASPECTS OF INTERDISCIPLINARY TEAMING

by

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Abstract

This research endeavor generated seven generalizations regarding selected aspects of interdisciplinary teaming at the middle school level. The generalizations were developed in an effort to understand middle school mathematics, school science, and technology education teachers' perceptions regarding teaming and interdisciplinary activity development. Four aspects of interdisciplinary teaming were studied. The first aspect examined the three groups' perceptions regarding how interdisciplinary teaming affects schools. The second aspect explored how the three groups' perceived interdisciplinary teaming influencing the professional lives of teachers. The third aspect examined how the three groups perceived the inclusion of technology education on interdisciplinary teams. The fourth aspect examined the three groups' perceptions regarding the formation of interdisciplinary teams comprised of mathematics, school science, and technology education teachers.

The purpose of the study was to provide practitioners and researchers, who have an interest in developing interdisciplinary programs, with information about individuals

who have worked as members of interdisciplinary teams. All informants in this study participated in a one day interdisciplinary education workshop in March, 1993 and completed an interdisciplinary activity with a team of fellow teachers.

A total of 41 informants including: 15 mathematics, 11 school science, and 14 technology education teachers completed a semi-structured telephone interview between June 27 and July 20, 1994 or January 16 and 20, 1995. A qualitative inquiry methodology, known as the Grounded Theory, was used to collect, analyze, and present the data. Four research questions and six hypotheses were written to facilitate the research. The researcher used the findings to develop the seven theories.

The findings indicated middle school mathematics, school science, and technology education teachers held similar perceptions regarding selected aspects of interdisciplinary teaming. The three groups shared similar views regarding: (a) the school environment and school principals' roles in interdisciplinary teaming, (b) how teaming influenced teachers' perceptions of other school subjects, (c) the inclusion of technology education in interdisciplinary curriculum development, and (d) interdisciplinary teams which included mathematics, school science, and technology education.

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KEY WORDS:

Interdisciplinary, Middle School, Technology Education, Grounded Theory

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Dedication

This work is dedicated to my Uncle Larry.

Pirate,

Angel,

Philosopher,

Friend.

When I close my eyes and listen to my heart,

I often hear your voice.

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Chapter One

Introduction and Rationale

Nature of the Problem

Although the employment of interdisciplinary team teaching has been a cornerstone of the middle school philosophy since the 1960's, the practice itself has received mixed reactions from educators. According to educational theorists, the concept where teachers representing several subject areas collaborate to develop problem solving units for their students has great value for teachers and students alike. (Alexander & McEwin, 1989; Beane, 1991; Blishen, 1970; Compton, 1983; Lake, 1989; Lawton, 1992; Mac Iver, 1990; Mac Iver & Epstein, 1989; Shafer, 1990). Unfortunately, educational practitioners have contributed limited information to support these theories. As curriculum researchers generate workshops and materials which support interdisciplinary teaming, this lack of information poses a serious problem. What support and information do teachers *actually* need as they participate on interdisciplinary teams?

American education crises throughout the 1980's and 1990's lead to a renewed focus on alternative teaching strategies for mathematics and school science education. This focus also expanded to include an interest in teaching American's children about technology. (Savage & Sterry, 1990). Fortunately, interdisciplinary curriculum theorists and curriculum developers capitalized on this nation-wide interest by developing alternative teaching strategies which included the subjects of mathematics, school science, and technology education (Cushman, 1991; Hatch, 1993; LaPorte & Sanders, 1993; Loepp, 1993; Scarborough, 1993).

This nation-wide interest in subject integration has been fueled by supportive research. An example of this historical data included the work of educators in the United Kingdom during the 1970's. In seeking to devise an education appropriate for young people

growing up in a rapidly changing world, experienced teachers working with the University of London Goldsmith's College Curriculum Laboratory expressed concern for educational practices. The teacher's perceptions, culminated by Blishen in 1970, suggested,

> (1) Much secondary education is totally unrelated to the interests and developmental needs of adolescents. (2) It does not give them experience of successfully identifying and exploring together problems which they recognize as important. (3) By its divisive and competitive nature it denies them the opportunity to gain confidence in themselves and each other. (4) Much schooling rewards only conventional thinking and accurate memorizing, yet the sciences, physical and human, pure and applied, as well as the arts, all call for imaginative, flexible, perceptive behavior, as do the ordinary problems of living our lives. (5) Hence education should be based on enquiry, interpreted broadly to include exploration (of materials and ideas), self-discovery and growth in perception of other people, and the creation and testing of hypothesis in both theoretical and practical studies. (6) Since most fundamental questions reach beyond subject barriers, an enquiry-based education must necessarily be largely interdisciplinary. (7) Owing to the increasing complexities of knowledge, education should stress acquiring the skills and interpretative concepts of the disciplines rather than subject matter, and this involves for part of the curriculum a co-operative interdisciplinary study, with specialist teachers acting as advisers and consultants (pp. 386-387).

Unfortunately, educators twenty years after this insightful examination still battled for acceptance when implementing interdisciplinary teaching strategies within schools (George & Stevenson, 1988; Mac Iver & Epstein, 1990). Although the benefits of interdisciplinary teaching methodologies have been argued since the turn of this century (Dewey, 1916), curriculum experts agree; interdisciplinary teaching approaches are not

found in the majority of American middle schools. In fact, data gathered in 1990 indicated only 42 percent of middle school age children received instruction through these types of activities between the fifth and ninth grades. Mac Iver and Epstein (1990) examined this concern and gathered:

> One reason for the great diversity of educational practices and approaches currently found in middle-grades education is that there [has] been little useful research to help educators decide which practices are beneficial for early adolescent students and which are ineffective (pp. 588-89).

Call for Academic Reform

To compound the issue of whether or not to implement interdisciplinary activities in middle schools, recent developments within the technological and scientific communities have recommended additional academic reform. A mounting public concern for economic conditions and lagging standardized test scores has reached the national spotlight (Apple, 1992; Bracey, 1993; Hamm, 1992). According to educational leaders, "There is now a clear national consensus in the United States that all elementary and secondary school children need to become better educated in science, mathematics, and technology" (American Association for the Advancement of Science [AAAS], 1989, p. 154). In an effort to commit to educational practices which raise test scores and improve the American economy, academic communities have responded with non-traditional solutions.

An increasing number of scholars have targeted a strong mathematics and science background as the key to economic competitiveness (AAAS, 1989). "Mathematics and science education is now inseparably coupled to the skills of the scientific and technical work force, to the development of critical technologies, and thereby to the state of the national economy in a competitive arena" (Federal Coordinating Council for Science, Engineering, and Technology [FCCSET], 1993, p. 36).

According to statistics gathered by the National Assessment of Educational

Progress [NAEP] (1989), poor standings of American school children represent a real problem. International comparisons of the late 1980's ranked American fifth graders ninth out of 17 countries in science achievement. By the ninth grade, students fell to fifteenth place in the same pool of counties. Results of mathematics achievements scores are similar. American eighth-graders scored well below other countries in problem-solving activities that required higher levels of thinking and analysis (National Education Association [NEA], 1989).

Meanwhile, proponents of technology education have promoted their profession as an integral part of the school day (Maley, 1984; Savage & Sterry, 1990; Todd, personal communication, August, 23, 1993). These leaders have suggested this age of rapidly developing knowledge, where sophisticated transportation, production, biotechnologies, and communications systems exists, demands the attention of school children. An understanding of these technological systems will be paramount for the work force of the future (Haney, 1990; Savage & Sterry, 1990). Additionally, research suggested extreme changes due to technological advancements in the past two decades have created an explosive demand for technologically-literate workers (Christensen & Martin, 1992; Daughterty & Wicklein, 1993).

Taken together, the test score decline and the explosive technological demand have lead educational change-agents to reexamine the entire educational picture. Enlightened educators such as Roy (1990) view this situation as a tremendous opportunity for educators. "For the first time in fifty years, the average citizen will turn to new solutions" (p. 10). These solutions, Haney (1990) hypothesized, will encompass meeting the intellectual needs of students by "relating science and mathematics to societal, technological and environmental issues" (p. 7).

Is an interdisciplinary relationship among mathematics, school science, and technology education necessary for the economic growth and educational maintenance of the United

States? Educational leaders have addressed this issue with vigor since 1990 (Cushman, 1991; LaPorte & Sanders, 1993; Loepp, 1993; Scarborough, 1993; Todd, Doyle, & Hutchinson, 1993; Todd & Hutchinson, 1991). Their efforts have proposed learning projects which are more reflective of the world outside of school. Cushman (1991) suggested interdisciplinary initiatives reflect a human problem solving philosophy parallel to the world outside of school where professionals working in mathematics, science, and technology come together to generate interdisciplinary solutions. In these situations Cushman noted, "Science may provide a theory for addressing the problem, but the solution requires the use of mathematics to provide a model and of technology to produce the final product or result" (p. 7).

Growing discontent with typical science and mathematics education in the United States has leaders in technology education convinced there has never a more exciting time for our profession to embrace subject integration (Gloeckner, 1991). School programs have produced the type of student who reflects negative attitudes toward mathematics and school science and these negative feelings tend to increase as students pass through the grades (Hamm, 1992). In recent years, mathematics and science curricula have been criticized for their removal of subject matter from the context of the real world. Students have found science and mathematics content presented in an abstract manner (Gloeckner, 1991; Hamm, 1992; LaPorte & Sanders, 1993). Hamm's (1992) research suggested new models of instruction should be designed where collaboration among teachers and the use of technology are used to positively lure students toward an interest in mathematics and school science.

Educational Communities Respond

The necessity to develop schools which closely resemble professional working environments, particularly those fashioned in interdisciplinary settings, may have sparked the dawning of a new educational movement (Oaks & Pedras, 1992). Critical analysis of

United States schools' curriculum content revealed school age youth from kindergarten through the twelfth grade "have not had access to curricula which would provide them a broad base of experiences in applying mathematics and scientific principles in problem situations representative to our high technological environment" (Jennings, 1988, p. 2). As a result, Haney (1990) argued, curriculum must be developed that closes the gap between actual school practices and situations where mathematics, school science, and technology education merge in the work world.

In 1989, the National Council of Teachers of Mathematics [NCTM] published national standards for curriculum and evaluation (Campbell & Bamberger, 1990; Jacobs, 1991; LaPorte & Sanders, 1993; NCTM, 1989). The Council was concerned that students viewed mathematics at the middle school level as dull and routine. Moreover, computational skills were emphasized at the expense of a more broad look at the world. The council suggested integrative efforts were all but forgotten (NCTM, 1989; Tishler, 1991). The new standards established a clear need for students to become problem solvers who have the ability to acquire, relate, and apply new mathematics knowledge in real world settings through mathematics investigations (Campbell & Bamberger, 1990).

The science community also responded with calls for a problem solving approach and interdisciplinary learning. The National Council on Science and Technology Education [NCSTE] specifically suggested mathematics, school science, and technology education must be connected during educational activities. In the Council's effort to identify the education of a scientifically literate person, interdisciplinary teaching strategies were alluded to. According to the suggestions, scientifically literate individuals should have an awareness of the ways that science, mathematics, and technology depend on each other (AAAS, 1990).

Forming Interdisciplinary Teams.

Forming an interdisciplinary team has been seen as a challenge and opportunity for

teachers, particularly in cases where the integration of core subject matter such as mathematics and school science are united with more kinesthetic activities involving technology (Oaks & Pedras, 1992). Although technology education is marked by interdisciplinary leaders as an essential factor in thematic approaches at the middle school level (Gloeckner, 1991; LaPorte & Sanders, 1993), actual middle school practices reflected technology teachers "are typically systematically eliminated from the teams, since planning time for teaching teams is scheduled by shipping students off to the 'related arts' " (LaPorte & Sanders, 1993, p. 17).

To aid in establishing interdisciplinary teams at the middle school level which included mathematics, school science, and technology education; a handful of initiatives received support from national level agencies (LaPorte & Sanders, 1993; Loepp, 1993; Scarborough, 1993; Todd & Hutchinson, 1993). At the Virginia-wide level, one project, *Make The Connection* was developed to serve in generating these types of teams (Dugger & Strand, 1993).

Make The Connection was an interdisciplinary project which yielded a series of workshops for middle school educators. It was implemented during the 1992-93 academic year through the directorship of William E. Dugger, Jr., Ph.D. of the Technology Education Program at Virginia Polytechnic Institute and State University. The project was funded by the Virginia Space Grant Consortium which received partial funding from the National Aeronautics and Space Administration [NASA].

The primary goal of the project was to familiarize middle school mathematics, school science, and technology education teachers and school administrators with the benefits of implementing interdisciplinary activities in their schools. In serving this goal, 333 individuals participated in one of four workshops held throughout Virginia in March, 1993. To participate in one of the workshops, the attendees were required to work in teams to develop and implement an interdisciplinary activity within their schools. The teams

were required to post the completed activity and their planning phases on a pre-designed template which was located on Virginia's Public Education Network [VA's PEN]. The workshop participants received training in the use of the computer template and VA's PEN. A total of 18 teams posted a *Make The Connection* interdisciplinary activity by the May, 1993 deadline.

Teachers' Integral Role.

Although the initiatives mentioned previously have support from several benchmarks and milestone curriculum initiatives at the national level, (Federal Coordinating Council for Science, Engineering and Technology [FCCSET], 1993; National Aeronautics and Space Administration [NASA], 1993; Salinger, 1992) the interdisciplinary movement where mathematics, school science, and technology education are truly integrated must ultimately be adopted by teachers. Teachers alone provide the insights on emerging movements though direct action in the classroom (AAAS, 1989). "Sensible professionals do not replace their strongly held views and behavior patterns in response to...the latest vogue; instead they respond to developing sentiment among respected colleagues, to incentives that reward serious efforts to explore new possibilities, and to the positive feedback that may come from trying out new ideas from time to time – all of which can take years" (AAAS, 1989, p. 154).

Statement of the Problem

The problem in this study stemmed from a lack of information of middle school mathematics, school science, and technology education teachers' perceptions regarding interdisciplinary teaming. The researcher wished to determine if the perceptions of the three groups were similar or different regarding four aspects of interdisciplinary teaming. The first aspect examined the three groups' perceptions regarding how the school environment and school administrators influenced interdisciplinary activity development and implementation. The second aspect explored how the three groups' perceived the participation

on an interdisciplinary team influencing their professional lives. The third aspect analyzed the three groups perceptions regarding the inclusion of technology education on interdisciplinary teams. The fourth aspect probed teachers' perceptions pertaining to interdisciplinary teams which included mathematics, school science, and technology education.

Need for the Study

As national and state level agencies continue to fund interdisciplinary teaming projects for middle school educators, research must be conducted to understand how these educators perceive select aspects of interdisciplinary teaming. The Carnegie Council on Adolescent Development (1989) suggested,

> Teachers on [interdisciplinary] teams should exercise creative control over how curricular goals are to be reached for their team. Teachers should collectively allocate budget and space for the team, choose instructional methods and materials for classroom use, identify and develop interdisciplinary curricular themes, schedule classes, select field experiences...and evaluate students' performance in light of school-wide objectives (p. 55).

The Carnegie Council's suggestions clearly identified some important aspects of interdisciplinary teaming. But, the question regarding whether teachers perceive select aspects of interdisciplinary teaming involving mathematics, school science, and technology education as worthwhile requires additional study.

Purpose for the Study

The purpose of this study was to create generalizations based on the perceptions of middle school mathematics, school science and technology education teachers regarding select aspects of interdisciplinary teaming. To determine if similarities and differences existed among the three teachers groups' perceptions, the researcher employed a qualitative research methodology known as the Grounded Theory. Through the Grounded Theory structure, the researcher developed a semi-structured telephone interview process to

collect the data. This interview procedure allowed members of the three groups to freely state their feelings and interpretations about professional experiences while working as a member of an interdisciplinary team.

Research Questions

This study addressed four general research questions:

1. What are the perceptions among mathematics, school science, and technology education teachers, who have participated on interdisciplinary teams, regarding how the school environment and school administrators influence interdisciplinary activity development and implementation?

2. How does the participation on an interdisciplinary team influence the professional existence of middle school mathematics, school science, and technology education teachers?

3. What are the perceptions of mathematics, school science, and technology education teachers regarding the inclusion of technology education on interdisciplinary teams at the middle school level?

4. How do middle school mathematics, school science, and technology education teachers perceive interdisciplinary teams and activities which include the three subject areas?

Assumptions.

The following assumptions are pertinent to conduct this study.

1. All respondents were active members of an interdisciplinary team where a mathematics, school science, and technology education teacher participated at the middle school level.

2. All respondents participated in a *Make The Connection* one day interdisciplinary workshop.

3. All respondents implemented their subject area component of the

interdisciplinary activity, as listed on Virginia's Public Education Network, between March and May, 1993.

Limitations.

There were two limitations considered in this study.

1. The small number of *Make The Connection* teams that elected to complete an interdisciplinary activity yielded a relatively small number of potential respondents for this study.

2. Although the original *Make The Connection* teams included a fourth member, an administrator, the researcher did not interview these individuals in the data component of this study. Members of the administrative group represented various professional capacities which included school district administrators, middle school curriculum directors, various teachers, and staff members.

Delimitations.

The delimitations of the study were necessarily imposed due to financial and time constraints as well as conditions of the original *Make The Connection* interdisciplinary workshops.

1. The population of mathematics, school science, and technology education teachers (or three teacher groups) was limited to those Virginia educators who participated in a *Make The Connection* workshop held in March, 1993.

2. The population of the three teacher groups was limited to those *Make The Connection* teams that completed an interdisciplinary activity and posted it on Virginia's Public Education Network.

3. The population of the three teacher groups was limited to those teachers who remained employed within the same school system from the 1992-1993 academic year to the 1993-1994 academic year.

4. The data obtained were limited to those interviews that were completed by

telephone between June 27 and July, 22, 1994.

Operational Definitions

For the purposes of this study, the following definitions were employed.

Curriculum. According to the National Education Association [NEA], (1989), the total curriculum is organized in four interrelated subdivisions:

> [1] The **core** program, a major part of general education, is devoted to the study of problems and the development of competencies commonly needed by all students. [2] Other required subjects which are designed to meet common needs that are not provided for through the core program. [3] **Elective subjects**...which provide for individual exploration and the cultivation of specialized interests to a greater depth than with the core program or the other required subjects. [4] The student activity program. (p. ii)

There are several assumptions and beliefs upon which the core program is based:

> [1] Interests, concerns, and needs expressed by students provide a valid basis for curriculum content and are central to the learning process. [2] Learning involves changes in behavior which are brought about through experience. [3] A democratic society values the worth and dignity of the individual. [4] A democratic society requires citizens who are skilled in the decision-making process. [5] Appropriate emphasis must be given to the various aspects of learning including: clarification of values, development of learning skills, mastering important concepts, and acquiring needed information. [6] Learning experiences are enhanced when the learner is encouraged and helped to draw upon all appropriate sources of information. [7] The extent and nature of classroom activity should determine the allocation of time. [8] The teacher's primary roles should be those of an advisor, a facilitator, a friend, and a fellow learner. [9] Teaching and many aspects of guidance are complementary functions of the teacher. [10] To bring about continuous improvement in learning, all concerned parties

should be involved in evaluation (p. iii).

Grounded Theory. According to Sherman and Webb (1988), the Grounded Theory is a method of qualitative inquiry which is concerned with:

> theory generation, rather than verification, through discovery of what the world appears to be to participants and, through an analysis of those perceptions, of the basic social processes and structures that organize the world. (p. 3)

Informant. "An individual person who provides information, either directly or indirectly, on which the results of a research project could, in whole or in part, be based" (Gorton & Carr, 1988, p. 86).

Interdisciplinary Team. The National Middle School Association (1982) suggested interdisciplinary teams are:

> A grouping of four or five teachers who usually present four or five subjects to four or five sections of students. The number of students involved usually ranges from 100 to 150. Generally, an interdisciplinary team features cooperative planning and instruction for a common group of students (p. 32).

Integration. "Integration infuses mathematical methods in science [and technology] and scientific [and technological] methods into mathematics such that it becomes indistinguishable as to whether it is mathematics or science [or technology]" (National Center for Science Teaching & Learning, 1991, p. 3).

Mathematics. "Mathematics is the science of patterns and relationships" (American Association for the Advancement of Science, 1989, p. 33).

Middle School. The National Middle School Association (1982) stated:

> The emergent middle school is a school providing a program planned for a range of older children, pre-adolescents, and early adolescents that builds upon the elementary school's program for earlier childhood and in turn is built upon by the high school's program for adolescence. It is a phase and program of schooling, bridging but differing

from the childhood and adolescent phases and programs (p. 15).

Problem Solving. According to the National Council of Teachers of Mathematics (1989), problem solving is:

> The process by which students experience the power and usefulness of mathematics [school science, and technology education] in the world around them. It is also a method of inquiry and application...to provide a consistent context for learning and applying mathematics, [school science, and technology education]. Problem solving situations can establish a 'need to know' and foster the motivation for the development of concepts (p. 75).

Qualitative Inquiry. Edson, (1988) found qualitative inquiry:

> Expands our understanding of research by making us conscious of our assumptions and by fostering an appreciation for complexity. Every operates from assumptions, and educational researchers are no exception...One hallmark of a qualitative approach is that it causes us to acknowledge our assumptions so that we can suspend beliefs in theses familiar convictions and examine evidence in a new and productive manner... Qualitative inquiry seeks to make phenomena more complex – not simpler – for complexity, not simplicity, describes life in both the past and the present (p. 45).

Qualitative Research. Qualitative research is "at best an umbrella term covering an array of interpretive techniques which seek to describe, decode, translate, and otherwise come to terms with the meaning, not the frequency, of certain more or less naturally occurring phenomena in the social world" (Van Maanen, 1979, p. 520).

School Science. The National Research Council (1993) suggested:

> Science subject matter includes those concepts, principles, facts, laws, and theories that constitute the body of scientific knowledge. Science introduces children and young adults to the natural world as it is investigated and understood by scientists...[It] is more than subject matter. It also includes the ability to carry out scientific investigations

and understand modes of reasoning involved in scientific inquiry – things important for understanding the nature of science" (p. 13).

Team Teaching. The National Middle School Association (1982) found team teaching:

> Represents an opportunity for a group of teachers to plan and implement an instructional program for a group of students for a common block of time. This approach represents a move away from the teacher-per-classroom arrangement used in many schools across the country and an effort to meet the unique learning needs of the early adolescent (p. 31).

Technological Literacy. According to Savage and Sterry (1990), technologically literate individuals are those who:

> (1) See themselves intrinsically involved in nature, (2) do not deny that there are problems created by technology and are willing to consciously add to the solution, (3) do not see themselves as a single entity, but rather as part of an interdependent world, and (4) realize that there is a pattern of relationships that provides opportunity for individuals in a technological society. (p. 10)

Technology. "Technology is a body of knowledge and the systematic application of resources to produce outcomes in response to human needs and wants" (Savage & Sterry, 1990, p. 7).

Technology Education. A school subject that "teaches students to understand, use and control technology. The curriculum covers the development of technology and its effect on people, the environment and society" (Technology Education Advisory Council, 1988, foreword).

Summary

Middle schools have supported core subject-oriented interdisciplinary teaming for over thirty years. Practitioners, however, continue to argue over the perceived value of this teaching strategy because a lack of information regarding its effectiveness plagues the teaching profession. As national level agencies highlight mathematics, school science, and technology education interdisciplinary approaches as a key for motivating students to learn and for promoting scientific and technological literacy; efforts must be made to measure if teachers align with interdisciplinary teaming. Welty (1990), suggested "the compartmentalization of time, teachers, and curricula in schools has created artificial barriers between the basic disciplines" (pp. 4-5). Therefore, it is the position of researchers to develop an understanding of how interdisciplinary teaming is perceived by teachers and how these perceptions will direct the future of education.

Chapter Two

Review of Related Literature

The intent of this chapter was to review and synergize literature relative to the scope of this study. The chapter was divided into eight sections, each focusing on a particular aspect of research relevant to interdisciplinary teaming practices in middle schools. An effort to establish national views on the interdisciplinary potential of mathematics, school science, and technology education; the perceptions of middle school principals and teachers regarding interdisciplinary teaming; and current interdisciplinary initiatives develop in the 1990's were included in the literature review.

The first section provides a historical analysis of interdisciplinary teaching theory and middle school education. Particular emphasis was placed on commissioned middle school and general education reports published in the 1980's and their effects on interdisciplinary movements of the 1990's.

The second section provides an overview of educational initiatives established at the national level as they pertained to issues in mathematics, school science, and technology education. Two reports, *Pathways to Excellence: A Federal Strategy for Science, Mathematics, Engineering, and Technology Education* published in 1993 by the Federal Coordinating Council on Science, Engineering and Technology [FCCSET] and *Science for All Americans,* published in 1989 by the American Association for the Advancement of Science [AAAS], were analyzed to explain the sentiment at the national level.

The third section provides an overview of middle school principals' reactions to interdisciplinary teaming. Two initiatives designed to collect data regarding principals' perceptions of teaming were included. The John Hopkins Center for Research on Elementary and Middle Schools 1989 report, *Education in the Middle Grades: Overview of National Practices and Trends* gathered by Mac Iver and Epstein (1990) and George and Stevenson's

(1988) research, *Highly Effective Interdisciplinary Teams: Perceptions of Exemplary Middle School Principals* were summarized.

The fourth section provides an understanding of teachers' behavior and perceptions regarding interdisciplinary teaming. One study, Sevick's (1989) practicum project, *The Ultimate Package*, outlined the progressive employment of interdisciplinary activities within one county's school system. An initiative directed by Sparapani (1991) was included in the review to demonstrate the consistency among teachers' perceptions of interdisciplinary teaming.

The fifth section provides an overview of the National Science Foundation's [NSF] missions and the funding of projects which support these missions. This section explored the works of four projects, *The Integrated Mathematics, Science, and Technology Project* [*IMaST Project*], *Technology/Science/Mathematics Integration Project* [*T/S/M Project*], Physics, Mathematics, and Technology [*PHYS-MA-TECH*], and *Project UPDATE*.

The sixth section provides an overview of the National Aeronautics and Space Administration's [NASA] commitment to educational programming in mathematics, school science, and technology education. The annual *NASA Educational Workshops for Mathematics, Science, and Technology Teachers* [*NEWMAST*]; a interdisciplinary curriculum package, *Mission 21;* and a research project and workshop series, *Make The Connection*, were investigated. Special consideration was given to *Make The Connection* because the participants of the workshops provided the perceptual information gathered in the data component of this study.

The seventh section provides on overview of qualitative inquiry in education. It discusses the Grounded Theory research method as described by Glassner and Strauss in 1967.

The eighth section of this chapter summarizes sections one through seven. It focuses on the recommendations and conclusions of national committee perspectives, middle

school principals' and teachers' perceptions regarding interdisciplinary practices, and the outcomes of funded interdisciplinary projects throughout the United States.

Section One: Historical Perspective

The intertwining of middle schools and interdisciplinary teaching strategies has deep seated roots which began at the turn of the twentieth century. The works of John Dewey spurned the later works of the Progressive Education movement in the 1920's and 1930's. Educational movements of the early 1940's offered an increased research base relating to studies in non-traditional teaching methodology. This movement was followed by a reverse effect in the later part of the decade. The flight of Sputnik ignited an educational crisis in the 1950's, which led to new measures in mathematics and school science educational performance. In the 1960's, obvious discontent with the education of adolescents ultimately led to the middle school movement. During this time, education in general became increasingly departmentalized. The 1970's decade brought with it a concern for the traditional boundaries within schools. Meanwhile, middle schools flourished. Economic decline in the 1980's marked another explosion in educational reform. A multitude of commission reports surfaced in this decade. Toward the end of the 1980's, mathematics, school science, and technology education scholars began to recognize the role of interdisciplinary concepts in promoting scientific and technological literacy. Funded initiatives branded the 1990's as a decade for interdisciplinary activity within American middle schools. Examples of joint efforts uniting disciplines offered a hint of where the future in education may lead.

Early Years of Interdisciplinary Activity.

The works of John Dewey and the Progressive Education movement in the early part of the 1900's defined the interdisciplinary teaching methodology of this century (Snyder, 1992). In his book, *Democracy and Education*, Dewey (1916) established the case for the integration of school subject matter and problem solving by stating that all members of a free society must have a certain level of social intelligence to be active participants in decision

making. Dewey believed this social intelligence could not be developed in highly departmentalized school activities (Haney, 1990). Work of the Progressive Education movement made great strides to create schools more reflective of the work world. (Progressive Education Association, 1943) "Throughout the first half of the twentieth century, progressive-experimentalist educators developed various modes for curriculum synthesis to meet the function of general education in schools and colleges" (Tanner, 1990, p. 197).

A major research effort was conceived in the early 1930's to apply the principles of the Progressive Education movement. According to *The Eight Year Study* (Aikin, 1942), investigators found evidence that secondary school programs were driven by a curriculum which catered to those destined for college. Educators believed that curriculum stifled innovation in a time when more non-college bound students were electing to complete high school. In the experiment, thirty schools radically redesigned their high school programs to encourage students to work more cooperatively and creatively. Major changes were made to break down barriers between subjects. Teachers representing different subject backgrounds banded together to implement problem solving activities (Aikin, 1942).

Haney (1990) suggested many non-traditional education programs, such as interdisciplinary activities, were dropped from American schools in the 1940's. He found the regression of schools back to a familiar sequence of traditional core subject delivery was due to a lack of understanding of interdisciplinary curriculum activities and the pressures to produce a work force suited to fulfill the needs of World War II.

Sputnik and Departmentalization.

The educational changes of the 1950's were defined by the continuing movement away from problem solving and interdisciplinary learning. With the passage of the National Science Foundation [NSF] Act in 1950 and the flight of Sputnik, the educational focus demanded increased comprehension of science and mathematics theory. As a result, strong departmentalization of subject matter was encouraged in an effort to build these skills

(Bybee, 1987; NSF, 1983). Educators responded with many curriculum initiatives. These developments reflected new teacher training practices, particularly through programs fostered by the NSF (1983). Once again, schools developed programs that appealed to students bound for the college or university settings (Bybee, 1987).

Middle School Emergence.

The emergence of a new type of school surfaced in the 1960's. By 1960, junior high schools had become so popular that approximately 80 percent of all high school graduates had gone through an elementary, junior high, senior high system (Hornbeck & Arth, 1991). However, dissatisfaction with the junior high school system was evident. Educators were concerned that students ages ten to 14 were not having their needs met in the junior high (Hornbeck & Arth, 1991; NASSP, 1985). Dr. William Alexander from the University of Florida in Gainesville presented his philosophy for an alternative school to meet the needs of adolescents. He suggested the implementation of the "middle school" (Alexander & McEwin, 1989, p. 2). In an effort to understand the magnitude of the middle school momentum later in the decade, Alexander conducted a national survey which provided data regarding the status of the new schools (Alexander & McEwin, 1989).

In the 1970's, two camps of educators gained recognition. While the rigid departmentalization of subject matter, representative of the 1960's persisted, many curriculum experts expressed a growing disrespect for the traditional boundaries that separated disciplines (Bybee, 1987). Meanwhile, the middle school movement continued to grow. "The elimination of de facto segregation in the 1970's became a real force behind the middle school movement in larger cities" (Sevick, 1989, p. 9). Approximately 4,000 middle schools were in existence by the end of the decade. In 1978, 15 states required special preparation to teach in the middle grades and an additional 13 states proposed similar requirements (Hornbeck & Arth, 1991).

Commissioned Reports of the Eighties.

Emphasis on middle school education exploded in the 1980's. Over 8,600 middle school and intermediate schools were functioning in the United States (Alexander & McEwin, 1989). Several major studies and reports funded by state and national governments and private agencies emerged. The first of these publications, *This We Believe*, was released by the National Middle School Association [NMSA] in 1982 (Lounsbury, Ed.). It emphasized the use of various instructional strategies, including interdisciplinary teaming, as essential elements in middle school teaching. (NMSA, 1982). In 1985, the National Association of Secondary School Principals [NASSP] formed the Middle Level Council to promote middle schools. The Council developed *An Agenda for Excellence at the Middle Level* (NASSP, 1985). The first of several state reports, *Caught in the Middle: Educational Reform for Young Adolescents in California Public Schools*, was released by the California State Department of Education in 1987. In addition, the John Hopkins Center for Research on Elementary and Middle Schools [CREMS] conducted a massive study to understand the perceptions of middle school principals in 1989. The findings were culminated in the report *Education in the Middle Grades: Overview of National Practices and Trends* (Mac Iver & Epstein, 1990). In June of 1989, the Carnegie Council on Adolescent Development published *Turning Points: Preparing American Youth for the 21st Century* (Carnegie Foundation, 1989). *Turning Points,* as it came to be known among middle school professionals, preceded a grant program which was designed to initiate state support for middle schools (Hornbeck & Arth, 1990).

A number of national reports on education were disseminated in the 1980's calling for a wide variety of systemic changes from pre-kindergarten to the post-graduate level. Many reports such as *A Nation at Risk: The Imperative for Education Reform* (Gardner, 1984), *A Place Called School: Prospects for the Future* (Goodlad, 1984), and *Academic Preparation for College: What Students Need to Know and Be Able To Do* (Hanford & Taylor, 1983)

underscored the need for dramatic changes in mathematics and science education. *Action for Excellence: A Comprehensive Plan to Improve Our Nation's Schools* (Education Commission of the States, 1983), *High School: An Agenda for Action* (Boyer, 1983), and *Education and Economic Progress: Toward National Education Policy* (Carnegie Corporation, 1984) included technology education or a plan to increase technological literacy in their benchmarks and goals. Reform specifications related to teacher programming and teaching strategies received special attention from *Making The Grade: A Report Card on American Youth* (National Collaboration for Youth, 1990), *A Place Called School: Prospects for the Future* (Goodlad, 1984) and *School and College – Partnerships in Education* (Carnegie Foundation for the Advancement of Teaching, 1983).

Renewed Focus.

A concern for the economic and technological stability in the United States was fueled by the successes of foreign competition in the 1980's. The American populace once again called for the educational reconstruction of science and mathematics to remediate the dire situation (Apple, 1992; Bracey, 1993). At this time, the science and mathematics communities began to recognize the importance of subject integration, particularly the integration of mathematics, school science, and technology education (AAAS, 1989; FCCSET, 1993).

In the 1980's, many science educators called for a renewed focus on "hands-on" science. This approach stressed the implementation of manipulative learning activities that corresponded with science content and the development of science skills (Bredderman, 1987; Fort, 1990; Glasson, 1989; Kyle, Bonnestetter; Gadsden & Shepardson, 1989; Shymansky, Kyle & Alport, 1983; Staver & Small, 1990; Tobin, Capie & Bettencourt, 1988).

Three reform initiatives directed by the science community began at this time. The first was an initiative established by the AAAS (1989). This long-term initiative was created to ensure all students would achieve a higher level of scientific literacy. *Project 2061* began in 1985 and will continue beyond 1995 (AAAS, 1989). In 1988, The National Science

Teachers Association [NSTA] began planning the *Scope, Sequence and Coordination of Secondary School Science Project.* The project focused on a curriculum which promoted a greater understanding of science by sequencing material according to the developmental levels of students. A guide entitled *The Content Core* served to organize the subject matter (NSTA, 1992). The third initiative was developed by the National Research Council's [NRC] National Committee on Science Education Standards and Assessment. The Council developed a coordinated action plan to maintain the strength of secondary level science and to strengthen the elementary level programs (NRC, 1993). These initiatives identified interdisciplinary programming as an integral part of school science education and acknowledged technology education as an active partner in such programming (Salinger, 1992).

In 1989, the National Council of Teachers of Mathematics [NCTM] published national standards for curriculum and evaluation. In 1991 the Council developed professional standards (Campbell & Bamberger, 1990; Jacobs; 1991; NCTM, 1989 & 1991). The Council was concerned that students viewed mathematics at the middle school level as dull and routine. Tishler (1989) supported interdisciplinary activity building and suggested,

> Mathematics experiences need not be restricted to the "math period" but can be incorporated throughout the school day. The importance of making mathematics connections, both within mathematics and between mathematics and other curriculum areas is emphasized by the inclusion of "mathematics connections" as one of the curriculum standards for school mathematics curriculum (p. 12).

As the mathematics and science communities defined their disciplines in the 1980's, industrial arts educators were in the midst of a philosophical transition. This transition yielded what is now known as technology education. This shift called for a broadened content base that changed in focus from industrial to more general technology (International Technology Education Association [ITEA], 1985; Savage & Sterry, 1990). Technology education leaders embarked on a campaign to modify school curricula and change their

professional image to appeal to a larger student populace (Starkweather, 1986). It was a goal of technology education leaders to create a school subject which would ultimately become known as an environment that was more amenable to cooperative, interdisciplinary efforts and the advancement of scientific and technological literacy (Brusic, Dunlap, Dugger & LaPorte, 1988; Erekson & Johnson, 1989; Gauger, 1989; Maley, 1984).

New leadership in the Department of Education and the National Science Foundation [NSF] established action-oriented changes in mathematics, science, and technology education. (Branscomb & Johnson, 1992). National interest established by the National Educational Goals of 1990 in *America 2000* (Bush, 1990) emphasized similar reform.

Section Two: National Sentiment

National level initiatives to examine how mathematics, school science, and technology education related to the academic achievement of United States school children became a central issue in the 1990's (FCCSET, 1993). According to the FCCSET (1993) findings:

> Our country has a fundamental stake in the educational achievement of its citizens. A well-educated citizenry is essential to the civic and economic health and well-being of the country. The Federal Government, therefore, has an important role to play in ensuring that every American child receives an excellent education (p. 1).

Pathways to Excellence.

In order to define the role of the national government in the implementation of the National Education Goals of 1990 as they related to science, mathematics, engineering, and technology, the science advisor to President George Bush, formed an inter-agency committee. The committee included those national departments and agencies whose missions were dependent upon a highly skilled science, engineering, and technology work force. The Committee on Education and Human Resources [CEHR] was chartered under the FCCSET. The CEHR developed a strategy for mathematics, school science, and technology education that was designed to "ensure U.S. world leadership in science and technology, build a highly

trained workforce, and increase the public understanding of science" (FCCSET, 1993, p. 5). The national departments represented on the committee varied greatly. The departments included: the U.S. Departments of Defense, Education, Energy, Agriculture, Interior, Labor, Transportation; the National Science Foundation [NSF]; the National Aeronautics and Space Administration [NASA]; as well as representatives from the Executive Office of the President; and a representative from the Smithsonian Institute.

To ensure the proposed goals would be met, an Educational Strategic Planning Framework was established and published in the document *Pathways for Excellence: A Federal Strategy for Science, Mathematics, Engineering, and Technology Education* (FCCSET, 1993). This framework included implementation priorities for elementary, secondary, undergraduate, and graduate education. Two of the numerous goals to achieve the priorities of this framework included: creating a public understanding of science and generating an awareness of technology education in the United States.

These goals were to be carried out through four strategic objectives. The first objective examined the importance of improving student performance from elementary school through graduate degree programs in science and mathematics. The second objective outlined building a technologically-oriented elementary and secondary teaching pool. The third encompassed creating an "adequate pipeline for the science and technology work force, including greater participation of individuals underrepresented in science, mathematics, engineering, and technology education, e.g., women, minorities and persons with disabilities" (FCCSET, 1993, p. 12). The final objective was to improve the science literacy of the general public.

According to the planning framework, these strategic objectives were to be carried out between the 1994 and 1998 fiscal years. The strategies emphasized in *Pathways to Excellence* related to interdisciplinary activities involving mathematics, school science, and technology education. This relationship was realized in the Council's agreement that

"technology-related activities improve the delivery of science, mathematics, engineering and technology education" (FCCSET, 1993, p. 24).

Project 2061.

The American Association for the Advancement of Science [AAAS] was involved in a long-term multipurpose undertaking to bring about educational change in the United States. *Project 2061* was designed to restructure kindergarten through twelfth grade education. Its goal was to ensure students would achieve a level of scientific literacy which would allow them to participate effectively in the twenty-first century. According to the project director, F. James Rutherford, *Project 2061* was motivated by a concern that the academic system was failing to teach a large number of students, especially minority children in the areas of mathematics, school science, and technology education. He explained, "Our world continues to change radically in response to the rapid growth of scientific knowledge and technological power" (AAAS, 1989, Foreword).

Project 2061 began in 1985 and continued through 1995. Three phases were designed to outline and implement the new curriculum (AAAS, 1989).

In Phase I of the project, a conceptual base was presented in five panel reports and the publication *Science for All Americans* (AAAS, 1989). Teams of educators worked to generate benchmarks for science literacy at grades 2, 5, 8, and 12 (AAAS, 1992). Future plans to examine alternative curriculum models for teaching and learning; systematic reform guides related to assessment, teacher education, and school organization; and a computerized system to link educators to *Project 2061* information were also previewed during Phase I (AAAS, 1992).

The end of Phase II and the execution of its four main goals ended in 1993. The four goals are paraphrased below. The project was intended to:

1. Produce curriculum models for kindergarten through high school education.
2. Create "blueprints for reforming the other components of education that

complement curriculum reform" (AAAS, 1992, p. 161).

3. Expand curriculum reform by identifying educators and scientists who were able to serve as experts for the project.

4. Reform science, mathematics, and technology education and to "promote reform efforts among teachers, administrators, and educational policymakers" (AAAS, 1992, p. 161).

Model schools were developed to facilitate the demands of Phase II. Six school districts across the nation were selected to design programs which promoted alternative curriculum models for education in mathematics, school science, and technology education. *Project 2061* coordinators demanded a considerable commitment of time and space from each participating school system. Local teachers were required to commit themselves to the project for several years and local universities had to commit intellectual resources and technical expertise to the model schools.

In the summer of 1989, educators met to formulate the six school teams. At the model schools, 25 team members including elementary, middle school and high school teachers, principals, and curriculum specialists worked cooperatively. These educators represented mathematics, the social and natural sciences, technology education, home economics, and vocational education (AAAS, 1992).

At the end of Phase II, the key features of these alternative schools were analyzed to determine their potential for success. However, the implementation phase was not completed (AAAS, 1989). "The actual implementation of educational reform based on the outcomes of this study will be the goal of Phase III [which] could last a decade or longer" (Haney, 1990, p. 4).

The dissemination plans for Phase III have been underway since 1991. In the summer of that year, leaders of *Project 2061* assembled to determine the desired outcomes for the overall program. Four models of student development were selected to serve as

strategies to create an understanding of mathematics, school science, and technology education. These strategies were employed in 1994 (AAAS, 1992).

As the research related to the advancement of scientific literacy continued through *Project 2061,* initial theories emerged. The panel suggested the educational curricula presented in United States schools does not provide enough problem solving situations for students. The panel reported that experiences representative of our highly technical environments, where mathematics and science principles were applied, were simply non-existent (AAAS, 1989).

Section Three: Principals' Perceptions

Efforts to understand the middle school philosophy were examined throughout the 1980's (California State Department of Education, 1987; Carnegie Council, 1989; George & Stevenson, 1988; Hornbeck & Arth, 1991; Mac Iver & Epstein, 1990; NASSP, 1985; NMSA, 1982). Two reports, the John Hopkins Center for Research on Elementary and Middle Schools [CREMS] publication *Education in the Middle Grades: Overview of National Practices and Trends* (Mac Iver & Epstein, 1990) and a less exhaustive research initiative, George and Stevenson's (1988) study, *A Study of Exemplary Middle School Practices* attained information regarding interdisciplinary teaming from middle school principals.

CREMS Report.

In 1989, Mac Iver and Epstein conducted a national research study which featured the perceptions of middle school principals. The researchers presented an overview of approaches and practices in schools that served early adolescents. The report, *Education in the Middle Grades: Overview of National Practices and Trends* (1990), summarized past, present, and expected uses of 22 educational practices. One of the practices examined was the employment of interdisciplinary teams as an alternative teaching strategy.

The selection of the 1,753 principals who provided information for the research was

based on a probability sample of 2,400 public schools. The researchers identified 25,000 schools in the United States that served seventh-grade students. These schools included middle schools, intermediate schools, and junior high schools. Fifty-six percent of the principals returned the mailed questionnaire. In addition, a random telephone sub-sample of all non-respondents was conducted bringing the raw response rate to 73 percent (Mac Iver & Epstein, 1990).

The results of principals' belief and attitude assessments supported several hypotheses initially stated in the 1990 publication. According to the researchers, principals suggested interdisciplinary teams formed a sense of community; a constant place where teachers went to examine concerns with their peers. These concerns included strategies for assisting students with learning difficulties, aspects of time management, the regrouping of students for special programming, and concerns involving parental conferencing.

Although the middle school philosophy stressed the importance of interdisciplinary teaming practices (Alexander, 1968), responses collected in this study indicated most schools did not exercise the use of interdisciplinary teams as a regular teaching strategy. According to the findings, 58 percent of middle school students did not receive instruction from interdisciplinary teams of teachers (Mac Iver & Epstein, 1990).

> Some department chairs believe that interdisciplinary teams dilute subject specialization. Some middle [school] teachers prefer to identify with a department, as high school teachers do...If staff development is not provided, the concepts and potentials of interdisciplinary teaming may not be understood or implemented (p. 33).

The CREMS report directors cited several reasons why more schools did not use this teaching strategy. They found principals who represented schools where interdisciplinary teams were not employed tended to overestimate the potentially negative aspects of teaming. Most negative comments concerned a lack of planning time and teacher training time. Mac Iver and Epstein (1990) suggested these principals also underestimated the positive aspects

of interdisciplinary teaming which included: more coordinated homework for students; closer communication between new and veteran teachers who served on the same team; and a more professional atmosphere among team members.

It can be derived from the research that interdisciplinary teams comprised of a mathematics, school science, and technology education teachers were uncommon. Principals acknowledged that 92 percent of all teams included a social studies teacher and an English teacher, 83 percent contained a mathematics teacher, 80 percent hosted a science teacher, and 65 percent included a reading teacher. Only one fifth of the schools included a team member who represented a traditionally non-core subject such as home economics, foreign language, technology education, or other subjects. The inclusion of a non-core member was only common to those schools where more than five teachers were working together. Mac Iver and Epstein (1990) insisted, "Schools with a strong commitment to teaming and successful practices are beginning to consider larger teams, including the teachers of elective or exploratory courses" (p. 35).

Highly Effective Interdisciplinary Teams.

In the spring of 1987, a survey was circulated to 154 principals representing the "nations supposedly best middle schools" (George & Stevenson, 1988, p. 1). The survey gathered data regarding the organization, attributes, strategies of successful interdisciplinary teams; and the characteristics of educators participating on them. The study also culminated principals' thoughts for maintaining successful teams.

The sample of principals was derived from a nomination process based on the researchers' criterion for exceptional middle schools. The criterion consisted of exemplary academic achievements featuring high ratings in student achievement and teacher morale. Other middle schools were included in the study based on previous participation in projects developed by Phi Delta Kappa, the Department of Education, and the Association for Supervision and Curriculum Development. Sixty three percent of the principals returned the

survey (George & Stevenson, 1988).

Data gathered by George and Stevenson (1988) paralleled the findings of the CREMS report (Mac Iver & Epstein, 1990). Similar interdisciplinary team organization, attributes, teaching strategies, and characteristics of participating educators were recorded. The findings of George and Stevenson's survey suggested a distinctive trend where four or five teachers serving 100 to 130 students proved most successful as an interdisciplinary team. In addition, every principal described a successful team as one having two types of planning periods: common team planning time and individual planning time. "It seems evident that for teachers to do their very best work on teams, they must have adequate planning time for both team responsibilities and instructional ones" (p. 5). Data indicated 43 percent of the teams had the benefit of daily periods for both team planning and individual preparation.

The placement of members participating on exemplary teams was explored in the study. The most successful teams were constructed by administrators, not by the teachers themselves. The project directors found principals attributed extensive conferencing between teachers and the principal as the key element in effective team placement. "Teams needed to constitute a balance of personalities, teaching specializations, and personal life-styles. Of greatest importance, however, was the essentiality of every teacher's willingness to work together, to commit to a common plan while respecting each other's differences" (George & Stevenson, 1988, p. 6).

The study concluded with practical advice for principals regarding the promotion of interdisciplinary teaming within schools. Principals suggested teachers must be honored and supported if they are expected to thrive on interdisciplinary teams. "Their daily activities should be freed of institutional obstacles, filled with a feeling of ownership, and cultivated with reasonable degrees of freedom in teacher autonomy" (George & Stevenson, 1988, p. 21).

Section Four: Teachers' Perceptions

Just as the AAAS (1989) exclaimed, the key to interdisciplinary teaming begins with the classroom teacher. Two research initiatives, a practicum conducted by Sevick in 1989 and Sparapani's supporting study in 1991 assessed the perceptions of teachers regarding interdisciplinary teaming.

The Ultimate Packet.

In 1989, a middle school program consultant, Mary Jane Sevick established a nine week practicum intervention and training program along with an interdisciplinary material series entitled *The Ultimate Packet.* It was piloted in a small United States county (Sevick, 1989). The program and supplemental material were designed to enhance the collaborative efforts of middle school interdisciplinary teams. These teams had been classified, by their own admission, as ineffective.

Initial site interviews of team members, surveys of team leaders, and observations conducted by the investigator judged 70 of the 152 interdisciplinary teams in the practicum school district in need of assistance. Sevick sited three underlying reasons for the ineffective teaming. First, the teamed teachers had not reached a state of personal teaching development within their own disciplines to make curriculum integration possible. Many respondents were first or second year teachers. Second, the teams lacked administrative support. Lastly, Sevick found core subjects needed to be reorganized into basic themes to make integration possible (Sevick, 1989).

To better understand the collaborative progression of the interdisciplinary teams that participated in the nine week program, Sevick adopted George's (1982) four stage teaming development framework. The stages included:

1. Creating organizational conditions where the team established rules and common practices.
2. Developing a sense of community among team members and within the school.

3. Implementing interdisciplinary activities within the classroom.

4. Committing of the entire school to share in the decisions regarding interdisciplinary team practices.

As Sevick (1989) originally hypothesized, many of the teams involved in the practicum did not exceed beyond phase three by the end of the nine week practicum. To test this hypothesis, a survey was given to middle school teachers who had used *The Ultimate Packet.* Results of the instrument reflected a greater use of interdisciplinary activities after having been exposed to the materials. During the practicum, all of the teachers admitted they had made casual reference to other subjects, including 55 percent who deliberately reinforced skills taught in other disciplines. Additionally, 50 percent of the teachers suggested they had or were implementing interdisciplinary units at the time of the survey (Sevick, 1989).

Sparapani Study.

In 1990, a questionnaire was mailed to 136 junior high and middle school teachers in Georgia, Michigan, Alabama, and Pennsylvania. The teachers who received the survey represented four socio-economic categories including: urban, urban/inner city, suburban, and rural settings (Sparapani, 1991).

The survey was designed to analyze teachers' knowledge and perceptions relative to curriculum and teaching strategies appropriate for adolescents. A section of the study explored their perceptions of interdisciplinary and team teaching. The researcher felt the 100 percent return rate of the mailed survey instruments indicated an increased interest in alternative teaching strategies at the middle school level. The study's findings were consistent with its literature review. Conclusions stated that teachers strongly believed in the benefits of using interdisciplinary teaming and supported the building of team networks within schools (Sparapani, 1991).

Section Five: The National Science Foundation

Funding through the National Science Foundation [NSF] spurned an increased

awareness in the integration of mathematics, school science, and technology education (Salinger, 1992). The National Science Foundation Act of 1950, as amended, authorized and directed the Foundation to support mathematics, science, and engineering educational programs in schools, colleges, and universities (Flemming, 1992). A more recent addition to NSF funding encompassed projects developed by technology education researchers (LaPorte & Sanders, 1993).

In order to serve one of the NSF's missions, which is to: "Improve the quality of the educational experiences of all students, [and] to deepen citizens' general understanding of mathematics, science and technology in order to insure fuller participation in a technological society" (Flemming, 1992, p. 1), several initiatives directed toward teaming mathematics, school science, and technology through problem solving activities surfaced in the 1990's. Four major interdisciplinary efforts sponsored by the NSF received national recognition.

PHYS-MA-TECH.

In 1990, the NSF funded an experimental project involving an interdisciplinary teaching approach designed to integrate physics, mathematics, and technology education known as *PHYS-MA-TECH*. Collaborative efforts on this project included the Illinois State Board of Education, the Illinois Department of Adult, Vocational and Technical Education, Northern Illinois University's Department of Technology, five Illinois school systems, and five industrial partners (Scarborough, 1993).

The initial goal of the initiative was to improve high school physics through an integrated curriculum and team delivery model. However, Scarborough (1993) found:

> In working toward their goal, project teachers began to realize that not only was physics going to become stronger, but the mathematics and technology content was going to be strengthened as well. The revised goal of the project became one of improving education across all three disciplines. (p. 29)

According to the *PHYS-MA-TECH* researcher's findings, participants suggested one

subject area did not seem to be any more important than the others. As teachers became more knowledgeable about each other, researchers found the professional respect and confidence toward their teammates grew visibly. Scarborough (1993) suggested the project participants also felt individual subject areas benefited from the positive and supportive professional relationships which developed as the result of learning about each other.

IMaST Project.

Three distinguished professors located at Illinois State University collaborated in 1991 to propose the Center for Mathematics, Science, and Technology and Integrated Mathematics, Science, and Technology Project [IMaST], (Loepp, 1993). Mathematics leader Dr. John Dossey, an instrumental developer of the National Council of Teachers of Mathematics's document *Curriculum and Evaluation Standards for School Mathematics* (NMTA, 1988) directed the mathematics component of the initiative. The school science representative was Dr. Thomas Finch. Finch was a teacher educator, developer of the Honors Project for Outstanding Teachers of Science in Illinois, and an expert grant writer. Dr. Franzie Loepp, a pioneer in the philosophical movement of industrial arts toward technology education and a consultant to Japanese industry assisted with the technology education component. Together they developed the Center's ideology (Cushman, 1991).

These leaders and their staff of four developed interdisciplinary activities for seventh grade education through the *IMaST Project.* During the 1992-1993 academic year, a total of ten field sites representing the states of Minnesota, Wisconsin, Michigan, Indiana, Illinois, and Missouri piloted the first curriculum module *Food Production* (Hatch, personal communication, August 24, 1993). Testing of the second module, *Wellness,* began during the 1993-1994 academic year. A design team, comprised of classroom teachers was selected at the onset of the project to assist in creating the integrative curriculum (Loepp, 1993).

The goals of the Center and the *IMaST Project* included the integration of mathematics, school science, and technology education. These goals are paraphrased below. According to

Loepp (1993), the project was designed to:

1. Conduct research which examined how integration increased scientific awareness.
2. Develop experiences which supported integrated teaching and learning.
3. Restructure undergraduate teacher training programs to emphasize subject integration.
4. Disseminate the new knowledge base.
5. Increase the number of minorities and women in mathematics, school science, and technology education.
6. Promote a national discussion.
7. Seek external forces to support these goals.

T/S/M Integration Project.

The *Technology, Science, and Mathematics Integration Project* [*T/S/M Integration Project*] was directed by Drs. James LaPorte and Mark Sanders and was assisted by Vincent Childress of the Technology Education Program at Virginia Polytechnic Institute and State University. The project evolved by teaming technology education teachers with mathematics and school science teachers (LaPorte & Sanders, 1993). Although the developers were technology education oriented, their project activities were based in the content area of school science. According to the *T/S/M Integration Project* researchers, their project attempted to synergize the "growing awareness of the important role of technology as it relates to both science and mathematics" (LaPorte & Sanders, 1993, p. 17).

The history of the project extended back to 1991. The orientation for the original interdisciplinary teams of teachers took place in May of that year. Teams included a mathematics, school science, and technology education teacher and an administrator from the same school system. In June, five teams attended a week-long workshop and developed sixteen activity ideas. During the remainder of the summer, the activities were further developed. Ultimately, a one page "Problem-Solving Brief" (LaPorte & Sanders, 1993, p.

19) and corresponding instructional package were produced for each activity. The activities were tested throughout the 1991-1992 academic year by schools within the Commonwealth of Virginia. In 1992, 40 field tests sites implemented and evaluated the material on a national and international level. The integrative activities were published in 1994. Themes which included rocketry, energy, weather, as well as many others, were showcased in the publication.

The researchers findings suggested mathematics, school science, and technology education teachers enjoyed working together. "The science and mathematics teachers were very excited about the activities – even those that technology education teachers have worked with in the past" (LaPorte & Sanders, 1993, p. 19).

Project UPDATE.

Project UPDATE was a funded effort directed by Drs. Ronald Todd and Pat Hutchinson. Its focus was to design integrative activities involving mathematics, school science, and technology education for use from kindergarten through the eight grade. Its philosophical base was one of a pre-engineering structure, similar to that of the *T/S/M Integration Project* (LaPorte & Sanders, 1993). Todd (personal communication, August 24, 1993) reported that the project aligned with the Design and Technology approach common to early grade programs found in the United Kingdom (Benson, 1992). "The design and technology paradigm shifts the focus away from the amount of knowledge acquired to the amount that can be applied. Design and technology, therefore, is about putting knowledge to work" (Todd & Hutchinson, 1991, p. 7).

The Project had several components which were completed within the span of the initiative (Todd, Doyle, & Hutchinson, 1993, p. 52). These included:

1. The development of curriculum materials.
2. The establishment of a clearing-house to disseminate information.
3. The development of linkages between schools and communities.

4. The generation of courses and workshops where educators were trained to internalize the design and technology paradigm.

5. An assessment program to evaluate student performance.

The initial material development phase of the project was conducted during the summer of 1993 with nine school systems participating. Due to the barrage of educators who had contacted codirector Todd regarding interest in interdisciplinary programming, he remained optimistic about the future of this teaching strategy (Todd, 1993).

Section Six: The National Aeronautics and Space Administration

The National Aeronautics and Space Administration [NASA] offered a variety of educational programs to meet the needs of educators and students throughout the entire educational process (NASA, 1993). In the 1990's, NASA's educational programming was driven by its own self interest which was to expand the potential pool of scientists, engineers, and technicians for the future. NASA's vision, "To promote excellence in America's education system through enhancing and expanding scientific and technological competence" (p. 11), was recognized through programming which integrated applications of mathematics, school science, technology education, and related subject matter.

In *NASA's Strategic Plan for Education* (1993), an educational strategies planning guide which encompassed the 1993-98 fiscal years, eleven educational objectives were developed. Two of the objectives discussed interdisciplinary education at the elementary and secondary school level. These objectives included: increasing the annual participation in NASA's teacher enhancement programs; and conducting workshops and conferences that focus on educational issues, interdisciplinary activities, and teaching practices. Three interdisciplinary initiatives, the *NASA Educational Workshops for Mathematics, Science, and Technology Teachers* [*NEWMAST*], the *Mission 21* curriculum series, and the *Make The Connection* project reflected these objectives.

NEWMAST.

Since the mid-1980's, approximately 900 educators have been served by an educational summer workshop program established by NASA known as NEWMAST. This annual endeavor, cosponsored by the National Science Teachers Association [NSTA] in cooperation with the National Council of Teachers of Mathematics [NSTM], and more recently, the International Technology Education Association [ITEA], formally invited technology teachers to participate for the first time in 1990.

The original program was designed to teach educators how engineers and scientists work together at NASA using principles of mathematics, science, and technology. Several approaches of "learning by doing" (Bachmeyer, Durban, Gauger, & Olson, 1990, p. 28) were explored by the participants.

Over 1,000 teacher applications were received in the previous years for the 100 available appointments. Teachers selected represented mathematics, school science, and technology education teachers who had demonstrated leadership in previous cross-disciplinary teaching endeavors.

The inclusion of technology education teachers changed the focus of the NEWMAST workshops. With the inclusion of the technology education professionals in the workshops, the directorate found the mathematics and school science teachers discovered technology education "provides a vehicle for interdisciplinary approaches, the development of critical thinking, and cooperative learning" (Bachmeyer, et al., 1990, p. 28). It was concluded that technology education teachers were more experienced in the use of interdisciplinary instruction and showed leadership when working among their mathematics and school science colleagues.

Mission 21.

In 1985, NASA awarded a Graduate Student Researchers Program Grant to the Technology Education Program at Virginia Polytechnic Institute and State University to develop *Mission 21*. It was a problem solving project designed to expose educators to the

notion of integrating technological concepts within existing pre-school, elementary, and middle school curricula. The problem solving activities featured in the program correlated with social studies, health and physical education, language arts, school science, and mathematics (Brusic & Barnes, 1992). "Three basic skills are emphasized throughout the program: creativity, problem-solving, and critical thinking. Every *Mission 21* activity helps children build these skills by calling their attention to the ways people create and assess technology" (p. 5).

The original *Mission 21* project was field tested between 1985 and 1989 (Brusic, Dunlap, Dugger & LaPorte, 1988). The central theme of technology guided the project. This theme included the classroom use of problem solving strategies, design briefs, folios, and student presentations (Brusic & Barnes, 1992). Field studies tested the methodology and planning guidelines set forth by *Mission 21*. According to Brusic and Barnes:

> Teachers adapted the program to suit their needs, they modified activities to fit their objectives and their classroom environments, and they experimented with new ideas and explored novel ways to integrate technological activities into their curricula. (p. 7)

Two doctoral dissertations centered at the Virginia Polytechnic Institute and State University Technology Education Program were compiled based on *Mission 21* research. Dunlap's (1990) dissertation research focused on whether third and fourth grade students exposed to the *Mission 21* program developed different attitudes toward technology than children who did not receive this type of instruction. He found that girls and boys who participated in the *Mission 21* program did have a significantly more positive attitude toward technology than students who did not participate in the program. Brusic's (1992) dissertation research focused on the determining effects on fifth grade students' achievement and curiosity when a technology education activity was integrated with a unit in science. She found the integration of technological activities with science instruction may positively

affect fifth grade students' curiosity but may not enhance or deter from their science achievement.

Make The Connection.

Make The Connection was a project designed to assist middle school educators in integrating mathematics, school science, and technology education using aerospace themes (Dugger & Strand, 1993). The project was funded during the 1992-93 academic year by the Virginia Space Grant Consortium [VSGC]. The VSGC is an agency comprised of public and private educational facilities in Virginia as well as NASA's national level headquarters. *Make The Connection* was directed by Dr. William E. Dugger, Jr. and assisted by Jo Strand of the Technology Education Program at Virginia Polytechnic Institute and State University.

Four *Make The Connection* workshops were held within the State of Virginia in March, 1993. An advisory board, comprised of VSGC institution members, assisted with the program throughout the year. These members represented the fields of mathematics, school science, and technology education.

The one day workshops featured aspects of formulating interdisciplinary teams within middle schools. All attendees participated in two concurrent 50-minute sessions featuring interdisciplinary activities. One session, conducted by Vincent Childress, a research associate for the *T/S/M Integration Project*, led participants through a hands-on session demonstrating rocketry. The second session, which featured relationships between the sun, moon, and earth, was conducted by David Hagan, the Director of Science Education at the Science Museum of Virginia. A third session outlined the use of Virginia's Public Education Network and one of the network's sub-directories, "The Space Connection." It was led by Patrick Golden, curator of "The Space Connection" (Dugger & Strand, 1993).

Make The Connection workshop participants also attended an informational assembly which introduced the philosophy of interdisciplinary teaming. A keynote address was given by a representative of the science or technology professional community. In addition,

participants were encouraged to use the workshop breaks and lunch periods to formulate integrative activities for future implementation within their school systems.

All participants left the workshop with the assignment to plan and implement an integrative activity within their school system. They were also assigned to post the activity on "The Space Connection" using a pre-designed template (Dugger & Strand, 1993).

To participate in a *Make The Connection* workshop, participants were required to work with an interdisciplinary team created within a single school system. Members of the team included mathematics, school science, and technology education teachers and an administrator. Various types of school administrators participated including: building principals, assistant principals, school system administrators, and curriculum supervisors representing mathematics, technology education, and school science. A total of 74 teams representing 68 Virginia school systems took part in the workshops. Of these, 18 teams created, implemented, and posted an interdisciplinary activity on "The Space Connection."

Section Seven: Qualitative Inquiry

Qualitative inquiry in education connotes a subjective process of understanding and assessing educational phenomena (Westbrook, 1990; Whitt, 1991). It concerns the examination of experience to answer questions of why, how, what is the process, and what is the relationship (Westbrook, 1990). In understanding qualitative research, Merriman (1988) suggested it is a method of understanding, rather than a method to generalize information. Qualitative inquiry allows researchers to examine the ways in which individuals make meaning of their experiences. According to Van Maanen (1979), the label qualitative research is:

> At best an umbrella term covering an array of interpretive techniques which seek to describe, decode, translate, and otherwise come to terms with the meaning, not the frequency, of certain more or less naturally occurring phenomena in the social world (p. 520).

Plucker (1990) found many advantages in using the qualitative research method. It does not depend on a large number of random samples, therefore, smaller samples are acceptable. Moreover, qualitative methods demand the use of a flexible design which allows the momentum of the research endeavor to be refined as the researcher deems fit. Plunker also suggested qualitative research generates findings that are more accessible to policymakers and practitioners. Miles and Huberman (1984) supported this later notion in their research:

> The findings from qualitative studies have a quality of "undeniably." Words, especially when they are organized into incidents or stories, have a concrete, vivid, meaningful flavor that often proves far more convincing to a reader, another researcher, a policymaker, [or] a practitioner, than a page of numbers (p. 15).

Qualitative research also has a holistic nature that many researchers find important (Plucker, 1990). It is unlike quantitative research, which assumes that phenomena must be broken into component parts, or variables, in order to be studied and understood. Rather, qualitative researchers seek to understand the ways in which the parts come together to form a whole (Merriam, 1988; Patton, 1990). For this reason, qualitative methods are considered to be superior to other research methods for achieving in-depth understandings of complex organizations and processes (Patton, 1990).

The Grounded Theory Method.

Numerous qualitative methods to measure educational and other social experiences have been derived since the times of Plato and Rousseau (Hutchinson, 1988). One method, The Grounded Theory, was developed by Glassner and Strauss from the University of California, San Francisco in 1967. Hutchinson (1988) suggested the Grounded Theory was developed because the sociologists were dissatisfied with sociological theories and research in the 1950's and 1960's. The pair felt that sociologists were unsuccessfully attempting to create large, all-encompassing theories to explain the human condition, rather than small, practical theories which were grounded in every day experience. Hutchinson (1988) stated:

> Glassner and Strauss believed grand theories were generated from idle speculation rather than from data and those who generated grand theories were not interested enough in research to test them out. Grand theories employ global concepts that are often poorly defined and ambiguously related to one another and everyday life. Too often they purport everything, while in fact they explain very little (p. 124).

The generation of Grounded Theory relies upon the inquiry of the researcher. It requires the researcher to conceptualize the essence of specific processes by gathering data about how people react to questions directed at "lived experiences" (Hutchinson, 1988, p. 125). Theories are generated by culminating and categorizing individual's reactions to these questions. Grounded Theories are guided by the assumption that people make sense out of their environments and develop patterns of meanings and behavior (Hutchinson, 1988). From an educational perspective, Richer (1975) contended Grounded Theory research can produce theories which closely mirror the social reality of the school and are, therefore, more useful than speculative theories that are not data based.

Glassner and Strauss (1967) suggested several criterion for researchers who generate grounded theory. In order for theories to be applicable to the practitioner, theories must fulfil certain specifications. The researchers suggested theories must: (a) closely fit the substanitive area in which they will be used, (b) be readily understandable by laymen concerned with the area, (c) be sufficiently general to be applicalbe to a multitude of diverse daily situations, and (d) allow the user at least partial control over the structure and process of daily situations.

Semi-Structured Telephone Interviews.

Many modern qualitative researchers have used semi-structured telephone interviews to collect data. Semi-structured interviews pose a series of questions and require an informant to base his or her responses upon personal experience. In practice, the questions are not Yes or No in nature, rather they are open-ended (Hutchinson, 1988). Merriam (1988) found most typical qualitative studies used a semi-structured interview process because it allowed

informants to fully express their perceptions regarding focal issues. Semi-structured interviews also allow the researcher to maintain a consistent approach in obtaining statements throughout the entire data collection process.

The use of telephones to collect responses to experiential questions has increased since the 1970's (Mishler, 1991). Researchers agree that numerous advantages such as lower cost, high-quality responses, and speed in collecting data were contributing factors to this momentum (Gorton & Carr, 1984; Lindsay, 1982; Mishler, 1991; Mitchell & Jolley, 1988). These experts also found the telephone interviewing method has advantages over the highly-revered personal interview style. According to Mitchell and Jolley (1988), interviewer bias is actually reduced because the interviewers do not see the informants as they respond to questions. The interviewer can't influence informants' responses with subtle visual clues (Gorton & Carr, 1984).

Summary

As our nation's educators turn to new solutions in the teaching of mathematics, school science, and technology education, key institutions have committed funds to interdisciplinary programming and research projects. In an effort to create educational environments reflective of the professional world, several enlightened curriculum developers have taken a pro-active stance to generate change. Policies and benchmarks generated by agencies such as the National Science Foundation (NSF) and the National Aeronautics and Space Administration (NASA) have also fueled the entire momentum.

From a historical perspective, interdisciplinary theories were developed through the works of Dewey (1916) in the early part of this century and through the continued efforts of researchers during the 1990's. The middle school movement, established by a commitment to address the special learning needs of adolescent students embraced the interdisciplinary philosophy from day one (Alexander, 1968). Research suggested teachers who have participated on interdisciplinary teams involving mathematics, school science, and technology

education are excited about the changes that are taking place in middle schools (LaPorte & Sanders, 1993).

The philosophical base to educate American children using interdisciplinary teaching methodologies in middle schools began with the work of John Dewey and the Progressive Education movement over sixty years before middle schools came into being. A pendulum effect, where interdisciplinary learning was emphasized as a successful tool in making education more relevant to adolescent students was advised in the early part of this century and later reversed in order to emphasize the importance of skill-building through the departmentalization of school subjects. In the 1990's, a renewed look at interdisciplinary learning, particularly in the subjects of mathematics, school science, and technology education has been advised by national teacher and principal organizations, middle school experts, and funding agencies in the state of Virginia and at the national level.

Taken together, *Pathways to Excellence* (FCCSET, 1993) and *Project 2061* (AAAS, 1989) demonstrated an acceptance at the national level to recognize technology education as a valuable partner to ensure educational achievement within the United States. Throughout both projects' documentation; mathematics, school science, and technology education were repeatedly mentioned together when demands called for securing successful educational practices. The key terminology resonated throughout the documents revolved around "problem solving" and "technology-centered" activity building.

An examination of the perceptions of middle school principals provided valuable information about the future possibilities to formulate interdisciplinary teams which included mathematics, school science, and technology education teachers. Principals have suggested successful interdisciplinary teams must have time to plan, the respect of the administration, and autonomy. Research findings provided evidence that principals who believed in the effectiveness of interdisciplinary teaming rated their whole school programs significantly stronger than principals who have opposing perceptions of teaming (Mac Iver & Epstein,

1989).

The conclusions compiled by Sevick and Sparapani suggested interdisciplinary teaming practices were welcomed by teachers at the middle school level. Teachers who received training and curriculum guides *did* use this knowledge in the classroom and supported related disciplines in this effort. According to Sevick (1989), most schools have not reached a point where interdisciplinary activity implementation is a common teaching strategy due to a lack of "community" (p. 17) within schools. Therefore, teachers must be pro-active and seek out opportunities which provide the guidance that they need. Similarly, developers of teacher training must take heed in the data collected to better serve the needs of practitioners.

The NSF's Educational Directorate has taken major strides to accommodate the needs of mathematics, school science, and technology education to formulate interdisciplinary activities. In a 1992 keynote address at the Pupil's Attitudes Toward Technology Conference, Dr. Gerhard Salinger posed the question, "Can we develop and implement projects -- design projects – about which the entire curriculum can be integrated?" (Salinger, 1992, p. 45). Apparently the NSF believed it can achieve this ideal. Together the four initiatives; *PHYS-MA-TECH*, the *IMaST Project*, the *T/S/M/ Integration Project*, and *Project UPDATE* served to show teachers at the middle school level have been exposed to interdisciplinary teaching strategies and have enjoyed the experience (LaPorte & Sanders, 1993; Loepp, 1993; Scarborough, 1993; Todd, 1993).

In a commitment to motivate students to pursue careers in aerospace and science-related programs, NASA served mathematics, school science, and technology education teachers through workshops such as *NEWMAST* and *Make The Connection.* In addition, curriculum guides such as *Mission 21* and the research that evolved from the project found educators aligned with interdisciplinary efforts and continued to use the these teaching strategies after receiving materials and training.

The Grounded Theory developed by Glassner and Strauss in 1967, provided qualitative researchers with an additional tool to understand how individuals perceived their world. The Grounded Theory emphasized the development of small, practical theories, rather than grand theories, to describe individuals' lived experiences. According to Richler (1975), theories developed through the Grounded Theory approach are more useful than speculative theories which often appear in educational research.

The use of telephones to conduct semi-structured interviews has aided qualitative researchers in their efforts to collect data. Telephones reduce the time and cost of data collection. Semi-structured interviews give informants the opportunity to discuss their perceptions freely while allowing the researcher to standardize interview questions and the interview process.

Chapter Three

Research Methodology

In Chapter Three, the Grounded Theory qualitative methodology used in this study was explained. The design of this study followed a modified research framework similar to the model discussed by Stainback and Stainback (1984).

A similar model was used by Kamke (1976) in her Arizona State University doctoral dissertation research: *The Role Personalization of Beginning Secondary Teachers: A Grounded Theory Study*. Kamke collated data based on interviews, observations, and the written statements of 11 secondary teachers in a Southwestern metropolitan school district. Through the Grounded Theory methodology, Kamke: (a) conducted a literature review, (b) developed 36 hypotheses based on three major categories of role personalization, and (c) drafted theory relative to select aspects of role personalization.

The research methodology used in this study included several distinct phases. Each phase, shown in sections, is discussed in detail throughout Chapter Three. The first phase identified the scope of the study and research population. The researcher selected 54 middle school mathematics, school science, and technology education teachers. These teachers had previous experience working as members of an interdisciplinary team during the 1992-93 academic year. During the second phase, the researcher explained the data collection instrument used in the study. Phase two included: (a) a brief rationale for selecting the semi-structured interview method to collect data, (b) the development of the actual interview questions based on the original research questions posed in Chapter One of this study, (c) an analysis of interviewer qualifications and techniques, and (d) the generation of a pre-interview informational handout. The third phase included the data collection procedures. A pilot team was used in the third phase to assist the researcher in structuring the interview process. Phase four outlined the researcher's data analysis procedures as recommended by

Grounded Theory qualitative research experts. The researcher used a five part essay format, based on a qualitative technique know as thick descriptions, to examine the data. The analysis process was outlined in the final section of Chapter Three. The actual data was presented in Chapter Four of the study.

Section One: Scope and Research Population

The following section outlines the scope, or purpose of the study, and the research population selected.

Scope of the Study.

The purpose of this study was to develop generalizations based on the perceptions of middle school mathematics, school science, and technology education teachers regarding select aspects of interdisciplinary teaming.

The researcher formulated a semi-structured telephone interview script to aid in understanding the informants' perceptions regarding interdisciplinary teaming. The script focused on four aspects of interdisciplinary activity development and implementation within middle schools. The first aspect examined the three groups' perceptions regarding how the school environment and school administrators influenced interdisciplinary activity development and implementation. The second aspect explored how the three groups perceived the participation on an interdisciplinary team influencing their professional lives. The third aspect analyzed the three groups' perceptions regarding the inclusion of technology education on interdisciplinary teams. The fourth aspect probed teachers' perceptions pertaining to interdisciplinary teams which included mathematics, school science, and technology education.

Identification of the Research Population.

In general, Stainback and Stainback (1984) found the development of qualitative sampling to be extremely flexible. One common method of sampling was referred to as the Purposeful Sample. In purposeful sampling, subjects are included in a study according to

their possession of relevant characteristics or criteria. These characteristics or criteria are determined by the researcher based on an analysis of the data to be collected and the research questions posed in the study.

The researcher used a purposeful sampling method to select the population for this study. The members of the population were selected because they had prior experience implementing an interdisciplinary activity within their school systems during the 1992-1993 academic year. All of the informants participated on a *Make The Connection* interdisciplinary team which included a mathematics, school science, and technology education teacher, and an administrator.

The researcher did not to assess the perceptions of the administrative representatives of the *Make The Connection* teams for two reasons. First, administrative members of the *Make The Connection* teams represented several types of professionals, not just middle school administrators. Of the administrative representatives, 45 percent were middle school administrators, 40 percent were school system administrators, and 16 percent represented other forms of educational expertise (Dugger & Strand, 1993). The second factor in the researcher's decision to exclude the administrators' perceptions was their inability to disclose personal experiences regarding actual classroom practices.

The population for this study consisted of three different groups of educators in the state of Virginia: middle school mathematics, school science, and technology education teachers who participated on a *Make The Connection* team and implemented an interdisciplinary activity during the 1992-93 academic year. A total of 54 teachers met the criterion listed above and were selected to participate in the study.

Pre-Data Collection Preparation

Hutchinson's (1988) research suggested the Grounded Theory qualitative method is guided by the assumption that individuals do, in fact, have patterns of experience and can identify those patterns when interviewed. For this reason, the researcher employed a semi-

structured telephone interview strategy to collect data in an effort to understand the three groups' perceptions regarding select aspects of interdisciplinary teaming. While developing the interview procedure, the researcher drafted the interview questions, determined the required qualifications for an interviewer, and designed a pre-interview informational handout for the study's research population.

Hypotheses and Question Formulation.

The purpose of this study was to develop theory based on three teacher groups' perceptions regarding interdisciplinary teaming. In an attempt to understand how and why middle school mathematics, school science, and technology education teachers perceived select aspects of interdisciplinary teaming, the researcher developed research questions, related hypotheses, and questions to guide a semi-structured interview process. Based on four research question stated in Chapter One, six hypotheses were developed and analyzed in this study. Hypotheses 1-A and 1-B related to the first research question. Hypothesis 2 related to the second research question. Hypothesis 3 related to the third research question. Hypotheses 4-A and 4-B related to the fourth research question.

In the Grounded Theory method, interview or field research questions and hypotheses are developed in an evolving and circular fashion. Hutchinson (1988) and Whitt (1991) suggested research questions are drafted to form hypotheses, just as hypotheses serve to generate additional questions for discovery. For this reason, the researcher listed the actual interview questions used in the data collection component of this study immediately following their corresponding research questions and hypotheses.

Research Question One.

What are the perceptions among mathematics, school science, and technology education teachers, who have participated on interdisciplinary teams, regarding how the school environment and school administrators influence interdisciplinary activity development and implementation?

Hypotheses Set One.

1-A. The three groups will maintain similar perceptions regarding how the school environment influenced interdisciplinary activity development and implementation.

1-B. The three groups will maintain similar perceptions regarding how school administrators influenced interdisciplinary activity development and implementation.

Interview Questions Set One.

1-A. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

Research Question Two.

How does the participation on an interdisciplinary team influence the professional existence of middle school mathematics, school science, and technology education teachers?

Hypothesis Two.

2. The three groups will maintain similar perceptions regarding how participation on an interdisciplinary team has influenced their professional existence.

Interview Question Two.

2. How has participation on an interdisciplinary team influenced you as a teacher?

Research Question Three.

What are the perceptions of mathematics, school science, and technology education teachers regarding the inclusion of technology education on interdisciplinary teams at the middle school level?

Hypothesis Three.

3. The three groups will maintain similar perceptions regarding the inclusion of technology education in interdisciplinary activity development and implementation.

Interview Question Three.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

Research Question Four.

How do middle school mathematics, school science, and technology education teachers perceive interdisciplinary teams and activities which include the three subject areas?

Hypotheses Set Four.

4-A. The three groups will maintain similar perceptions regarding interdisciplinary teams which include the three subject areas.

4-B. The three groups will maintain similar perceptions regarding interdisciplinary activities which include the three subject areas.

Interview Questions Set Four.

4-A. How do you feel about interdisciplinary teams which include mathematics, school science, and technology education?

4-B. How do you feel about interdisciplinary activities which include mathematics, school science, and technology education?

Interviewer Qualifications.

The researcher intended to host the 54 telephone interviews between 6:30 p.m. and 9:00 p.m., Eastern time, on weekday evenings between June 27 through July 22, 1994.

The researcher determined that she was qualified to conduct the interviews after perusing the work of several experts. Lindsay (1982), Moser (1958) and Mishler (1989) found female telephone interviewers have significantly higher rates of interview completion as compared to male interviewers when data are collected in the evening. Lindsay's (1982) research suggested female voices are less threatening during these hours, thus resulting in a greater response rate.

The researcher also felt that her qualifications met Dillman's (1978) requirements for successful telephone interviewers. Dillman determined a telephone interviewer must have three essential communication skills if he or she is to perform assignments with a high degree of success. First, the interviewer's voice should be clear, pleasant, and understandable. Second, the interviewer must have the ability to read through the questions fluently. And finally, the interviewer should be able to respond to the questions which are asked by the informant. Based on her experiences with the *Make The Connection* teams, the researcher was uniquely qualified to respond to the informants' questions regarding interdisciplinary teaming and the study itself.

Pre-Interview Information Handout.

The researcher mailed a pre-interview information handout to the 54 informants on June 20, 1994. (See Appendix A for the front and back sides of the handout.) This mailing was sent seven days before the first evening of the telephone interviews. Similar to a standard cover letter, the handout was designed to inform the teachers about the research project and the upcoming telephone interviews. In developing the pre-interview information handout, the researcher followed several measures discussed in related literature. The works of Gay (1987), Karlman (1988), Mitchell and Jolley (1988), Suskie (1992) as well as Walizer and Weiner (1978) were considered.

The contents of the pre-interview handout overviewed six areas. The first area reminded the teachers of their participation in the March, 1993 *Make The Connection* workshop. It also re-introduced the researcher, Jo Strand, as the research associate for the original workshops. The researcher outlined the need for the study and the teachers' potential role in the research throughout the second area of the handout. The teachers were also given a timeline of when the ten minute interviews would take place. The third area of the handout established the seven step interview procedure. The researcher noted she would seek the teachers' verbal consent for the interviews to be audio taped. The actual interview questions

were found in the fifth area of the handout. The last section of the handout encouraged the teachers to answer the questions honestly and without hesitation. In this area, the researcher included her address and telephone number for those teachers who had questions prior to the interview.

The pre-interview informational handout was accompanied by a printout of each teachers' *Make The Connection* interdisciplinary activity as they appeared on Virginia's Public Education Network [VA's PEN].

Data Collection Procedure

The researcher developed a seven step procedure to collect the informants' perceptions regarding select aspects of interdisciplinary teaming. To obtain the information in a consistent manner, Suskie (1992) recommended the use of a script to conduct the semi-structured telephone interviews. (See Appendix B for the complete script.) With the use of the script, the researcher:

1. Greeted each informant and determined if he or she was available to complete the interview.
2. Determined a suitable time and date for those informants who were not available at that time.
3. Discussed the issue of confidentiality with the informant and asked for his or her verbal consent to tape record the interview.
4. Asked each informant to state his or her name, the date, and his or her approval for the interview to be tape recorded.
5. Proceeded with the semi-structured interview.
6. Asked the informant if he or she wished to receive a transcribed copy of his or her interview.
7. Welcomed the informants' additional comments regarding the *Make The Connection* workshop or additional aspects of interdisciplinary teaming.

At the end of each interview, the researcher thanked the informant on behalf of herself and Virginia Polytechnic Institute and State University. After the interviews, the researcher mailed a hand written thank you note to each informant. If requested, the researcher enclosed a copy of the transcribed interview with the thank you note.

Pilot Team Interview.

The researcher selected one *Make The Connection* team to pilot the interview procedure and the interview questions. Prior to commencing the interviews with the pilot team members, the researcher informed them that she would ask their opinions about the interview procedure and the content of the interview questions after the interview had been conducted. The pilot team interviews allowed the researcher to practice interviewing and using the recording device. Based on the pilot team members' opinions, the researcher restructured elements of the interview procedure and made adjustments to the interview questions.

Data Analysis Procedure

After the semi-structured interviews took place, the researcher used the Grounded Theory described by Hutchinson (1988) to analyze the data. The steps involved in analyzing the data included transcribing the interviews, labeling the informants to ensure anonymity, and presenting the data in a written format.

The researcher transcribed the audio taped interviews into a Macintosh computer word processing format. For reporting purposes, she gave each informant a label which reflected his or her team number and the title mathematics teacher, school science teacher, or technology education teacher.

Based on the research developed by Fetterman (1989), Patton (1990) and Whitt (1991), the researcher used thick descriptions to report the data. The thick descriptions included:

1. What was done to collect the data and why it was done,

2. An analysis of the consistencies and inconsistencies within the data collection process,

3. An explanation of the phenomena studied, and

4. The development of categories for presenting informants' responses.

The perceptions of the mathematics, school science, and technology education teachers were presented in written format as *Make The Connection* Teams one through 18. Each team was represented in a five section essay format. The first part overviewed how and when the researcher conducted the interviews. It also discussed any consistencies and inconsistencies within the researchers approach toward collecting the data. The second, third and fourth sections of the essay detailed the mathematics, school science, and technology education teachers' perceptions respectively. In these sections, the researcher included noteworthy quotations from the teachers to illustrate the phenomena studied. The fifth section summarized the similarities and differences among the three team members.

Summary

Through the employment of the Grounded Theory qualitative research methodology, the researcher developed several phases to collect and analyze middle school mathematics, school science, and technology education teachers' perceptions regarding select aspects of interdisciplinary teaming.

The first phase identified the informants, or the research population, used in the semi-structured interviews. A total of 54 teachers met the criterion developed by the researcher and were selected to participate in the study. Although a select group of school administrators were members of the 18 original *Make The Connection* teams, the researcher did not interview them based on the differences with the administrative group and their inability to present information from a teacher's perspective.

Phase two of the research methodology included four sections. In the first section, a brief rationale for selecting the semi-structured interview method was analyzed to gain

insight into the researcher's strategies. The second section outlined the researcher's strategies for developing the actual interview questions. The researcher analyzed the original research questions posed Chapter One to develop hypotheses. From the four research questions, six hypotheses were developed. Six semi-structured interview questions were structured to focus on the six hypotheses. In section three, the interviewer overviewed the work of several telephone interview experts to establish criterion for successful interviews and for a qualified interviewer. Based on the findings, the researcher determined that the best time to reach the potential informants was between 6:30 p.m. and 9:00 p.m. on weekdays.

The researcher conducted a majority of the telephone interviews between June 27 and July 20, 1994. Prior to the interviews, the informational handout was mailed to each informant on June 20, 1994. Due to professional responsibilities, the researcher was unable to contact six of the respondents between June 27 and July 20, 1995. Therefore, she sent an updated informational handout on January 10, 1995 to the six respondents and conducted the remaining interviews between January 16 and 20, 1995.

The contents of the handout included: an overview of the study, a timeline for the interviews, the interview procedure, information regarding the interviews being audio taped, and the actual interview questions. The researcher included her home address and telephone number for those teachers who had questions regarding the study prior to the interviews. A copy of the teachers' *Make The Connection* interdisciplinary activity were included with the mailing of the handouts.

Dillman's (1978) qualifications for a successful interviewer were analyzed by the researcher prior to the actual interviews. Dillman suggested the telephone interviewer have a clear voice, the ability to read questions fluently, and the ability to respond to questions posed about the study by informants. Section four included the researcher's development of the pre-interview information handout.

The third phase of the qualitative research methodology included the data collection procedures. To glean the perspectives of the teachers regarding select aspects of interdisciplinary teaming, the researcher established a script. With the use of the script the researcher: (a) greeted the informant, (b) determined a suitable time for rescheduling the interviews, if required, (c) discussed the issue of confidentiality, (d) asked for permission to tape record the interview, (e) proceeded with the interview, (f) asked the informant if he or she required a copy of the transcribed interview, and (g) welcomed additional comments from the informants. To aid in developing the interview process and the interview questions, the researcher designated *Make The Connection* Team One as the pilot team. Each team member was questioned after the actual interview about elements of the ten minute telephone conversation.

Phase four of the research methodology outlined the researcher's data analysis procedures. To present the qualitative research to her desired audience, which included present and future interdisciplinary curriculum developers, the researcher used a five part essay format for each of the 18 *Make The Connection* teams. The five parts of the essay included: (1) an overview of the procedures, (2) perceptions of the mathematics teacher, (3) perceptions from the school science teacher, (4) perceptions from the technology education teacher, and (5) a comparison among the team members.

After the comparisons among the three team members were analyzed in each of the 18 *Make The Connection* teams, the researcher examined the similarities and differences among the key phrases in the mathematics teachers' group, the school science teachers' group, and the technology education teachers' group. The six hypotheses established in Chapter Three were then reviewed to determine if the researcher's findings supported or did not support the hypotheses.

Chapter Four

Data Collection and Analysis

The intent of Chapter Four is to summarize middle school mathematics, school science, and technology education teachers' perceptions regarding select aspects of interdisciplinary teaming. The six hypotheses, designed to study the teachers' perceptions, were analyzed at the end of the chapter.

The teachers' perceptions were focused on four aspects of interdisciplinary teaming which included: (a) the school environment and school administration, (b) teachers' professional lives, (c) the inclusion of technology education on interdisciplinary teams, and (d) teams and activities which include mathematics, school science, and technology education.

The teachers selected to participate as informants for this study had previous experience working as members of interdisciplinary teams at the middle school level through the *Make The Connection* workshop series. Their perceptions were culminated in semi-structured telephone interviews between June 27 and July 20, 1994 or January 16 and 20, 1995. The researcher used an interview worksheet to maintain consistency among the interviews. (See Appendix C for interview worksheet.) The researcher had originally planned to complete all interviews by July 20, 1994. However, due to professional responsibilities, she was unable to reach two teams of teachers. Therefore, the researcher conducted six interviews between January 16 and 20, 1995.

After the interviews were completed on January 20, 1995, the researcher transcribed the telephone interviews. (See Appendix D for transcriptions.) To protect the anonymity of the respondents, the researcher selectively edited the transcriptions to protect the names of teachers, principals, and school systems. The researcher did not include conversations between the informants and the researcher that did not pertain to the study.

The researcher collected data from one pilot team and 17 additional teams. A total of 41 teachers' perceptions were recorded from the data component of this study. For various reasons, 13 teachers' perceptions were not included in the study. Telephone records indicated the average interview was nine minutes and 32 seconds in length.

The chapter is divided into four sections.

The first section of the chapter overviewed the pilot team's semi-structured interview results. The pilot team's responses were presented in a five part essay. The first part included a discussion of what was done to collect the data and why. It also analyzed any inconsistencies within the researcher's procedure to collect data from the respondents. The second, third, and fourth parts of the essay summarized the mathematics, school science, and technology education teachers' perceptions. Each of the parts discussed the informants' concerns, feelings, and experiences related to interdisciplinary teaming. In the fifth part, the researcher presented an analysis of key phrases discussed throughout parts two, three, and four. The researcher noted the similarities and differences among the informants' responses.

The second section of Chapter Four summarized the pilot team's suggestions regarding the interview process and the actual interview questions. After the pilot team completed the interview process, the interviewer asked the three respondents to suggest needed changes. The researcher incorporated their suggestions into the data collection procedure for five days before continuing with the next team's interviews.

The third section summarized the 17 remaining *Make The Connection* teams' perceptions regarding select aspects of interdisciplinary teaming. The teams' interviews were discussed in the five part essay structure mentioned above. As the interviews proceeded, the researcher discovered that two of the 17 teams, or six individuals identified as potential informants for the study, had not participated on an interdisciplinary team for various reasons. This experience was a requirement for all respondents of the study.

The fourth section of this chapter analyzed the six hypotheses discussed in Chapter Three. Hypotheses 1-A and 1-B were concerned with the first research question which concerned the school environment and school administration. Hypothesis 2 was concerned with research question two which studied teachers' professional lives. Hypothesis 3 was concerned with the third research question which studied the inclusion of technology education on interdisciplinary teams. Hypotheses 4-A and 4-B were concerned with research question four which concerned interdisciplinary teams and activities. To analyze each hypotheses, the researcher: (a) culminated middle school mathematics, school science, and technology education teachers perceptions, (b) identified key phrases within these perceptions, (c) determined similarities and differences among the key phrases of the teacher groups, and (d) analyzed the hypotheses using the data mentioned above.

Section One: Pilot Team

This section describes the researcher's use of a pilot team to refine the data collection process. The section discusses: (a) the pilot team's perceptions regarding select aspects of interdisciplinary teaming, (b) the pilot team's suggestions about the interview procedure, and (c) the researcher's reactions to the suggestions.

Pilot Team's Interviews.

Team One, the pilot team, developed an interdisciplinary activity about hydroponics. Their perceptions were collected through telephone interviews on June 27 and 28, 1994. The three teachers responded to each of the six questions posed.

The mathematics teacher expressed several concerns about the middle school environment and the inclusion of technology education on interdisciplinary teams in her 12 minute interview on June 27, 1994. She suggested the middle school had been a welcoming environment for teaming and experimentation. In addition, she felt that her principal was supportive of their team because she helped locate materials needed to implement the activity. However, she expressed concern that the team was not given enough time to work

with Virginia's Public Education Network [VA's PEN]. The math teacher was also influenced by the decision to include the special needs students on the students' project teams. When asked about teams and activities which included the three subject areas, the teacher responded:

> The three areas working together is good in theory. I think it will take a mind shift to create teams and projects where the technology teacher is seen on the core level, not the exploratory core level. When we were planning, I felt that his needs were met after mine and the science teachers.

The school science teacher on Team One emphasized the principal's contribution to the activity and the special content of the interdisciplinary activity in his 11 minute interview. He suggested, although they had been given time to plan the activity, he took more paperwork home during the duration of the activity. The teacher also found interdisciplinary activities should be planned after Christmas, and not so close to the end of the year as his team had done. He responded to the question regarding the inclusion of technology education on teams by stating:

> Technology is such an important part of kids' lives. They have been exposed to so much Nintendo and video games. I think that we have found a way to hold their interest.

The technology education teacher representing Team One confirmed aspects of the mathematics and school science teachers' comments during his ten minute interview on June 28. The teacher stated the middle school operated by a team approach and the principal was helpful in attaining needed supplies. He suggested including technology education on interdisciplinary teams was a necessity. Futhermore, he felt the students and teacher enjoyed the interdisciplinary activity. With regard to teaming, he said:

> ...It gives you a chance to develop ideas. I think that I work better with a group of people than by myself. So it's good to bounce ideas off your colleagues. I think that you can get more gone.

The three teachers, representing the pilot team, shared similar and opposing views regarding various aspects of interdisciplinary teaming. The members of Team One recognized they had been given two professional days to develop the activity. However, all team members agreed additional time was needed to plan. The science teacher suggested the principal was not involved with the planning of the activity, but he agreed with his teammates that the principal was helpful in finding the needed supplies. The science and the technology education teachers stated the interaction among the team members had been a positive professional influence. The mathematics teacher was influenced by the inclusion of special needs students in the activity. The three teachers suggested the incorporation of the subjects was a good idea in theory, but voiced concerns about developing a unit which accommodated each subject equally.

The researcher used the same data collection procedure in each of the three pilot team member's interviews. This procedure was outlined in Chapter Three of this study.

Section Two: Pilot Team's Suggestions

The researcher asked each of the three pilot team teachers to discuss any concerns or suggestions they had regarding the interview procedure and the interview questions. A discussion about the opening statements included: the greeting, the guarantee of anonymity, and the statement regarding informants' permission to tape record the interview. The researcher also asked the pilot team teachers' opinions regarding the structure of the interview questions.

The pilot team's opinions were gathered on June 27 and 28, 1994. Between June 28 and July 5, 1994 the researcher incorporated the following suggestions into the data collection procedure.

The first pilot team member suggested that questions 1-A and 1-B should be combined to form one question. She also felt the researcher should combine questions 4-A and 4-B. The researcher incorporated these suggestions and restructured the script. Question 1-A: "How

did the school environment affect your team's ability to develop and implement the interdisciplinary activity?" and question 1-B: "How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?" were asked separately if the respondents did not mention the school administration in their response to question 1-A. Questions 4-A: "How do you feel about interdisciplinary teams which include mathematics, school science, and technology education?" and question 4-B: "How do you feel about interdisciplinary activities which include mathematics, school science, and technology education?" were asked separately if the respondents did not discuss the activities while answering question 4-A.

The second pilot team member suggested the questions were too long. The respondent felt the phrases "develop and implement" could be shortened to simply "implement." He also suggested the terms "interdisciplinary activity" and "interdisciplinary team" should be shortened to "activity" and "team" after the first question. The researcher incorporated the suggestion throughout the data collection stage if she felt the respondents would understand the simplifications. The researcher did not use suggestion if she thought the informants would be confused by the simplifications.

The third pilot team member said the researcher interrupted her when she was speaking. The researcher incorporated this suggestion and allowed more time for respondents to pause and collect their thoughts during the interviews.

Section Three: *Make The Connection* Teams' Responses

Team Two.

Members of Team Two were contacted between July 6 and 14, 1994. Their original project, the CO_2 car, provided the mathematics and the school science teachers with their first opportunity to work with the technology education teacher in developing curriculum.

The mathematics teacher was impressed with the inclusion of technology education on

the interdisciplinary team. In her eight minute interview, the teacher appreciated the idea that other teachers and the school principal were supportive of the team's activity. Throughout the interview, the teacher mentioned how the activity provided the team with practical applications for the students.

The school science teacher found the principal was supportive of teaming prior to the combined mathematics, school science, and technology education team. The teacher felt interdisciplinary teams have the potential to be successful if adequate time is allocated for planning. During the ten minute interview, the informant suggested the team was led by the technology teacher who had presented the activity in his class before. She said:

> Without a doubt, this was the most successful teaming project I have participated on thus far. The technology made it real - tangible. The students brought it home, banged on it, raced it. They didn't just read about it or make a paper model.

The technology education teacher concurred that he had used the CO_2 car in his classroom prior to the interdisciplinary teaming activity. During the nine minute interview, he noted he had taught the math and science elements of the activity on his own prior to teaming with the mathematics and school science teachers. When reflecting on the interdisciplinary activity, he suggested:

> The team was successful because we didn't have to start from ground zero. The CO_2 cars are exciting. My kids just buzz when we move toward race day. With the math and science teachers involved in the activity, it just became so much more practical. They could use their math and apply the principles of science to something they had created. I hope the three of us will work together this year. Maybe on a different project.

The representatives of Team Two held similar beliefs regarding how their school environment and the principal affected the interdisciplinary team. The school had been supportive of teaming prior to the onset of this interdisciplinary activity. According to the team members, the principal supported the teachers by giving them verbal acknowledgments

and setting aside planning time for the team. The three teachers shared the view that teaming was a effective experience because the technology education teacher had used it previously in his classroom. As a result of the original experience, the team members plan to participate on similar interdisciplinary teams.

Team Three.

The members of Team Three worked together to develop an interdisciplinary activity on model rockets. The interviews were culminated on June 27 and July 5, 1994. Team Three was originally selected as the pilot team. However, after interviewing the mathematics teacher on June 27, the researcher was told the technology education teacher had moved to another school system in 1993. The researcher then switched the first and third teams. The switch was done so that the researcher would have the opportunity to interpret the findings of two full teams which included a mathematics, school science, and technology education teacher.

The mathematics teacher was concerned with her school administration's decision to split the original interdisciplinary team up. According to her, the principal "mixed and matched" two sets of teachers in order to create two interdisciplinary teams. The teacher suggested both teams received limited planning time to develop the activities and found themselves planning during their personal preparation times. According to the teacher, the school principal went to the *Make The Connection* workshop with the team, was verbally supportive, and gave the teachers time to use VA's PEN. The teacher suggested the teaming was very time consuming. She noted, "I recognized how much planning interdisciplinary activities take. I didn't think that we had enough time to add it to our schedule." The mathematics teacher felt including the technology teacher on the team added real world application to the activity. When asked about interdisciplinary teams, the teacher added:

> I think they are good, but I would like to see language arts and social studies as well. There are some bigger teams at our school that are really having good results.

The school science teacher was pleased with the support that his team received from the principal. He also confirmed the mathematics teacher's notion that their school had been involved with teaming prior to this experience. The science teacher enjoyed working with the technology education teacher and with another hands-on activity. He said, "I always have on-going projects where students are out of their seats and experimenting. The activity approach is not new to me or to science." The science teacher did express concern that the activity was based on technology education. He "felt cheated in a way" when he "had to skip some neat science to facilitate a technology project."

The mathematics and school science teacher from Team Three shared similar perceptions regarding the school environment and school administration's support of the interdisciplinary team. They said the principal split the original team in order to develop two teams, but supported the teams by giving them some time to plan and time to learn VA's PEN. The school had been involved in teaming prior to the event. The teachers suggested more planning time and rescheduling of classes was need to support the project. The team was positive about how the activity had reached the students. "The kids loved the special attention. The parents were pleased. I received several positive comments from parents. I was glad we did it," reported the school science teacher.

Team Four.

The members of Team Four were contacted between July 6 and 11, 1994. The respondents discussed the differences in teaching styles among the team members and recognized the importance of understanding personalities prior to developing interdisciplinary teams. Together the team members generated a project on solar energy.

The mathematics teacher's interview lasted eight minutes. She was deeply concerned, prior to the activity development stage, that the technology education teacher had an arts and crafts focus. She felt his focus would prevent the team from doing a highly-technological project. However, after the project began, she was more comfortable with his abilities. The

mathematics teacher felt the roles and potential contributions of each teacher should be determined prior to beginning an interdisciplinary activity. Furthermore, the teacher suggested the other members of her team had vastly different approaches to teaching. She reported:

> The science teacher and the technology teacher don't follow their books. They both have several activities designed for team teaching purposes. Not that their classes aren't well-planned, they are. I just feel that we need to cover certain units before the students move on...

The school science teacher discussed her concern for the lack of planning time the team had to implement the activity. She said she "became frustrated because [she] did a lot of the planning on [her] own.'" The school science teacher also suggested the principal was not involved with the project. She noted this may have been due to the fact that a special education teacher represented the administrator at the *Make The Connection* workshop. When asked how she felt about interdisciplinary teaming activities, the teacher said, "It's interesting for the students and the teachers. I hope the math teacher, and the new technology teacher will be interested in trying something similar."

The technology education teacher on Team Four suggested the "biggest hurdle was finding time to plan." According to the informant, he had to miss a great deal of the team planning time because the team met in the morning when he had additional duties. He found the principal was only available when asked and didn't actively participate in the activity development. He shared the school science teacher's teaching style and noted the mathematics teacher's lack of interest in teaming did negatively affect the overall project. The technology education teacher returned to the high school in 1994-95 after having taught three years with the middle school. He felt the new technology education teacher was hired because he had a background in computers.

The representatives of Team Four shared similar perspectives regarding the school environment and the school administration. The teachers agreed, due to the technology

education teacher's additional duties, the planning time was limited. The three also found the principal unsupportive. However, the team members agreed, interdisciplinary teaming activities which include the three subjects, are interesting, needed, and practical. Despite the challenges the team members faced, each respondent suggested he or she would be interested in working on a similar team in the future.

Team Five.

Members of Team Five were interviewed on July 11 and 12, 1994. The mathematics teacher was not available to be interviewed. The researcher could not contact her in her attempts throughout the months of July and August 1994 and in January of 1995. The team of teachers developed an interdisciplinary project on magnetic levitation vehicles.

The school science teacher brought out the concerns that the teachers did not share the all of the same students. She felt this had contributed to the scheduling difficulties the team faced. However, the teachers did share a limited number of students. According to the informant, the principal assisted the team by taking responsibility for students who weren't a part of the interdisciplinary activity. She also suggested the teaming opportunity was important to the teachers because their school system was changing from a junior high to a middle school approach. The school science teacher was influenced by the students' interest in the activity. According to her:

> They [the students] looked forward to us [the teachers] coming in. In fact, I had students that asked me, the next year in my classes and individually. They were anxiously awaiting more. That motivation is great to see and that they learned that much from it. And enjoyed it. They made it very enjoyable and they made it very worthwhile for me.

The technology education teacher also suggested the team members did not share the same students. He commented about the principal's commitment in support of the team by covering his classes when he was working with the interdisciplinary students. The technology education teacher suggested the use of interdisciplinary activities was timely to the middle

school. He stated that he had participated in several discussions about interdisciplinary teaming throughout the summer of 1994 due to implending systemic changes within the school. The technology education teacher felt, although the teaming of mathematics, school science, and technology education was new to the them, the students demonstrated the ability to be innovative. He stated:

> Our school has active technology invention fairs and science fairs. Students are used to following a creative planning process to design, implement, and test things. The math element was the new spin. We don't usually connect much in-depth math to the technology, in such detail. The students seemed surprised by how much math applied to technology.

The school science and technology education teachers representing team five shared a handful of students. As a result, the teachers had to not only schedule to work with the students but also had to schedule time to create an activity for them. However, the principal was instrumental in substituting his time in support of the activity. Both teachers suggested his support was helpful in implementing their activity on magnetic levitation. The two informants representing Team Five agreed, teams which include the three subjects help students apply subject material to tangible projects.

Team Six.

The school science teacher representing Team Six was contacted on July 7, 1994. After the researcher greeted the informant, the teacher immediately told the researcher that her team did participate in a *Make the Connection* workshop, but did not work together to implement the class activity posted on VA's PEN. The informant felt the main reason her team did not work together was because the technology education teacher was located in a different middle school. According to the school science teacher, she was disappointed by the team's choice to not complete an activity together. When the researcher questioned whether she had participated on an interdisciplinary team after the original *Make The Connection*

workshop, the informant said that she did not have additional opportunities to do so.

According to the respondent, the activity posted on VA's PEN by Team Six was developed during the two hour car ride immediately following the *Make The Connection* workshop in Blacksburg, Virginia. The activity was augmented by the mathematics teacher prior to posting it on VA's PEN. The administrative representative of the team, a special education teacher from the school district, did not ride with the team and did not participate in the development of the activity.

The researcher thanked the teacher for her honesty and information after the three minute conversation. Based on the information presented by the informant, the researcher did not contact the mathematics or technology education teachers on Team Six.

A qualitative and quantitative research study of those *Make The Connection* teams that did not post an integrative activity was developed by Dugger and Strand in 1993. This information provided similar findings to those stated by the school science teacher representing Team Six. The researcher felt contacting the other members of the team would be a replication of the previous publication and would not provide information relative to this research study.

Team Seven.

The three members of Team Seven were interviewed between July 6 and 13, 1994. The team's technology education representative was actually a media and computer specialist. The computer specialist assisted the team with understanding VA's PEN. The team completed an interdisciplinary project on kite flying.

The mathematics teacher reported the principal was an active part of Team Seven. The principal assisted with the planning of the project. When asked about teaming, the informant suggested large teams can become too "complex to manage." According to her, the team with three teachers was the right size for the school and the activity. The mathematics teacher commented on the dynamics of the team during her nine minute interview. She said:

Our working relationship, the teams, was good. We got along and that made a big

difference. That's important for a team. I worked with a committee this fall, multi-disciplinary, and we never seemed to get anything done because we didn't have anything in common. The science, technology teacher, and I had similar teaching styles...

The school science teacher agreed that the principal was a part of the team during his ten minute interview. The principal provided encouragement and worked with the team. The teacher also felt the interdisciplinary team had positively influenced him. He recognized the value of integrating math and science with computer technology. When asked to respond to his feeling about teams which included the three subject areas, he stated:

I think it's good for student to see them work together. I think a lot of times in the classroom a student will say, "This is science, I can forget everything else." So to realize education includes all of these aspects. You use all of these in the classroom. Science in the science classroom is not just science. You need time to put it all together.

The technology education representative of the team, a computer specialist, explained the teaming situation during her eight minute interview. According to her, she facilitated the research of their activity, "Go Fly A Kite." She also assisted the students as they drafted their kite designs on personal computers. She suggested the principal was active with the team. The administrator's participation on the team was influential because it allowed the principal to see what the teachers were capable of developing. The teacher found the interdisciplinary activity to be a positive project. She recalled her experience on the final day of the kite flying activity:

The day was special. It was education, middle school, the last two weeks before summer. Yet, it was bigger than that. All of the subjects, together really in a field. There must have been over 100 kites flying, and some not flying, that they had designed. [They] studied the scientific aspects, the math, designed it, built it. I remember at the beginning of the planning we thought we should give awards to certain kites; most

creative design, biggest, you know. It wasn't necessary. I think it would have ruined the beauty of it...

Team Seven was comprised of a mathematics teacher, a school science teacher, and a computer specialist. The team was supported by the principal who had originally attended the *Make The Connection* workshop. The team found time to plan after school for approximately two weeks prior to the kite day activity. The team welcomed the use of VA's PEN and depended on the computer specialist to lead them. The three members agreed that the interdisciplinary activity made learning "real."

Team Eight.

Team Eight worked together to design and implement a balloon launch interdisciplinary activity during the 1992-93 school year. The team's mathematics and technology education teachers were contacted on July 14, 1994. The science teacher was not interested in participating in the study. When she was contacted, she did not wish to answer questions regarding the study nor did she wish to be tape recorded. The informants suggested the administration, or the school principal, did not get involved in the activity. According to the technology education teacher, the principal was not available to contribute because he was looking for a replacement after he would retire.

The mathematics teacher found it hard to bring an additional project into her teaching day. She reported:

> The hardest thing was finding the time for an extra project within the school day. We choose to do it through the students' exploratory time block because they were all in their technology time at the same time. That meant the science and math teacher, me being the math teacher, had to give up our free time for about two weeks to work with the students. Now that doesn't really sound like a lot, but in the course of the school day, it gets to be tiring. If there were a way to work out a time that we were all free to work with the students, it would have been more convenient...

The mathematics teacher also expressed concern that the principal was not involved in the activity. However, the informant suggested he was helpful in allowing the students to go off school grounds to launch their balloons. The teacher was interested in working with the team again. She thought it would be helpful if workbooks or teachers' manuals were published with interdisciplinary activities already planned.

The technology education teacher enjoyed the opportunity to work with the team. He confirmed the mathematics teacher's suggestion that the activity was developed during the exploratory or technology period. He also agreed with the mathematics teacher as he discussed the principal's lack of participation. The informant was professionally influenced by how advanced the students mathematics abilities were. He stated:

> I didn't realize how advanced some of the students can get in seventh grade math. I always have some students who are bright, but the students who don't take my seventh grade offering are sharp. They added a neat balance to the group of students. I often forget how many students are involved in the other elective subjects. It was the first time I have worked with 60% of those students.

The mathematics and technology education teachers shared similar perceptions regarding when and where the activity was developed. They also found the principal was not an active participant on the team due to his preoccupation with finding a replacement for his position. The mathematics teacher and the technology education teacher both expressed an interest in doing another interdisciplinary activity. The mathematics teacher suggested teachers' manuals containing helpful ideas for developing interdisciplinary activities, are needed. She said:

> I'm sure that there are great ideas out there. If somebody, or a team of people, could get together and say, "Look here, ideas that you can do." Kind of write a text book or a course manual that would show ideas of how you could bring science and math into these difference projects. I think that would be very helpful because you're beginning

to see rocket launches and balloon launches a lot. Some of the other projects that I saw seemed kind of far-fetched. They didn't seem very practical.

Team Nine.

The mathematics, school science, and technology education teachers representing Team Nine were interviewed on July 14 and 18, 1994. The team members developed an interdisciplinary project about the airplane business. The team executed the project in May, 1993. The were concerned about the lack of materials available to them at the end of the academic year. As a result, the team created a scavenger hunt to acquire additional materials.

The mathematics teacher suggested the seventh grade students and their parents were "thrilled to be a part of an experimental activity." The math teacher also added the technology class was "the glue that held the activity together." During her interview, the informant noted it takes a new teacher a few years to develop his or her teaching abilities before becoming an active member of a team. She recalled:

> It was the first time I hard worked on an interdisciplinary project. I spent my first two years at the school trying to get my bearings and be creative with math. I felt I was ready to work with the science and technology teachers when we went to the workshop and started planning the activity.

The school science teacher expressed her concern for the team's lack of planning time. She acknowledge the principal's assistance in motivating the team and stated:

> Our principal was a great contributor. Toward the end of the year, it's always hard to requisition equipment and supplies. We usually have to be conservative with our material. With this project, because it was new to our school, we received additional materials, which was a relief. You'd hate to plan something, like the airplanes, and then not have the materials to build them...

The technology education teacher's interview lasted nine minutes. The teacher commented about the principal's commitment to the activity. The principal assisted with the

materials and gave verbal support to the team. The teacher found that the activity took a great deal of additional planning time. It was suggested that the next activity be planned earlier in the academic year, rather than toward the end. The teacher mentioned he felt the school was a fun environment. He stated:

> The middle school is always such a fun environment to try new ideas. I think the project was so well received because the kids were so excited about it. The smartest thing we did was to get the parents involved right away in the beginning. Right at the planning stage. We sent home requests for household supplies. I made the assignment kind of like a scavenger hunt.

Members of Team Nine were in agreement about bringing the parents into the school environment. The three teachers also agreed, the principal had participated with the team and assisted in gathering materials. The technology education component was also alluded to as an instrumental aspect of the activity. The teachers found the activities developed by the mathematics, school science, and technology education teachers to be innovative and effective in creating an interest in learning.

Team Ten.

Team Ten developed and implemented an interdisciplinary activity about bee hives. Their perceptions were culminated in interviews between July 13 and July 20, 1994. The team had a difficult time planning and leading their students. This was due to two factors: the first being the technology education lab was on the opposite side of the building and the second was that the teachers did not share a similar planning period.

The mathematics teacher found the principal was not supportive of the project. She stated:

> The administration was not as supportive of the project as we hoped he would be. When we started the project, the principal was fine, but he didn't really show an interest in the project. In other words, he understood what we were doing and that was fine. But,

when we asked him to come see it and when the newspapers came to take pictures, none of the administration showed up. I mean, we had the kids there, which was great, but you didn't have...You felt like you worked hard. Not that you wanted a pat on the back, yet you didn't see the enthusiasm when the project was completed.

The mathematics teacher felt teaming was important, however she said teams should be self-directed and small in size. She added technology is needed on teaming activities as well.

The school science teacher confirmed the idea that the technology education teacher had limited time to participate on the team due to scheduling and proximity issues. In his nine minute interview he also discussed his concern for ordering materials.

What really surprised all of us was the materials that are needed. When you take on a project in your own classroom, you'd expect it to come out of your budget. Where does the money for materials come from when there are three different teachers, different subjects, working on one project? Is it divided three ways? That was an unexpected issue.

The mathematics and school science teacher decided to pursue the bee hive project together after the difficulties they had experienced with the technology education teacher's schedule. However, the science teacher felt the bee hive project didn't have the "dazzle" the second year because the technology education component was important to the team.

The technology education teacher's interview lasted ten minutes. He expressed his disappointment over not having a schedule suitable to work with the team. He taught only in the high school after the project was over in 1993. The teacher reported he spent a great deal of time preparing in the high school teachers' lounge and felt at home there. According to the teacher, he views technology education as an interdisciplinary subject by nature. He also suggested he wasn't necessarily sold on the idea of interdisciplinary teaming.

The activity was exciting, but I don't think you have to form a team to be interdisciplinary. A creative teacher should have the ability to step away from a lesson and recognize there is, or can be, other supplemental subject matter within a unit. We use technology to solve mathematics problems, computers, simple calculators. And science and technology go hand in hand.

Team Ten was faced with the challenge of working with a technology education teacher who had a different teaching schedule and a classroom far from the school science and mathematics teachers. According to the informants, the school principal was not as supportive as the team had originally hoped he would be. The team members also seemed disappointed when the principal didn't attend a showcase presentation of the bee hive activity. The team members recognized the benefits of interdisciplinary activity development, but found the planning and scheduling of such activities cumbersome.

Team 11.

The members of Team 11 developed an interdisciplinary activity for their middle school students on the subject of rocketry. The mathematics and technology education teachers' perceptions were gathered on July 15 and 20, 1994. Both interviews were nine minutes in length. The school science teacher had been selected to teach at the governor's school during the 1993-94 academic year. As a result, he had moved to Richmond, Virginia and had an unlisted telephone number at the time of the interviews.

The mathematics teacher felt fortunate to share the same planning periods with the school science and technology education teachers. She admitted the school principal was not supportive of their teaming activities. However, she remained optimistic about interdisciplinary teaming and expressed her desire to work with a similar team in the future. When asked how she perceived the inclusion of technology education on interdisciplinary teams, she replied:

The technology part of the project drew the math and science part together. The kids were receptive to the math in my class, but they put it together in the technology class.

I'm glad I came into the technology classroom to help them with the hand tools....It's a great age for activities like that.

The technology education teacher noted the team members had worked on planning committees prior to the activity, but had never developed curriculum as a team. According to him, the principal did not get involved with classroom activities. The team felt, because this activity was new to the school, the principal might have shown more interest. The technology education teacher was influenced by the teaming process. He stated:

Teaming is very positive for me. I often feel like I'm on the outside of curriculum planning, looking in. I think the other teachers, even those who weren't on the team, saw technology in action for the first time.

The technology education teacher also found the success of interdisciplinary teams depends on the personalities of teachers and the group of students. He noted, "The year we did the rocket activity we had a great bunch of kids. Last year, I don't know if we could've pulled it off."

Although the principal was not supportive of the team, the fact that the members shared a common planning time may have been the key to the team's success. The three teachers worked with the same group of students in the technology lab to design and construct the rockets. Fortunately the team members found the personalities of the fellow members similar to their own and agreed, teaming was a positive experience. The two teachers interviewed felt the shared content among mathematics, school science, and technology education subjects provides a worthwhile environment for teaming activities.

Team 12.

Members of Team 12 were interviewed on July 18, 1994. The team's original mathematics teacher was not available to be contacted due to an out of state commitment during the summer of 1994. The school science teacher and the technology education teacher were available to discuss their activity, rafter testing and home construction. When the

researcher attempted to contact her in January, 1995, she found the number disconnected. The mathematics teacher's answering machine noted that she would be working at a summer camp through mid-August.

The school science teacher was available for a brief interview which lasted five minutes. During the interview, she expressed her concern for the team's lack of planning time to develop the interdisciplinary activity. She found the principal helpful. She said the administrator ordered additional supplies and materials when the team had miscalculated their needs. She found that students who aren't involved with technology education during the year were exposed to it during the interdisciplinary activity. When asked how she perceived interdisciplinary teaming, she responded:

> I think it's fine. But, I think you need to have a common planning period. In the middle school, with the exception of the exploratory teacher, the regular core teachers had two planning periods. Where the exploratory teachers, or the technology teachers, only had one. And that was designated as their personal planning time. And I think in order to be effective, that person would have to plan with the team.

The technology education teacher was extremely pleased with the school principal's support. The respondent suggested:

> Our principal worked with us from beginning to end. He was helpful in getting the school involved. When we were actually working with the rafter construction, he helped us determine what we needed and drove to the lumber yard to get it. I was so impressed with how he helped us, it made us feel needed.

The technology education teacher representing Team 12 noted the school was not conducive to planning the interdisciplinary activities because the teachers didn't share planning time. The teacher enjoyed working with the core teachers because he felt alienated from them during the year.

Team 12 expressed deep concern for the lack of planning time. The principal, however, was supportive of the teaming. According to both the school science and the technology education teacher, he measured, calculated, and retrieved needed supplies and materials. Both informants found those students who did not have the opportunity to work in the technology education lab did have that opportunity during their interdisciplinary activity. They felt including technology education on the team allowed the technology education teacher to take part in planning with other teachers, which is rare in their school system.

Team 13.

Members of Team 13 were contacted on July 6 and 15, 1994. The team members developed a CO2 car activity for their students during the 1992-93 academic year. The three team members shared several insights regarding select aspects of interdisciplinary teaming.

According to the mathematics teachers, the school environment was good for teaming. She felt the school's decision to create a team out of the school science, social studies, English and mathematics teachers, prior to this activity, provided a springboard for this project. According to her, the school administration was helpful because interdisciplinary activity development was expected as a part of the curriculum. She was professionally influenced by the difference among the teaching styles of her teammates. She said:

> It made me bite my tongue sometimes. One of the guys was a first year teacher and I have been teaching for 20 years, so I had to not keep saying, "That's not going to work," and let him keep trying by himself. It was hard to back off and let them do the things that I thought I could get across better in my classroom. The main problem that I saw during the teaming was discipline. I felt that the other teachers were not as good of disciplinarians as they could have been when the large group of kids got together for the project.

The mathematics teacher felt technology education was vital to teaming because it allowed her students to be more inventive. However, she suggested it was a challenge to

balance the three subjects equally. She noted:

> It was hard to find one activity that included all three subjects on the same day. A lot of times, I would have to give them the background math, and then the students would do the science experiment, and then we would go to the technology classroom and do the experiment in the lab there. It takes a lot of research.

The school science teacher representing Team 13 shared similar perceptions regarding his team's interdisciplinary activity. He felt the school's decision to create pods of students and teams of teachers made this type of teaming approach particularly innovative and timely. He also found the principal supportive and an advocate of interdisciplinary teaming. When asked how he viewed the inclusion of technology education on teams, the school science teacher suggested:

> Technology is an important element of the teams. It was a needed course offering at the middle school here. The technology teacher was very open to adjusting his plans. Whereas it was harder for us, the math teacher and I, to develop a project that wouldn't interfere with our schedules.

The technology education teacher was new to the school system during the year he participated in the activity. He felt the principal was responsible for creating an upbeat perception of teaming among the teaching staff. He also noted the mathematics and school science teachers themselves were very receptive to technology education as a subject. He said, "When I suggested the CO2 car project, the math and science teachers both jumped right in." The technology education teacher also felt the idea of building activities with the three subjects offered students applied problems. His sentiments were similar to those of his teammates.

The members of Team 13 were positive about their interdisciplinary activity development experience during the 1992-93 school year. The teachers found the school environment excellent for teaming because the principal expected specialty educational programs from

them throughout the year. The three informants suggested the inclusion of technology education on the teams was beneficial to their students because it allowed them to apply all subjects to one activity. Furthermore, the teachers felt teams and activities which include the three subject areas are innovative, and reflect real-world problems.

Team 14.

The researcher contacted the mathematics teacher from Team 14 on July 12, 1994. The school science teacher explained to the researcher that her team did not work together to develop and implement an integrative activity within their school. The integrative activity posted on VA's PEN was developed and implemented by the technology teacher within his own classroom.

The mathematics teacher representing Team 14 believed her team did not implement the interdisciplinary activity because the team procrastinated and ran out of teaching days at the end of the 1992-93 academic year. When asked if the team implemented the interdisciplinary activity during the 1993-94 year, she responded that the school science teacher had retired from education. She suggested an interdisciplinary activity may have been too overwhelming for the first year school science teacher who had taken the place of the retiree.

After the four minute conversation with the mathematics teacher, the researcher thanked the informant. The researcher did not contact the technology education teacher for his perspectives regarding why the team had not implemented the interdisciplinary activity. His comments would have been a replication of the study conducted by Dugger and Strand in 1993.

Team 15.

The teachers on Team 15 were contacted on July 6 and 15, 1994. The members of Team 15 had mixed reactions toward their interdisciplinary activity development experience because the original school science representative of the team did not take part in the project wholeheartedly. Furthermore, the team members mentioned the school principal did not

assist the team with the activity development process. The technology education teacher on Team 15 had moved to another school system prior to the interviews, therefore, the researcher was not able to contact him for this study.

The mathematics teacher discussed the school environment, their school principal, and various other aspects of interdisciplinary teaming during her eight minute interview on July 15, 1994. The teacher mentioned the original school science representative of the team, a life science teacher, shared the responsibilities of the school science component with a physical science teacher. As a result, the scheduling of team planning was more difficult because four teachers' daily routines had to be considered. The mathematics teacher found the principal was not helpful with the teaming process. She said he was needed to order additional supplies, but did not assist the team. When working with the technology education and school science content, the mathematics teacher said:

> I learned a lot about technology. I haven't worked with the technology teacher other than coach the soccer team. It was a certainly a first for me to be in the technology classroom. I learned some physical science. When we were planning the project, we had to go over what each other was teaching. I tried to reinforce some of the science in my classroom.

The mathematics teacher found teaming to be worthwhile. She suggested it was helpful that the members of the team were friends prior to working with the interdisciplinary activity.

The school science respondent representing Team 15 was the life science teacher who attended the *Make The Connection* workshop. During her nine minute interview, she acknowledged the difficulties the team faced by adding the physical science teacher to the team. She also agreed with the mathematics teacher's perceptions that the principal did not help the team develop the activity. She suggested teaming worked only if the teachers had good "people" skills. She said, "you have to be able to work with other people. You have to be broader minded and go outside of your exact discipline to fit with other things. It makes

you more broad minded."

The school science teacher suggested the inclusion of technology education on teams is practical. She also noted technology, math, and physical science apply to each other.

The mathematics and school science teacher representing Team 15 found teaming worked well if: (a) the teachers shared similar schedules, (b) principals assisted in the activity development, and (c) the team members enjoyed working with each other in general. These respondents felt their principal did little to assist them in their teaming efforts. They also suggested technology education adds practicality to teaming projects and felt interdisciplinary teaming benefited students in several ways.

Team 16.

Members of Team 16 were contacted on July 7, 1994. Together the teachers developed a moon settlement activity. Both the mathematics and the technology education teacher were available to be interviewed. The school science teacher had retired from teaching prior to the summer of 1994 and did not have the same telephone number as listed by the *Make The Connection* registration data.

The mathematics teacher felt the school environment was negatively influenced by the teachers' ambivalent attitudes toward teaming. She felt the original team was not very cooperative. After the original team activity, the teacher joined a different interdisciplinary team which included a special needs, or inclusion teacher. Furthermore, she felt the principal was not particularly helpful with teaming, even though the school called for interdisciplinary activity development in its curriculum plan. She found technology education was a much needed addition to the team, but suggested her new team did not include the subject. She said:

> Right now, the technology is not a part of the new team. And that's something that our team would like to encourage on our own - not make it official. The team concept is maybe something that we would work with the technology teacher on. But, I think that the teams are new at our school. And we're trying to introduce a few things at a time,

and I don't know if we're really ready for technology to be added.

The technology education teacher representing Team 16 resonated several comments made by the mathematics teacher. He found their school environment encouraged teaming, but the principal was not helpful in scheduling team planning or adding to the teaming process.

When asked about teams which include the three subjects, the teacher stated:

> I did see a lot of value in technology being on the team, we all did. It's the school. It's that we've been charged with creating a teaming environment. The core teachers are off and running. I see them planning for the new year already this summer.

The mathematics and technology education teachers representing Team 16 found the team lacked a cooperative feel. They also suggested the principal encouraged creative teaming, but was not supportive of this team in particular. Both teachers noted the inclusion of technology education on the team was enjoyable and effective. However, they admitted it was unlikely the technology education teacher would participate in similar activties in the future, simply because he was not a member of the preexisting core planning team.

Team 17.

Members of Team 17 were contacted on January 16 and 18, 1995. The original school science teacher felt her comments would not be valid in this study because she only facilitated the mathematics and technology education teachers in the activity development. According to the school science teacher, the satellite activity developed by the team did not apply to her curriculum, therefore she did not teach it in her classroom.

The mathematics teacher on Team 17 suggested their school environment was conducive to teaming because the team members shared similar planning times. She also found the principal helpful in locating supplies, linking the satellite, and attending the opening day presentation. The informant felt her relationship with the technology education teacher influenced her professionally. She noted:

The technology teacher had some great ideas. He was skilled in the use of satellites. I think he has one at home because he lives so far out. I had never realized the opportunities, the math content, that's available on the educational channels. I didn't realize how much science related to the satellites.

The mathematics teacher representing Team 17 found teams which include technology education to be "active" and able to develop hands-on approaches for students.

The technology education teacher's interview was nine minutes long. During that time, he resonated several comments made by the mathematics teacher and felt particularly knowledgeable of the middle school mathematics component because he had taught the subject for 15 years prior to moving into the computer technology teacher position. He suggested the school environment and the school principal were positive influences on their teaming experience. In addition, the informant found working with the team to be worthwhile. He felt teams which included the three subjects fit together, and stated:

> Well, they definitely tie in. It's about time we start teaching kids the practical aspects of it. So many of the kids, you tell them something about science in math class and they say, "This is math, this isn't science, why do we have to hear that in here?" The more you can get across that all of these things cross over and tie into your everyday life. That's what makes life. It's not compartmentalized.

The members of Team 17 suggested the school environment and the principal were helpful in creating their interdisciplinary activity. Both teachers noted their school could use more activities, similar to the one they had developed. Furthermore, members of Team 17 found working on teams to be a worthwhile venture because it tied the subjects together and broke down compartmentalized barriers between the subjects.

Team 18.

The researcher attempted to contact representatives of Team 18 between January 18

and 20, 1995. The mathematics and school science teachers were interviewed on January 18, 1995. The researcher attempted to contact the technology education teacher on the evenings of January 18, 19, and 20 but, was unsuccessful. The members of Team 18 implemented an activity about hydroponics in their school. during the 1992-93 academic year.

The mathematics teachers felt the school environment and the administration were not particularly helpful as the teachers attempted to implement their activity. According to her, the students' conflicting schedules only allowed the mathematics and school science teacher to work with two classes, or 25 students each. She felt the principal's "hands-off" approach was not helpful to the team. According to the mathematics teacher, their school was a middle school in theory, but a junior high school in practice. She felt this was due to the departmentalization of the disciplines within the school The teacher felt adding technology education to the middle school team was important. She noted, "It should be mandated. It shouldn't be an option." The respondent suggested interdisciplinary activity development should be a serious effort which includes the core and related arts subjects such as technology education. She indicated interdisciplinary teaming is not a standard practice within their school. She stated, "It's a lot of talk and a lot of hype. But, it's rhetoric. It ain't happening."

The school science teacher reflected similar perceptions as those stated by her mathematics colleague on Team 18. She noted the difficulties the teachers' had in scheduling their students and securing the administrations' assistance. She was also concerned the team did not have enough time to work on the project:

> I don't really feel like we go into it long enough to make any long range plans. The way it was scheduled, we could only work it into part of our classrooms and not all. Even at best.

In addition, the school science teacher felt the inclusion of technology education on interdisciplinary teams was exciting for her students. She also noted the subjects of

mathematics, school science, and technology education complimented each other but take a great deal of planning.

The mathematics and school science teachers representing Team 18 shared similar perceptions regarding selected aspects of interdisciplinary teaming. According to the two teachers, the school environment was not conducive to teaming because the students' schedules were not flexible. The teachers suggested the principal was not particularly helpful with the development and implementation of the project. They felt they needed his assistance in scheduling students and allowing for additional project implementation time. The teachers also noted their participation on the interdisciplinary team did not influence their professional lives because they did not have enough time to work with their students, the activity, or the team. However, members of Team 18 suggested the inclusion of technology education on teams increased students' interest in the overall project. Both teachers perceived interdisciplinary teams, which include the three subjects, as good in theory, but required a great deal of additional time.

Section Four: Summary of the Six Hypotheses

The following section summarized the six hypotheses developed for this study. Each hypotheses is followed by a statement supporting the findings. A narrative analysis details the mathematics, school science, and technology education teachers perceptions regarding select aspects of interdisciplinary teaming.

Hypothesis 1-A.

The mathematics, school science and technology education teachers maintained similar perceptions regarding how the school environment influenced interdisciplinary teaming.

Regardless if mathematics teachers perceived their schools as environments conducive to interdisciplinary teaming, a majority of teachers perceived finding time to plan as a major

concern. Data indicated mathematics teachers planned the design, development, and implementation phases of their interdisciplinary activities on their own time. Teams met before school hours, after school hours, and during their personal preparation time. Teachers felt successful teams should be provided with planning time, specifically allocated for the interdisciplinary activities.

A majority of school science teachers reflected similar perceptions. The group believed the school environment would provide a more favorable arena for teaming if additional planning time, during regular school hours, were allocated to interdisciplinary teaming activities. School science teachers also noted that the technology education teachers, elective subject teachers, did not teach all of the same students as instructed by the mathematics and school science teachers. As a result, more planning time was need to structure students' schedules.

The technology education teachers resonated the mathematics and school science teachers' perceptions regarding the need for more planning and scheduling time. According to this group of teachers, they are viewed as elective or exploratory teachers in schools. As a result, they do not participate on core planning teams which include the mathematics and school science teachers. The technology education teachers suggested their participation on interdisciplinary teams required additional team planning time. Findings also suggested the technology education teachers' personal planning periods did not coincide with the other members of the team. In addition, the technology education teachers noted those teams that were given some additional planning time to prepare the activity by their school principals still needed more hours to further develop it.

The three groups of teachers reflected similar perceptions regarding how the school environment influenced interdisciplinary teaming. The teachers felt they needed additional planning time to develop and implement the interdisciplinary activity. Regardless if the

teachers who served on the teams shared similar planning periods, the teachers met before school, after school, or during their personal preparation time to plan.

Hypothesis 1-B.

The mathematics, school science, and technology education teachers maintained similar perceptions regarding how school administration effects interdisciplinary teaming.

The mathematics teachers cited their principals as the representatives of the school administration who most influenced interdisciplinary teaming. Teachers found principals should provide teams with four distinct means of support. First, the principals should verbally acknowledge the additional efforts of those teachers who serve on interdisciplinary teams. Second, interdisciplinary teams suggested a lack of planning time inhibited their performance. Therefore, principals who are interested in supporting interdisciplinary teams should provide the teachers with additional time to plan or alternative teaching schedules to accommodate planning. Third, additional materials and supplies are needed to implement interdisciplinary activities. Teachers suggested their school principals should provide additional funding or resources for the activities. Lastly, principals should show an interest in the interdisciplinary teaming by attending events which relate to the activities.

A majority of school science teachers concurred with the mathematics teachers' perceptions regarding how school administration affects interdisciplinary teams. They found it was not necessary for the principals to actively participate in the development or implementation of the activities. However, the school science teachers felt it was imperative for principals to assist in allocating supplies, providing encouragement, and attending interdisciplinary teaming related activities. The school science teachers also found it helpful when principals set aside additional planning time for the interdisciplinary teams to meet during the school day.

The technology education teachers resonated similar perspectives regarding how the

school principals influenced interdisciplinary teaming. The teachers agreed it was not imperative for the principals to be an active partner on the teams but they should consider several actions to support the teachers. The actions mentioned were similar to those stated by the mathematics and school science teachers.

The three groups of teachers found the principal was the school administrator who most influenced interdisciplinary teaming. The mathematics, school science, and technology education teachers suggested it was not imperative for the principal to serve on the interdisciplinary teams during the development or implementation stages of the activities. However, the teachers said it was imperative that the principals support the teams. The principals' support was needed to acquire additional materials and to schedule planning time. Teachers also suggested principals should provide verbal acknowledgments for teaming contributions and should represent the school administration at activity-related events.

Hypothesis 2.

The mathematics, school science, and technology education teachers shared similar perceptions regarding how participation on an interdisciplinary team influenced their professional lives.

The mathematics teachers' group found interdisciplinary activities increased their awareness of school science and technology education curriculum. Working with the team allowed the teachers to share information and study the content of other subjects. The mathematics teachers found themselves rediscovering principles of science and learning, in a broader sense, how technology education fits into the middle school environment. The mathematics teachers also discussed the importance of working with a group of teachers who had similar personalities and common educational goals.

The school science teachers found teaming with the mathematics and technology education teachers enjoyable. The group stated the development and implementation of the

activities provided an interchange of subjects. The teachers saw, first hand, how mathematics, school science, and technology education were related. Similar to the mathematics teachers, the school science teachers found it important to serve on teams where the teachers shared similar teaching styles. According to the school science teachers, it was imperative for teams to have a good working relationships.

A majority of technology education teachers found interdisciplinary teaming activities enhanced their understanding of mathematics and school science curriculum. The technology education teachers expressed their appreciation for being included on a team with the mathematics and school science teachers. The teachers also commented that teaming called for effort to develop educational units which equally balanced the content of mathematics, school science, and technology education. Technology education teachers felt this balance was achieved by those teams that worked well together.

The three groups uncovered several issues when discussing how interdisciplinary teaming had influenced their professional lives. The mathematics, school science, and technology education teachers found the experience increased their awareness of each others' subjects. The activities allowed the teachers to understand how the three subject areas shared content. The teacher groups also suggested the success of interdisciplinary teams hinged on team members' personalities. Teams were deemed successful if the teachers felt they had similar teaching styles, agreeable personalities, and common educational goals.

Hypothesis 3.

The mathematics, school science, and technology education teachers maintained similar perceptions regarding the inclusion of technology education on interdisciplinary teams.

The mathematics teachers' group found the subject of technology education was a necessary element of teaming. The teachers stated the technology education component

sparked students' interest and maintained their interest throughout the interdisciplinary activity development and implementation.

School science teachers supported the mathematics teachers' group perceptions. The school science teachers felt technology education was the key to holding students' interest. The teachers stated the technology education component made the interdisciplinary activity fun for the students and enjoyable to teach.

The technology education teachers' group found the technology element to be a new source of interest for many of the students. According to the teachers, it was the first time many of the students worked in the technology education lab. It was also the first time several of the mathematics and school science teachers planned curriculum with an elective core teacher. Overall, the technology education teachers valued adding their subject material to interdisciplinary teamed activities.

The three teacher groups found the inclusion of technology education subject materials on interdisciplinary teams worthwhile. The groups perceived technology education as a vehicle for attaining and maintaining students' interest while participating in interdisciplinary activities.

Hypothesis 4-A.

The mathematics, school science, and technology education teachers maintained similar perceptions regarding interdisciplinary teams which included the three subject areas.

A majority of mathematics teachers' group suggested interdisciplinary teams which include the three subject areas are good in theory. According to these teachers, the three subjects share common themes. However, the mathematics teachers stated that these teams must balance the content of mathematics, school science, and technology education fairly. No one subject area should be the focus of the activity. The mathematics teachers suggested when this balance has been achieved, teams offered students and teachers a strategy to apply

the three subjects to one problem or project.

The school science teachers also found it imperative for teams to develop an interdisciplinary activity which fairly emphasized each subject area. Teams worked well together when the teachers equally shared ideas to develop practical activities for their students.

The technology education teachers found most interdisciplinary activities focused on the technology education component of the activity at the onset of the activity. They found the school science and mathematics units were often developed after the activities had been deemed feasible by the technology education teachers. These teachers also found the activities practical for their students. The stated the inclusion of technology education made the activities more reflective of the world outside of school.

The three teacher groups suggested teams which include mathematics, school science and technology education are practical learning activities. The mathematics and school science teachers found most interdisciplinary teams selected an activity which focused on the technology education content initially. The mathematics and school science content elements were developed after the technology education material. According to the three groups, it was necessary to achieve a consensus among the team members to ensure no subject received more focus than the others.

Hypothesis 4-B.

The mathematics, school science, and technology education teacher groups maintained similar perceptions regarding interdisciplinary activities which included the three subjects.

The mathematics teachers found the experience in developing and implementing the activities enjoyable for the middle school students. According to the teachers, the students were able to apply to mathematics and school science content to the actual development of the products derived from the activities. The teachers perceived the application of the two

subjects in the technology education laboratory to be the most enjoyable aspects of the activity.

The school science teachers' group stated similar perceptions to those of the mathematics teachers regarding interdisciplinary activities. The teachers found the students enjoyed the opportunity to develop hands-on projects. The application of the subjects in the technology laboratory or classroom provided students with a place to put all of their ideas and knowledge together.

The technology education teachers stated the interdisciplinary activities were practical. The teacher group suggested the activities provided students with an opportunity to apply their knowledge and skills to one project. Furthermore, the teachers found the students' enjoyed participating on the activities because they were viewed as "real world" activities rather than unapplied, book-oriented problems.

The three teacher groups maintained similar perceptions regarding interdisciplinary activities. The teachers found the activities provided students with the opportunity to apply mathematics, school science, and technology education. In addition, the three groups resonated the notion that the students enjoyed participating on the activities. Although the teacher groups held positive perceptions regarding activity development, few teachers suggested they planned to develop similar projects in future academic years.

Summary.

In an effort to understand selected aspects of interdisciplinary teaming, the researcher conducted semi-structured interviews with middle school teachers. A total of 41 teachers, including: 15 mathematics, 12 school science, and 14 technology education representatives completed an interview. This represented 76 percent of the original population. Although the researcher intended to host 54 interviews, 13 teachers did not participate in the study for various reasons.

In order to collect data from each respondent consistently, the researcher established a framework based on previous Grounded Theory studies. The researcher: (a) sent a pre-interview information hand-out to 54 teachers, (b) conducted the telephone interviews with the use of a script, and (c) transcribed each audio taped interview. The researcher selectively edited the transcriptions to protect the anonymity of the respondents.

After the interviews were transcribed, the researcher noted the similarities and differences among the mathematics, school science, and technology education teachers' groups. The researcher had previously developed four research questions and six hypotheses to direct the research investigation.

Findings indicated the mathematics, school science, and technology education teachers maintained similar perceptions regarding selected aspects of interdisciplinary teaming. They shared views regarding: the school environment and school principals, how teaming influenced their perceptions of other subjects, the importance of including technology education on interdisciplinary teams, and the benefits of interdisciplinary teams which included mathematics, school science, and technology education.

Chapter Five

Discussion and Conclusions

The intent of this chapter is to create generalizations based on selected aspects of interdisciplinary teaming. The researcher developed seven generalizations. The generalizations were designed to assist present and future interdisciplinary curriculum developers in their quest to serve the needs of middle school mathematics, school science, and technology education teachers.

The chapter is divided into five sections. Section one summarized: (a) the purpose of the study, (b) the four original research questions and six hypotheses, (c) the study's theoretical framework based on a literature review, and (d) an analysis of the data collection procedure. The second section summarized the research findings. Each research question and its relevant hypotheses were discussed in detail. The researcher also identified uncontrolled conditions which may have influenced the results of the findings. The third section discussed the research findings. The researcher compared the study's results to related middle school interdisciplinary teaming studies and projects. The researcher also recognized how the limitations of the study may have influenced the results. The researcher developed generalizations regarding select aspects of interdisciplinary teaming in the fourth section of this chapter. The theories culminated the study's findings and related research. Section five of the study outlined the implications for curriculum developers. The researcher discussed how curriculum developers could better assist mathematics, school science, and technology education teachers in developing interdisciplinary activities. The sixth section of the chapter examined recommendations for further study.

Section One: Purpose, Research Questions, Theory, and Data Collection

Middle school philosophers have insisted interdisciplinary activities develop students'

imagination, self-discovery, and interpretive skills. According to research, participation on interdisciplinary teams assists teachers in recognizing the value of other subject areas within the school. Teaming also allows teachers to break down compartmentalized barriers among related subjects such as mathematics, school science and technology education (Blishen, 1970).

Although the benefits of interdisciplinary team teaching have been argued since the early 1900's by John Dewey and others; studies indicated by the early 1990's, less than half of all middle school students participated in interdisciplinary course work (Aikin, 1942; Epstein & Mac Iver, 1987).

Purpose of the Study.

As curriculum developers work to create interdisciplinary teaming programs, they must ask, "Why do a majority of American teachers, who have resources which support the benefits of interdisciplinary teaming, continue to present subjects independently?" Perhaps a key to answering this questions lies within the perceptions of those middle school teachers who have participated on interdisciplinary teams. These individuals may have the insight which will allow curriculum researchers to culminate the information and support required for interdisciplinary teaming.

Specific questions regarding: (a) how interdisciplinary teams are affected by the school environment and school administration, (b) how participation on an interdisciplinary team influences teachers' professional lives, (c) how the inclusion of subjects such as technology education influences team structure, and (d) how interdisciplinary teams and activities function when mathematics, school science, and technology education are included. Four research questions and six hypotheses were developed as a result of this study to understand the question stated above.

Research Questions and Hypotheses.

The researcher in this study developed four research questions and six hypotheses to understand teachers' perceptions regarding interdisciplinary teaming.

Research Question One.

What are the perceptions among mathematics, school science, technology education teachers, who have participated on interdisciplinary teams, regarding how the school environment and school administrators influence interdisciplinary activity development and implementation?

Hypotheses Set One.

1a. The three groups will maintain similar perceptions regarding how the school environment influenced interdisciplinary activity development and implementation.

1b. The three groups will maintain similar perceptions regarding how school administrators influenced interdisciplinary activity development and implementation.

Research Question Two.

How does the participation on an interdisciplinary team influence the professional existence of middle school mathematics, school science, and technology education teachers?

Hypothesis Two.

2. The three groups will maintain similar perceptions regarding how participation on an interdisciplinary team has influenced their professional existence.

Research Question Three.

What are the perceptions of mathematics, school science, and technology education teachers regarding the inclusion of technology education on interdisciplinary teams at the middle school level?

Hypothesis Three.

3. The three groups will maintain similar perceptions regarding the inclusion of technology education in interdisciplinary activity development and implementation.

Research Question Four.

How do middle school mathematics, school science, and technology education teachers perceive interdisciplinary teams and activities which include the three subject areas?

Hypotheses Set Four.

4a. The three groups will maintain similar perceptions regarding interdisciplinary teams which include the three subject areas.

4b. The three groups will maintain similar perceptions regarding interdisciplinary activities which include the three subject areas.

Theoretical Framework Based on Literature Review.

In the 1990's, Americans demanded academic reform in light of falling standardized tests scores in mathematics and school science. It was at that time when a focus on alternative teaching strategies catapulted interdisciplinary teaming into the limelight. Mathematics, school science and technology education teachers were charged with the task of creating curriculum which was practical and more hands-on (Apple, 1992).

New educational standards from the National Council of Teachers of Mathematics [NCTM] and the National Council of Science and Technology Education [NCSTE] required students to become problem solvers. Benchmarks from the American Association for the Advancement of Science's [AAAS] *Project 2061* suggested the educational curricula presented in the United States must be representative of a highly technical environment, where mathematics and science are applied to students daily lives rather than simply presented in an abstract manner (AAAS, 1989).

The history of interdisciplinary activity development and implementation extends

back to John Dewey's work in the 1920's and 1930's. It continued to evolve though the 1990's. Educators in Dewey's era, known as the Progressive Education movement, were deeply concerned that American education catered to those bound for college (Aikin, 1942). To counter that notion, 30 experimental schools radically changed their curriculum to focus on interdisciplinary activities and cooperative learning in the 1930's. Although the 1930's experimental project was lauded as creative and innovative, many non-traditional educational programs were dropped by 1940 to produce a workforce suited to fulfill the needs of World War II (Haney, 1990).

Teaching strategies in the 1950's reflected a commitment to compartmentalized mathematics and science education. With the flight of Sputnik, national agencies such as the National Science Foundation, worked diligently to prepare teachers with increased mathematics and science skills. Once again, school programs were developed to appeal to college bound students (Bybee, 1987).

The emergence of middle schools in the 1960's directed a renewed focus toward interdisciplinary teaching strategies. Educators, such as William Alexander, Ph.D., were committed to develop an alternative school structure that met the needs of students ages ten to 14. With the new school structure, Alexander suggested alternative teaching strategies such as interdisciplinary teaming.

In the 1970's, two educational camps emerged. The first maintained a 1950's fixation for departmentalized learning while the second supported Alexander's idea of subject integration.

During the 1980's and 1990's a continued philosophical split existed. While numerous studies and reports supported the benefits of interdisciplinary activity development at the middle school level, a majority of teachers did not participate on interdisciplinary teams (Epstein & Mac Iver, 1987).

National education committees and agencies alike banded together in the early

1990's to fund interdisciplinary curriculum projects. Noteworthy benchmarks were listed by the Committee on Education and Human Resources [CEHR] under the Federal Coordinating Council for Science, Engineering and Technology [FCCSET] in *Pathways to Excellence.* The document underscored the national government's desire to make education more integrated in nature. Similar reform suggestions were outlined in the American Association for the Advancement of Science's [AAAS] *Project 2061* goals.

Principals' perceptions regarding interdisciplinary teaming were culminated in Mac Iver and Epstein's 1990 report, *Education in the Middle Grades: Overview of National Practices and Trends.* The report analyzed the past, present and expected uses of 22 educational practices. Similarly, teachers' perceptions were summarized in Sevick's 1989 study, *The Ultimate Packet* and Sparapani's (1991) project which studied team teaching strategies.

The National Science Foundation [NSF] and the National Aeronautics and Space Administration [NASA] responded to interdisciplinary teaming demands by funding several curriculum building projects and teacher workshop programs. Those funded by the NSF included *PHYS-MA-TECH*, the *IMaST Project*, *T/S/M Subject Integration Project* and *Project UPDATE.* Projects sponsored through NASA included the *NEWMAST* workshops and *Mission 21. Make The Connection*, a project funded by the Virginia Space Grant Consortium, received indirect funding from NASA's educational budget and direct materials and support from NASA's educational staff. The researcher in this study, a research associate with Make The Connection, selected participants from the project to understand their perceptions regarding interdisciplinary teaming.

Data Collection Procedure.

The researcher choose a qualitative statistics methodology, known as the Grounded Theory, to collect and analyze teachers' perceptions regarding select aspects of interdisciplinary teaming. Educational research suggests qualitative research methods are used to provide an

understanding of a select population's experiences or beliefs. The Grounded Theory process allows researchers to collect and analyze data for the purpose of developing practical theories to be used by practitioners (Hutchinson, 1988). According to research, these theories often reflect social and educational realities (Richer, 1975).

To gather teachers' perceptions, the researcher used a semi-structured interview method. The 1970's marked an increased rise in the use of telephones to collect data in qualitative research. The advantages of using telephones to collect data, as listed by experts includes: a lower cost than personal interviews, high-quality responses, and speed in collecting the data.

A total of 54 mathematics, school science and technology education teachers originally met the researchers' criterion and were selected to participate in the study. However, the researcher later found 13 of the original 54 did not meet the criteria or were unavailible to participate in the study for various reasons. A total of 41 teachers completed the interviews. All informants had previous experience developing and implementing an interdisciplinary activity within their middle schools during the 1992-93 academic year.

Using the Grounded Theory methodology, the researcher collected data through semi-structured telephone interviews. Prior to conducting the interviews, the researcher sent each informant a pre-interview informational handout on June 20, 1994. The handout contained an overview of the study, an outline of the data collection procedure, and a list of the proposed interview questions. A pilot team was contacted on June 27 and 28, 1994. After the pilot team's interviews, the researcher made adjustments to the interview script.

The researcher then completed 35 interviews between July 5 and July 20, 1994. Due to professional responsibilities, the researcher did not contact six of the original respondents during that time. Therefore, she sent out an updated informational hand-out on January 10, 1995 and conducted the remainder of the interviews between January 16 and 20, 1995.

When all of the interviews were completed on January 20, 1995, the researcher

transcribed the telephone interviews. To protect the anonymity of the respondents, the researcher selectively edited the transcriptions to eliminate names of teachers, principals, and school systems.

Each team's perceptions were then reported in a five part essay. These essays included an overview of the research procedures, an analysis of the mathematics, school science and technology education teachers' responses, and a comparison among the three groups. The hypothesis stated in Chapter Three were analyzed based on the comparisons among the three groups. These findings also served as the data used to develop theory in Chapter Five of this study.

Section Two: Research Findings.

The following section analyzes the findings of the four research questions posed in Chapters One and Three of this study. Each research question and its relevant hypothesis or hypotheses were discussed. The researcher also summarized any uncontrolled concerns or issues which may have influenced the results of the study.

Research Question One.

The first research question was studied through the data collected from Hypotheses 1-A and 1-B. Hypotheses 1-A focused on the school environment and 1-B focused on the school administration.

Findings summarized in Chapter Four provided the researcher with data to respond to research question one. Middle school mathematics, school science, and technology education teachers perceived the lack of planning time as the greatest factor which affected interdisciplinary teams. In essence, school environments were not conducive to teaming because the teachers used their personal preparation periods and time before and after school to develop the interdisciplinary activities.

The teachers identified their school principals as the school administrator who most directly affected the interdisciplinary teams. Teachers suggested it was not necessary for

principals to work with the teams to develop and implement the interdisciplinary activities. However, findings suggested principals' support was needed in the form of: (a) offering verbal encouragement to team members, (b) requisitioning needed materials for the activities, and (c) adjusting teachers' schedules to provide more time for the team to develop and implement the interdisciplinary activity. Teachers also suggested the principals should represent the school administration at all interdisciplinary activity-related event or programs.

Uncontrolled Conditions: Research Question One.

Uncontrolled events or issues which may have affected the findings collected as a result of research question one included aspects of the school environment and characteristics of school principals. The school environment was not the same for members of the *Make The Connection* teams interviewed in this study. Aspects of school environments which could not be controlled included: (a) the course and preparation schedules of teachers, (b) the number of students in each school who elected to take technology education as an exploratory subject, and (c) the physical location of the technology education laboratory and its relationship to the mathematics and school science classrooms. Other issues which may have affected the school environment included when the team of teachers choose to implement the activity during the 1992-93 school year and how many supplies and materials were available to the teachers during implementation.

The level of support from the school principals varied among the teams. Although the original *Make The Connection* directorate required each team to have one administrative representative, the representative may have been: a school principal, a curriculum specialist, a teacher, or another school system staff member. As a result, principals may or may not have been exposed to the interdisciplinary teams. Teams located in schools where principals had a greater awareness of the interdisciplinary activities may have received more support from the school administration.

Research Question Two.

The second research question was analyzed through the findings collected by Hypothesis 2.

According to the findings summarized in Chapter Four, teachers' professional lives were influenced through the interaction of the three subject areas. For example, the school science and technology education teachers learned more about the principles of mathematics while developing and implementing the activity. Similar exchanges of information were discussed regarding school science and technology education content. The professional lives of teachers were also influenced by the inclusion of technology education on the team. For most teams, this inclusion represented the first time the technology education teacher had served with the core teachers to develop curriculum. Furthermore, teachers were influenced by the need to balance content among the three subject areas when developing the activity. The teacher groups also stated that technology education was often the focus of the interdisciplinary activities. As a result, the mathematics and school science teachers felt their subjects served to augment the activities which were developed in the technology education labs.

Uncontrolled Conditions: Research Question Two.

The findings of this study may have been influenced by concerns or issues that could not be controlled. Findings suggested some mathematics and school science teachers had previous experience developing interdisciplinary activities with subjects such as language arts or social studies. This may have influenced the teams' abilities to develop and implement an interdisciplinary activity which included the three subjects, mathematics, school science, and technology education. Furthermore, the personalities and teaching styles of the individual teachers may have contributed to the outcomes of the teaming. Findings suggest the teachers were concerned about the technology education unit becoming the focus of the activities.

Teachers indicated this may have been avoided if the teachers had similar teaching and presentation styles or common personalities.

Research Question Three.

The third research question was analyzed through Hypothesis 3.

The teachers perceived technology education as a necessary addition to interdisciplinary teams. Teachers suggested technology education sparks and maintains students' interest throughout the interdisciplinary activity development and implementation stages.

Uncontrolled Conditions: Research Question Three.

Uncontrolled issues which may have affected the findings gathered as a result of research questions three may have resulted from the individuals who worked on the activities. The *Make The Connection* directorate could not control the middle school students who actually participated on the interdisciplinary activities. These students may have been more interested in technology education than average middle school students. Furthermore, the teachers who participated on the interdisciplinary teams may have been exceptional teachers as well. These teachers may have perceived benefits of teaming with a technology education teacher prior to the *Make The Connection* workshop.

Research Question Four.

The fourth research question was studied through Hypotheses 4-A and 4-B.

Findings suggested teachers perceived interdisciplinary activities which included the three subject areas as practical problems for students that are applicable to their daily lives. The teachers found integration of the three subject areas provided students with the opportunity to apply the principles of mathematics and school science to the problems presented in the technology education laboratory or classroom. They also suggested the students enjoyed participating on the interdisciplinary activities because they were experimental and unique.

Uncontrolled Conditions: Research Question Four

The findings culminated to analyze research question four may have been influenced by concerns or issues that could not be controlled by the researcher or the original *Make The Connection* directorate. The personalities of the school administration, other teachers within the school systems, and the teachers who participated on the interdisciplinary teams may have influenced the findings. The teachers and principals' willingness to facilitate the development and implementation of the activities may be directly associated to their personalities, teaching or administrative styles, or miscellaneous factors within the school environment.

It should be noted that the teams were generated by teachers who volunteered to take part in the original *Make The Connection* workshops in March, 1993. The team members may have had predisposed notions regarding interdisciplinary teaming and the development of teams which included mathematics, school science, and technology education.

Section Three: Related Studies.

The following section analyzes similar interdisciplinary teaming research which supported this study's findings. Each research question and its findings are supported by educators' research or the published works of educational associations.

Research Question One.

The teachers in this study indicated the lack of planning time influenced the teams' abilities to implement interdisciplinary activities. Several research studies supported the idea that interdisciplinary activity development demands additional planning time (AAAS, 1992; LaPorte & Sanders, 1993; Mac Iver & Epstein, 1990). Mac Iver and Epstein's (1990) research indicated teachers who participated on interdisciplinary teams needed two planning times during the school day: personal and team planning. Furthermore, teams that participated in the American Association for the Advancement of Science's [AAAS] *Project 2061*, committed considerable time to develop interdisciplinary programming.

This study found teachers who served on interdisciplinary teams expected their school principals to support them in various ways. The teachers required principals' assistance in setting aside time for the teams to plan and for finding needed materials for the activities. Teachers also expected principals to give the team members verbal acknowledgments for their additional efforts and to attend activity-related events. Previous research indicated similar findings (Carnegie Council on Adolescent Development, 1989; Mac Iver & Epstein, 1990; George & Stevenson, 1988; Sevick, 1989).

According to the Carnegie Council on Adolescent Development (1989), principals should support teams as they choose materials and instructional methods for their classrooms. George and Stevenson (1988) found principals suggested teachers must be honored and supported if they are expected to thrive on interdisciplinary teams. Their research found it necessary for principals to: (a) free teachers' daily activity of institutional obstacles, (b) provide teachers with a feeling of ownership, and (c) give teachers autonomy (p. 21). Sevick's (1989) research suggested one of the main reasons interdisciplinary teams fail is because school administrators don't support their efforts.

Research Question Two.

Teachers who participated in this study were influenced by interdisciplinary teaming. Findings suggest their professional lives were mainly affected in two ways. First, the teachers were pleased that they had the opportunity to relearn or explore other subject content. Second, the teachers suggested the interdisciplinary activities they developed focused on technology education content more than the mathematics or school science content. Teachers felt it would be more fair to all team members if the activities balanced the three subjects equally.

Two researchers, Scarborough (1993) and Sevick (1989), disseminated data similar to that of this study. According to Scarborough's research, teachers who participated on interdisciplinary teams became more knowledgeable of their fellow team members' subject

material. Furthermore, the teachers gained personal respect for each other and developed supportive professional relationships. Sevick suggested the teachers she interviewed made references to other subjects during their tenure on interdisciplinary teams. Over half of the teachers who responded to Sevick's study stated they made casual reference to other subjects while working with the team. In both studies, the authors were aware that interdisciplinary activity development focused on one subject area. However, the two studies did not detail teachers' perceptions regarding the imbalance of the subject focus.

Research Question Three.

Teachers interviewed in this study found the inclusion of technology education on interdisciplinary teams sparked and maintained students' interest in learning. Similar findings were generated by proponents of technology education (Bachmeyer, et. al., 1990; Maley, 1989; Savage & Sterry, 1990; Todd, personal communication, August 23, 1993). These researchers found the technological information explosion in the 1980's and 1990's demanded the attention of school children. They also found the relationship among mathematics, school science, and technology education provided a rich ground for hands-on education. NASA researchers suggest technology education provides a vehicle for interdisciplinary approaches. According to NASA's findings, the activities allow students to develop critical thinking and cooperative learning skills (Bachmeyer, et. al., 1990).

Research Question Four.

Findings gathered from this study indicated teachers perceived interdisciplinary activities as practical approaches to education. Researchers representing mathematics, school science, and technology education gathered similar findings. Mathematics professionals found students involved in interdisciplinary activities became better problems solvers. The National Council of Teachers of Mathematics was concerned that students viewed mathematics as a dull subject. As a result, their recent educational standards suggested students must have opportunities to become problem solvers with abilities to apply mathematics skills to real

world settings (Campbell & Bramberger, 1990; NCTM, 1989). The science community gathered similar data. The National Council on Science and Technology Education found the subjects of mathematics, school science, and technology education must be connected during educational activities. Representatives of the technology education arena generated similar studies. Researchers such as Brusic and Barnes (1992) found interdisciplinary activities emphasized critical thinking, creativity, and problem solving skills.

Limitations.

The researcher determined the first limitation, as shown in Chapter One of this study, did not influence the findings. However, the second limitation may have influenced the findings.

The first limitation concerned a small number of potential informants for the study. A total of 18 *Make The Connection* teams chose to post an interdisciplinary activity on VA's PEN. After contacting teachers who represented Teams 6 and 14, the researcher determined the teams' responses were not suitable for this research study. However, data gathered from the interviews indicated mathematics, school science, and technology education teachers maintain similar perceptions regarding select aspects of interdisciplinary teaming. The researcher felt additional interviews, or more informants, would have served to strengthen, not refute the findings.

The second limitation concerned the researcher's decision to omit the perceptions of administrative representatives from the study's data collection. The administrative members of the original *Make The Connection* teams represented various professional capacities. These included: several types of school administrators, various school curriculum directors, various teachers, and staff members. Although the intention of the study was to gather teachers' perceptions regarding interdisciplinary teaming, the administrative representatives may have offered additional insight. Hypothesis 1-B was developed to study how school administrators influenced interdisciplinary teaming. The three teacher groups determined the

teams desired support from their middle school principals. Telephone interviews with principals may have provided information which supported or refuted teachers' perceptions.

Section Four: Generalization Development.

The researcher developed seven generalizations as a result of middle school mathematics, school science, and technology education teachers perceptions regarding select aspects of interdisciplinary teaming. The theories were written to serve practical information for future interdisciplinary activity curriculum developers.

Generalization One.

Teachers who participate on interdisciplinary teams require additional planning time to develop subject content and to work with the other team members.

This planning includes: (a) meeting with the team to select and development the interdisciplinary activity, (b) meeting with the team to balance subject material so that no one subject is viewed as the focus of the activity, and (c) individual teacher development time to structure subject content in support of the activity.

Generalization Two.

Principals who wish to have interdisciplinary teaming within their schools must support the interdisciplinary activity development and implementation process.

Although it is not essential that the principals work with their schools' teams to plan the activities, the principals must support the teams in various capacities. The teachers expect principals to: (a) acknowledge them for their additional commitment of time and innovation, (b) attend interdisciplinary activity events or presentations, (c) allocate additional planning time for teaming, and (d) fund or locate needed materials required to implement interdisciplinary activities.

Generalization Three.

Participation on interdisciplinary teams offers individual teachers the opportunity to

examine the similarities and differences in content among subjects featured on the teams.

Generalization Four.

Teachers' personalities influence the working relationships of interdisciplinary teams.

A team is influenced by an individual teacher's: (a) ability to work with a team, (b) interest in working with the other team members, and (c) flexibility in developing an activity which balances all subjects represented on the team.

Generalization Five.

Mathematics, school science, and technology education teachers who have participated on interdisciplinary teams together view technology education as a subject which promotes students' interests in applying mathematics skills, school science principles, and technological advancement.

Generalization Six.

Technology education teachers have had limited opportunities to participate on interdisciplinary teams with mathematics and school science teachers because they are not viewed as core subject teachers.

Generalization Seven.

Interdisciplinary activities which include mathematics, school science, and technology education provide students with applications to connect school assignments to the world outside of school.

Section Five: Implications for Curriculum Developers.

The generalizations created as a result of this study have several implications for future interdisciplinary curriculum developers. The developers must recognize how the school environment and administration influenced the teams interviewed. Findings indicated the three teacher groups' professional lives were affected by the interdisciplinary experience. Therefore, curriculum developers should create programming which accommodates teachers'

professional development. The three groups also suggested technology education is a needed element of interdisciplinary activities. Curriculum developers need to understand why technology education was so influential. Lastly, interdisciplinary teaming and activity generation was viewed as worthwhile investment in time and materials by those interviewed. Curriculum developers should understand the implications of creating interdisciplinary programs for teachers and their students.

The generalizations developed suggested teachers needed additional time to plan the interdisciplinary activities. As curriculum developers create activities and offer workshops such as Dugger and Strand's (1993) *Make The Connection*, they should alert teachers to the fact that interdisciplinary activity development requires additional planning time. Consequently, teachers should be asked to consider their daily schedules and determine if their personal preparation periods correspond with the other members of the team. School principals who are interested in facilitating interdisciplinary teaming should also be asked to consider teachers' schedules. Findings indicated the technology education teachers' schedules were not conducive to team planning as a rule. Therefore, curriculum developers should point out to teams and principals this potential problem. The implications are clear. In order to facilitate interdisciplinary activity teaming efforts, curriculum developers must alert teachers and their principals to the importance of setting aside enough time for the teams to plan.

The seven generalizations have several implications for curriculum developers who wish to assist principals in supporting interdisciplinary activities within their schools. Curriculum developers must provide principals with an understanding of how teachers wish to be supported while serving on interdisciplinary teams. The teachers indicated it was not imperative for principals to participate on teams, however, several other means of support were expected. When interdisciplinary programs and workshop are created for teachers and principals, curriculum developers must establish forums which allow school principals to

understand teachers' expectations.

The generalizations suggested teachers' professional lives are influenced by interdisciplinary teaming. Curriculum developers must recognize the implications and create programming which reflects teachers' concerns. Teachers found teaming participation increased their awareness of other subjects. As a result, curriculum developers should suggest that teachers designate specific times to learn about the content of other subjects area.

The generalizations indicated subjects must be balanced when teachers attempt to create interdisciplinary activities. Therefore, as curriculum developers create workshops, they should consider presenting model interdisciplinary activities from the mathematics, school science, as well as the technology education perspectives separately. This would allow teachers to better understand the subject content and how to balance it during the activities.

The teachers in this study noted the interdisciplinary activities developed for the *Make The Connection* project had a technology education focus. Although teachers felt technology education was an important element of the teams, curriculum developers must recognize the implications of this trend. Teams should be offered the opportunity to develop interdisciplinary activities which focus on mathematics or focus on school science content. In addition, technology educators should have the opportunity to view their subject content as simply a supplement to the other two subject areas.

The study's generalizations suggested the three teachers groups perceived interdisciplinary activities which include mathematics, school science, and technology education as practical strategies to promote students' interest in education. As curriculum developers generate interdisciplinary projects and workshops, it is imperative that they recognize the implications of integrating the three subjects. The developers must give teachers the opportunity to explore what sparks students' interests. This may be facilitated by gathering the perceptions of middle school students who have participated on interdisciplinary activities and featuring those perceptions at interdisciplinary planning sessions.

Curriculum developers should recognize the implications of this study's findings and the seven generalizations. While serving on interdisciplinary teams, all teachers needs, as well as the needs of school principals, should be met. Interdisciplinary activities which include the subjects of mathematics, school science, and technology education are viewed as innovative, practical experiments. Therefore, curriculum developers should plan informative programs for interested teachers which focus on team building, planning preparation, and other aspects of activity development.

Section Six: Recommendations for Further Research

As middle school curriculum developers continue to create alternative teaching strategies and materials for teachers, they must recognize the importance of integrating mathematics, school science, and technology education. Recent benchmarks, generated by national level agencies such as NASA, the NSF, and the AAAS underscored interdisciplinary activity implementation as a viable strategy for increasing science and technological literacy. Their findings also suggested interdisciplinary activities make mathematics and school science more practical and applicable to students' lives. Additional research must be done to aid curriculum developers in their quests to market interdisciplinary curriculum workshops, projects, and materials for middle school teachers and their principals.

Qualitative and quantitative research must be conducted which aids curriculum developers in understanding several aspects of interdisciplinary teaming. Research should be carried out to understand how science and mathematics teachers perceive the value of technology education in middle school before and after participating on interdisciplinary teams. Additional studies must be implemented which support the development of creative teams or partnerships which include technology education teachers. Furthermore, a study should be considered which outlines how middle school students and their parents perceive technology education and its value in interdisciplinary team activities. Finally, researchers may also consider implementing a series of studies which examine the characteristics of

effective principals when supporting interdisciplinary teams that include mathematics, school science, and technology education.

Pre and Post Teaming Analysis.

Research studies which aid curriculum developers in determining the differences among teacher groups before and after they attend workshops or use educational materials in the classroom are needed.

Although the *Make The Connection* workshops were developed by educators, as well as several individuals representing mathematics, school science, and technology education served as advisors; no steps were taken to determine participants' perceptions regarding interdisciplinary teaming prior to the workshops. After the workshops, the directorate ascertained the teachers' perceptions in three ways. First, workshop evaluation sheets were distributed among the participants to determine immediate reactions to the presenters and the workshop locations. Second, telephone interviews were conducted to determine the perspectives of teachers who did not develop an interdisciplinary activity after the workshop. Lastly, the research associate, Jo Strand, contacted those individuals who served on teams where an interdisciplinary activity was developed and posted on VA's PEN.

Findings suggested the *Make The Connection* respondents in the three evaluative efforts did feel interdisciplinary teaming was worthwhile. However, the directorate was unable to determine if their remarks were based on the *Make The Connection* workshop, experiences prior to this effort, or due to related efforts. Hence, future interdisciplinary curriculum developers may wish to determine the pre-workshop perspectives of participants and compare them to post-workshop perspectives. It would allow for any uncontrollable conditions to be noted and explained in research findings.

Alternative Teams and Partnerships.

Research studies must be developed to determine if mathematics and school science

teachers, who have worked with technology education teachers on interdisciplinary teams, will continue to work with them in the future. Additionally, technology education teachers should be contacted to determine if they have interests in becoming members of teams which include different subjects such as English or social studies.

These creative strategies may include developing larger teams as well as two discipline partnerships. The value of interdisciplinary teams which include mathematics, school science, technology education, English, and social studies should be researched further. In addition, the introduction of interdisciplinary partnerships between mathematics and technology education, or school science and technology education must be considered for further study.

Marketing Technology Education.

Research efforts must be conducted to develop marketing strategies for the purpose of increasing enrollment in technology education courses and to expose all middle school teachers to the subject matter. In this study, technology education was viewed as an elective or exploratory subject by the informants. Technology education competed for students with band, choir, foreign language, or home economics. Several teachers comments suggested technology education seemed to fail at interesting "higher" achieving students, while attracting students from the lower half of the achievement continuum. As a result, the full benefit of interdisciplinary activities, which included the subjects of mathematics, school science, and technology education, was limited to those students who were not in band, choir, and the like.

Methods must be developed through research with aid curriculum developers and technology educators in understanding the mentality of the modern middle school student. Researchers must ask, "How can technology education materials be marketed to increase students, parents, and teachers appreciation for the subject?"

Principals' Roles in Interdisciplinary Teaming.

Additional research is needed to determine the role of school principals while supporting interdisciplinary teams. According to the three teacher groups from this study, school principals were expected to support the teams in various ways throughout the development and implementation of the interdisciplinary activities. Therefore, data which outlines how principals can provide better support should be culminated by contacting principals, students, teachers who have participated in interdisciplinary activities.

Summary

Mathematics, school science, and technology education teachers agree with the idea that creating effective interdisciplinary activities is a worthwhile, yet demanding endeavor. Teachers face the challenges of: (a) balancing the content of all subjects on the interdisciplinary team equally, (b) working with limited planning time and resources, and (c) educating middle school children to meet the scientific and technological advancements of the year 2000 and beyond.

Early attempts to integrate subject matter were made by John Dewey at the turn of this century. At that time, his ideas were challenged by mainstream educators who maintained barriers among the school disciplines. Unfortunately, today's enlightened curriculum developers face similar barriers.

From the Ivy League to small middle schools, the key toward breaking down such barriers is through timely programs and collaboration. Together curriculum developers, teachers, students, and principals can plan innovative interdisciplinary activities for everyone.

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Appendix A

Pre-Interview Informational Handout

Make The Connection

Special Re-Connection Edition • June 17, 1994

The Workshop

In March, 1993, you participated with a team of educators in a *Make The Connection* workshop. *Make The Connection* was sponsored by the Virginia Space Grant Consortium and directed by William E. Dugger, Jr. with his research associate Jo Strand (me). We represent the Technology Education Division at Virginia Polytechnic Institute and State University in Blacksburg, Virginia.

As you may recall, the workshop was designed to introduce your middle school to the benefits of developing interdisciplinary activities which include mathematics, school science, and technology education. Between March and May, 1993, your team developed and implemented an interdisciplinary acitivity in your school. Ultimately, you or a member of your team posted this acitivity on Virginia's Public Education Network [Virginia's PEN].

The Research

My interest in *Make The Connection* continues with my doctoral dissertation research. I am interested in gathering your experiences on interdisciplinary teaming through *Make The Connection* and any activities that you and your teammates have developed since May, 1993.

As a student of technology education, I am particularly interested in how the technology education component of the interdisciplinary activities influences teachers' interactions, activities development, and various other aspects of interdisciplinary teaming. As the daughter of two middle school teachers, I understand how important your perceptions are in influencing future educational program development.

I am hopeful that you and your teammates will participate in my study. I plan to collect data based on your interdisciplinary team experiences through telephone interviews. If you agree to participate in the study, each interview will last approximately ten minutes. You will find the questions we will discuss on the reverse side. In addition, I have enclosed a copy of your team's *Make The Connection* activity from Virginia's PEN to reacquaint you with the project.

I will host the telephone interviews from my home in Minneapolis, Minnesota between June 27 and July 22, 1994. I plan to call your home telephone number between 6:30 p.m. and 9:00 p.m. on a weekday evening or between 9:30 a.m. and noon on a Saturday morning. Your home information was listed by you on the original *Make The Connection* workshop registration form.

Interview Procedure

I intend to follow this procedure when interviewing you and your team members.

1. I will greet you and determine if you are available to complete the ten minute interview at that time.
2. If you are available, we will proceed with Steps 3 through 7. If you are not available, we will determine a suitable time to reschedule the interview.
3. I will then discuss the confidentiality of your responses and ask for your permission to tape record the interview.
4. If you approve of my taping the interview, you will be asked to state your name, the date, and your approval for having the interview recorded on audio tape for educational purposes.

Continued on reverse side.

Procedures (*Continued*)

5. We will proceed with the interview.
6. When the questions have been completed, I will ask you if you wish to have a printed copy of the transcribed interview.
7. At this time you may add additional thoughts or concerns regarding *Make The Connection* or interdisciplinary teaming.

Interview Questions

Based on your teaching experiences, you will be asked the following questions:

1a. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

1b. How did the school administration affect your team's ability to develop and implement the interdisciplinary acitivity?

Consider these issues...
- Was the school environment conducive to planning time, activity development and implementation?
- Were adequate resources set aside for acitivity development and implementation?
- How could the school administration have supported you differently?

2. How has the participation on an interdisciplinary team influenced you as a teacher?

Has participation affected:
- Your abilities to relate to teachers within or outside of your team?
- Your teaching style and abilities?
- Your understanding or appreciation of other subjects areas?

3. What are your perceptions regarding the inclusion of technology education in interdisciplinary acitivity development and implementation?

What are your:
- Positive reactions toward technology education as it relates to mathematics and school science?
- Negative reactions?

4a. How do you perceive interdisciplinary teams which include mathematics, technology education and school science?

4b. How do your perceive interdisciplinary activities which include mathematics, technology education and school science?

Ask yourself...
- Has the experience working with the team been worthwhile?
- Do you plan to develop similar activities in the future?

Thank You!

Make The Connection and interdisciplinary team research has been a major element of my interests as a graduate student while at Virginia Polytechnic Institute and State University and in my home state of Minnesota. I encourage you to recall and share any anecdotes which may aid in illustrating your experiences as an interdisciplinary team member. Please answer the interview questions knowing that your honest responses will serve as guidance for future educational programs.

If you have concerns regarding the study, please contact my home (612) 821-0463 or work (612) 323-0180. My home address is: 3449 Garfield Ave. So., Minneapolis, MN 55408.

I look forward to speaking with you in June or July!

Jo Strand

Appendix B

Interview Script

Interview Script

Hi, May I speak to: _____

If Yes

Hi, this is Jo Strand from Virginia Tech. Recently I sent you a blue information sheet about my doctoral dissertation and the Make The Connection workshops, Did you receive the information?

If No

I'm trying to reach him/her for an interview. Do you know when would be a good time to try back?

_____

Thank you,
Goodbye.

If Yes

Are you available for a 10 minute interview?

For my doctoral dissertation, I am talking to math, science, and technology education teachers about their experiences while participating on interdisciplinary teams in middle schools - *more*

in particular, I am interested in teachers' experiences while working on a Make The Connection project. Do you remember participating in the Make The Connection workshop in March, 1993 and posting an interdisciplinary activity on Virginia's Public Education Network in May, 1993?

Are you available for a ten minute interview about your opinions regarding interdisciplinary teams?

If No, End

If Yes

Before we begin, I want you to know that your name and school will not be connected to your responses in my research documentation. I am interested in your opinions so that I can help future middle school workshop developers create programs that meet your needs.

Would it be OK if I recorded this interview so I can accurately transcribe your responses? Could you please state your name and the date for legal purposes.

Appendix C

Interview Worksheet

Interview Worksheet

Make The Connection Team #	Position: Math Science Technology

Name _____

Phone ( ) _____

Project Title _____

Project Subject _____

Time & Date	Reschedule	Respondent
		_____ Successfully Completed _____ No Answer _____ Informant Not Home _____ Refused to Participate _____ Wrong Number _____ Disconnect
		_____ Successfully Completed _____ No Answer _____ Informant Not Home _____ Refused to Participate _____ Wrong Number _____ Disconnect
		_____ Successfully Completed _____ No Answer _____ Informant Not Home _____ Refused to Participate _____ Wrong Number _____ Disconnect

Questions

Name _____

1a. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

1b. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

2. How has the participation on an interdisciplinary team influenced you as a teacher?

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

4a. How do you feel about interdisciplinary **teams** which include mathematics, science and technology education?

4b. How do you feel about interdisciplinary **activities** which include mathematics, science and technology education?

Appendix D

Make The Connection Teams' Transcribed Interviews

The following pages are transcriptions of telephone interviews conducted by the researcher. The interviews were conducted between June 27 and July 20, 1994 or January 16 and 20, 1995. The interviews were transcribed between July 16, 1994 and January 20, 1995. A total of 41 respondents, representing 16 teams, were interviewed. After contacting representatives of Teams Six and 14, the researcher determined the teams did not complete an interdisciplinary activity within their school systems during the 1992-93 academic year. As a result, six potential informants were dismissed from the study.

Summaries of the transcribed interviews are found in Chapter Four of the study.

Team One: Hydroponics Activity

Mathematics Teacher: June 27, 1994.

1-A. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

Our middle school environment is set up for experimentation. We have been developing different types of teams for the last three years. This is the first time the technology teacher and I worked together. He is very energetic. I would imagine he will be involved in more teaming this fall now that we know where his strengths and interests are.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

She was supportive of the actual activity, but wasn't very helpful in giving us time to learn Virginia's computer education network. There are some valuable tidbits for teachers to use and learn. The trouble is limited modems in our building. She did help us locate the materials that we needed though. We appreciated that.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

The activities inspired all students to participate. Because we divided the students into development teams, we found the inclusion, or special needs students, participated right along with the rest of them. In my experiences with experimental projects, I've found the gifted students usually run with it and the special needs students flounder. I was pleased with the cooperation.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

It's important to show the math part of technology. When I work on teams, I often work with science, but not technology. It's needed. I wish the technology teacher was openly invited to the core or even team planning meetings. He always works with the experimental core. I guess that's the structure of our school.

4-A & B. How do your feel about interdisciplinary teams which include mathematics, science and technology education?

The three areas working together is good in theory. I think it will take a mind shift to create teams and projects where the technology teacher is seen on the core level, not the exploratory core level. When we were planning, I felt that his needs were met after mine and even the science teachers.

School Science Teacher: June 27, 1994.

1-A & B. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

The principal was very helpful. She didn't really participate in the planning, but she did seem interested in the activity. She even found the materials and supplies we needed. I was particularly concerned because we have such limited resources by the end of the year. The planning time was a big concern through. I used all of my personal

planning time to develop the team's idea. This meant I took a lot of work home at night during the three weeks that we took to develop the activity and teach it in our classes.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

I enjoyed working with the technology teacher. I haven't really worked with him since he moved into the middle school. I felt he appreciated working with us. I would like to see it happen this school year again. I think this year we should do an activity in the middle of the year, maybe after Christmas, so that our resources won't be so limited.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

Technology is such an important part of kids' lives. They have been exposed to so much Nintendo and video games. I think we have found a way to hold their interest. They responded well to the actual planting phase of the project, especially when we used the computers to chart the rate of growth.

4-A & B. How do your feel about interdisciplinary teams which include mathematics, science and technology education?

The activity our team developed was more technology oriented. I think the math teacher and I need to become more active in finding a project which parallels our units. I had to teach a lesson again, from almost the early fall, to accommodate the activity. Although my kids were interested in applying the science. I was a little disappointed I couldn't cover new material. It will take more planning, and juggling of units to work in the future. I think it's worth the effort to try though.

Technology Education Teacher: June 28, 1994.

1-A. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

Well we operate on the team approach, so all of us are really used to working on

teams, not this particular team that did this project but, our principal really encourages us to work together. Almost all of this was done after school.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

She's always really supportive of everything that we do. And we had a couple of meetings during the school days, and we were able to get professional days to do that. It was helpful to us that the administration helped us get supplies for the interdisciplinary activity.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

Well it gives you a chance to develop ideas. I think that I work better with a group of people than by myself. So it's good to bounce ideas off your colleagues. I think that you can get more done.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

I think that it's almost a necessity now. I'm in middle school and we try to include technology now in everything that we do because we feel that if we do not give these kids the skills and opportunities, to learn technology, that they will miss out, not just in high school, but in life. I just see the effect that technology has on these children, if they don't start using it now, they are going to miss out on a lot of opportunities.

4-A. How do your feel about interdisciplinary teams which include mathematics, science and technology education?

The three just go hand in hand. So it's easy to incorporate the three.

4-B. How do you feel about interdisciplinary activities which include mathematics, science, and technology education?

We didn't have time that we wished we had to develop the activities fully. But, what we did, we thought was fun and the kids enjoyed it.

Team Two: CO_2 Car Activity

Mathematics Teacher: July 6, 1994.

1-A & B. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

The other teachers in my grade level very supportive. They helped cover our classes when we were working with the cars. The principal was also very helpful. He gave us some additional time to plan, a few days before were started. Still, we could've used some additional time to plan.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

The science teacher worked hard on the project. I learned a lot about physical properties and elements. The technology teacher was extremely creative. I felt the three of us shared our information well and the project was successful. It really changed how I felt about science and technology. I often find myself only planning with the other math teachers. Sometimes I don't realize how interested the kids are in the other subjects.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

The technology teacher was very creative. I could tell his kids enjoyed working with him. I would like to see more of the students in my math classes in technology. Although the other elective subjects, like choir and computers are important, you can see how much my students enjoyed being in the technology lab.

4-A & B. How do your feel about teams which include mathematics, science and technology education?

It is important for students to learn practical applications to math. I would like to participate on team with the science and technology teachers again. I have worked with the language arts teacher and the civics teacher since then, but we didn't build anything. That was really the special focus of our success before.

School Science Teacher: July 6, 1994.

1-A. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

Our principal has always been supportive of teaming. Typically the math and language arts teacher, and even sometimes the social teacher, and I have worked together on simple projects that are more for fun than for learning. I guess. That's why he was so interested in this project, not only because is made us focus on content, but also because it included technology.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

I always enjoy new information and workshops. This activity was so interesting for me because we were led, essentially, by the technology teacher. He had done the CO2 car in his class before, but I think he brushed over the math and barely covered the scientific aspects of the project.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

Without a doubt, this was the most successful teaming project I have participated on thus far. The technology made it real - tangible. The students brought it home, banged on it, raced it. They didn't just read about it or make a paper model.

4-A. How do your feel about interdisciplinary teams which include mathematics, science and technology education?

The teams are fine if everyone has a common planning time. In our school we have teacher teams for every reason. Extracurricular planning, core planning, you name it. This team was successful because we wanted it to happen.

4-B. How do you feel about interdisciplinary activities which include mathematics, science, and technology education?

I enjoy working with other teachers to develop projects. The use of technology

reinforced the math skills tremendously. I remember the speaker that we had at our workshop. He said that many interdisciplinary projects are "window dressing". That stuck in my mind. I wanted to work with a project that was meat and potatoes math, applied science, and technology, I think the CO2 cars required the students to think, measure, and do in all the subjects.

Technology Education Teacher: July 14, 1994.

1-A How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

Our principal has been a big proponent of team projects. Last year I worked with several teachers in short activities. One or two day activities. During the CO2 cars project, the principal allowed me to plan with the science and math teacher, which was helpful. This year I will be working on a project in the fall, maybe it's because of this, I'm not sure.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

Usually I do the cars with my students just in my own lab - it takes about two weeks to go from the design states to the race day. I have always had to give the math, or measurements, and I've never worked too much with the science. It was interesting for me to see the math and science expanded. I never presented much physical science, the theory behind how the gasses make the cars run. And as far as the math, I've often measured the materials myself, and have calculated the miles per hour on race day by computer. Working with the math and science teachers made the project much more involved.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

I enjoyed working with the math and science teachers. I think everyone worked so hard because this type of team was new to all of us.

4-A & B. How do your feel about interdisciplinary teams which include mathematics, science and technology education?

This team was successful because we didn't have to start from ground zero. The CO2 cars are exciting. My kids just buzz when we moved toward race day. With the math and science teachers involved, it just because so much more practical. They could use their math and apply the science to something that they had created. I hope the three of us will working together this year. Maybe on a different project.

Team Three: Rocketry Activity

Mathematics Teacher: June 27, 1994.

1-A. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

The school was not extremely helpful because we were not on the same team the next year, after we went to the workshop. The administration broke up the team so that we could share our information with other teachers in the school and implement several interdisciplinary projects instead of just the one. They took one team and then developed a second team and mixed and matched us. We used our own planning time throughout the day, but we weren't given additional planning time.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

It was the administration's decision to break the team up. The principal went with us to the seminar. He was very supportive and helped us get on the computer. He gave us some meeting time during the school day, which was very helpful.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

I recognized how much planning interdisciplinary activities take. I didn't think that we had enough time to add it to our schedule.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

I think that's important because students see the real world applications. This is the first time that I have worked with the technology education teacher on other committees at school, but this is the first time I have worked with him to develop and plan activities for the students.

4-A. How do your feel about interdisciplinary teams which include mathematics, science and technology education?

I think that they are good, but I would like to see language arts and social studies as well. There are some bigger teams at our school that are really having good results. The students are responding well and their parents. They have a back to school night about their interdisciplinary unit.

4-B. How do you feel about interdisciplinary activities which include mathematics, science, and technology education?

I thought they were good for the students. We are going to use it for the gifted and talented students as a back up resource. We have a gifted and talented teacher right in the building who is always trying to find additional resources for her students.

School Science Teacher: July 5, 1994.

1-A. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

We didn't have enough time to plan. If I were going to work with a similar team again I would ask for more planning time. I think we did procrastinate some. We didn't get started until early April. By then you pretty much have the year planned out to the end. I had to drop an important unit.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

The assistant principal, who came with us to the workshop, was good with Virginia's PEN. He had taken a short class in it during the year. Otherwise I don't know if we would've gotten it on the computer by the deadline. It isn't as easy to use as it should be.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

We do a lot of teaming activities in our school. That year we met daily with all the grade level teachers. The seventh grade teachers met right before lunch period ends. But, the technology teacher didn't meet with us. He teaches seventh and eighth grade, and he

had a class during that time with the eighth grade. I enjoyed working with him. Unfortunately, he left our school.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

Technology is exciting. My students seemed to enjoy working with the technology teacher. But, the real problem is scheduling. I don't see that changing again this year.

4-A & B. How do your feel about interdisciplinary teams which include mathematics, science and technology education?

I always have on-going projects where students are out of their seats and experimenting. The activity approach is not new to me or to science. I liked working on the team, but the activity was technology focused. The technology teacher had used it before, so there wasn't much planning or juggling for him. I felt cheated in a way, that I had to skip some neat science to facilitate a technology project. The key to projects that are truly interdisciplinary is developing them with math and science and technology in an equal balance. If we had more time to create one, I would use it again and gladly work with the team.

The kids loved the special attention. The parents were pleased. I received several positive comments from parents. I was glad that we did it.

Team Four: Solar Energy Activity

Mathematics Teacher: July 11, 1994.

1-A. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

The technology department has been trying to get a toe hold in our school for some time. The teachers, myself included, thought it would be more computer driven. The technology teacher has a more arts and crafty approach. It doesn't seem very technological to me. I was a little skeptical to start the project. I wasn't quite sure how the solar energy project would fit between the technology teacher's model cars and book shelf projects.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

He wasn't too involved. I don't even think he asked us how the project went at any time during those few weeks. The team was self-driven. We has most of the supplies in the technology lab, which was a good thing.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

The science teacher and the technology teacher don't follow their books. They both have several activities designed for team teaching purposes. Not that their classes aren't well-planned, they are. I just feel that we need to cover certain units before the students move on. I didn't see how math fit into the project, other than when the technology teacher was making measurements in his classroom.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

I recognized the importance of including technology after the project had started. The students were interested in applying the math and science to the technology. I think it takes a lot of planning and materials to develop activities like this one. I see the value in it, but it takes joint planning time, which we didn't have.

4-A. How do your feel about interdisciplinary teams which include mathematics, science and technology education?

I would feel more comfortable with team projects, like this one, if I understood exactly how much math is needed to complete them. I felt the math was really an afterthought. The project was about technology, not about math or science. I don't think I would participate in a project like this one again unless there was a greater focus on the units I need to teach.

School Science Teacher: July 11, 1994.

1-A How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

We didn't have time to fully develop the activity. Our team was limited to meeting times because the technology teacher was not available in the morning and I had similar bus duty responsibilities after school. We needed a common planning period or a set time to meet. I became frustrated because I did a lot of the planning on my own.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

The administration wasn't really involved. A special education teacher represented our administration at the workshop in Richmond. They were never exposed to our assignment or the Virginia computer network.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

I was impressed with the information available on the computer network. Since that time I have taken two summer workshops to learn more about how to access and share the information. Our school has limited resources to buy computers and equipment, so I find myself working at home a lot to get what I need.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

Technology is important. I have two kids of my own, twins, in the middle school. They seem enjoy the classes with the technology teacher. I have a feeling that my daughter thought she wouldn't enjoy technology class, but she does. She understands much more about our home computer than I do. They have been on the computer non-stop during the summer. I wish they would get outside more so I can get my own summer school work done. I'm working on my masters degree now, it's been a hectic summer. I'm excited to get it all finished.

4-A & B. How do your feel about interdisciplinary teams which include mathematics, science and technology education?

It's interesting for the students and exciting for the teachers. I hope the math teacher, and the new technology teacher will be interested in trying something similar. I remember being so tired after the project was completed. Sure enough though, students with older brothers and sisters were asking about the solar cooker on the first day back in school the next year.

Technology Education Teacher: July 6, 1994.

1-A. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

The biggest hurdle was finding time to plan. We met before school which was a big problem for me. I have early hall and bus duty, so I had to do a lot of catching up with the other members of the team. I think they did most of the planning without me.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

The principal was there when we asked him to be. He didn't attend the workshop with us, so I think he felt a little distanced by our activity. A time conflict at the last minute

prevented him from attending.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

I really brushed up on my science skills. I saw how the three subject areas cross paths and work together. I found the science teacher and I had a lot of lessons that could be shared. Her teaching style and mine are similar. She doesn't use the book much and I rarely do. She and I have done some teaming together since then. Mostly hydroponics. Unfortunately, the math teacher follows the book diligently - she wasn't really interested in joining us after the original project.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

Technology is an elective subject in our school. Students in band and the foreign languages usually won't take my classes. It was interesting to see those students, in particular, participating in the project. We actually built the solar cookers during technology class and in the science class so all students could work on them.

It was the first time I had worked with the mathematics teacher. The science teacher and I had worked on an extracurricular committee earlier that year. The personalities on teams like these are important. Principals should be aware of that when organizing teams. In fact, teams like these should be organized by the teachers themselves.

4-A & B. How do your feel about interdisciplinary teams which include mathematics, science and technology education?

These activities show students that science and mathematics can be applied and that the technology classes are not just about building and construction.

I'm going back to the high school this year. It's going to be a big change. I enjoyed the middle school too. The teachers seem younger and there seems to have more creative energy. The high school has much better facilities. I'm looking forward to that. The new middle school technology teacher emphasizes computers. I know he was brought on

because he has a lot of experience with them. I just hope the computers don't become the focus of the middle school technology curriculum.

Team Five: Mag Lev Vehicle

School Science Teacher: July 11, 1994.

1-A. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

Well, my administration at school which is my principal, was very supportive of our teaming. And worked with us as much as he possibly could because we did not have a planned period where we could get together and plan. So a lot of our planning had to take place on our own time, which was after school. However, after we met several times and decided what we wanted to do, we decided that we needed to include some our students. And the problem was that we each taught different grade levels and achievement levels.

We were looking at themes that we could incorporate together. Fortunately, we were able to schedule the kids that the math teacher and the technology education teacher and I together. We were able to work within the time periods where we could switch off and take different classes. And that required our principal to let us get out of our one of our classes and to come in and be with another class and take turns sharing the responsibility with those kids. It was quite a coordination problem, particularly with us having different levels to teach. I taught eighth and ninth, and the math teacher taught eighth and the technology eduation teacher taught all of ninth. As far as the coordination, most of that was done on our own time, because the school schedule was just not set up for it.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

He was very supportive in, number one, trying to let us spend as much time as we could with our interdisciplinary class.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

Oh, it's influenced all of us tremendously. I think all of us were able to see how the

science and math really are coordinated together. And we were able to bring that together for the kids. And for once the kids could see the importance of how math applies to science and how science applies to math and how important it is in the technology.

They looked forward to us coming in. In fact, I had students that asked me, the next year in my classes and individually, when you and [the other team members] were going to get together. When are you going to get together to do such and such. They were anxiously awaiting more. That motivation is great to see and that they learned that much from it. And enjoyed it. They made it very enjoyable and they made it very worthwhile for me.

I think that I can see lots of applications for math. I think that sometimes math people are more zoomed in on a curriculum that narrows them to a great extent. I think projects like this one can open them to see that they can fit this in to something in science.

But what really helped me was that I could teach the students something applicable. I could get the student's to relate to it. I could say [the science teacher] when she is talking about Newton's law, and you're talking about formulas, they knew how to work it out when they went to the science class, what Newton was in math and science. It meant the application of them being able to actually test the mag lev vehciles and being able to see it. We built the model and were able to use all of the principles that are true to every day life.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

I feel very positive about it. We will be a full fledged middle school for the first time. I think that our new middle school style will allow for teachers to have planned teaming periods. Where you can get together to make a plan and organize. And you are working with those people just to do that and you will have the time to organize and get your materials.

4-A. How do your feel about interdisciplinary teams which include mathematics, science and technology education?

I feel very positive. Coordination of information, team planning, planning of what you can use to keep your students' interested.

4-B. How do you feel about interdisciplinary activities which include mathematics, science, and technology education?

I'm looking forward to getting new ideas. I think that teaming is going to help us a lot. This was really the first time that we got together and it was all on our own time. Especially with families, it was hard. Teaming is an essential plus for us. To be able to have the three together in the middle school. So that we can come up with some more applications. To show our children what is out there in the world and they can be able to use it. We need to make school more useful to them. On all levels, not just for those that are going off to college. I think that we need to gear our education to the skilled workforce and we can do that through this interdisciplinary education. I hope it's going to be more productive for us and I hope that we can use it more in the next few years. It has not been available to use in the old schedule.

Team Seven: Kite Flying Activity

Mathematics Teacher: July 6, 1994.

1-A. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

Our working relationship, the team's, was good. We got along well and that made a big difference. That's important for a team. I worked with a committee this fall, multi-disciplinary, and we never seemed to get anything done because we didn't have anything in common. The science and technology teacher and I had similar teaching styles. We were all interested in using the computer network in our classrooms, not only for the project but in general. That brought us together more than the project planning at first. We were interested in the contents of the computer network, the different types of hotlines - or sub-directories.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

The principal was on our original team, she made every effort to work with us. We spent about two weeks after school planning with her. She used to be a teacher, so she was helpful and had some solid ideas that we used.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

I've never been a team type. I've always found it a little easier to work by myself and contribute to teams and committees after the fact. Teams have to have similar personalities, common goals. This one worked out.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

We used this project as a pilot. It was never intended to be a part of our annual curriculum. But we used it again last year and it will be used again this upcoming year. Technology made it interesting. I do build models in my math classes, but it isn't the same.

Technology is needed. Not just the computers, but the whole gammit.

4-A. How do your feel about interdisciplinary teams which include mathematics, science and technology education?

The multi-disciplinary approach that we have used in the past is just too complex to manage. Too many teachers. The team with science, technology, and math was the right size.

4-B. How do you feel about interdisciplinary activities which include mathematics, science, and technology education?

I'm always trying to develop models and scenarios that are real world to my students. When we talk about money, I have money - play money on hand. When we study rations, I use a football game example. I never realized that the science teacher struggled to make lessons more real to his students too. I guess I assumed that his units were all fairly practical and hands-on.

School Science Teacher: July 13, 1994.

1-A. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

We had a lot so we were able to work with the materiels that we needed. We were able to do fine with what we had. We had the equipment that we needed. We didn't have enough time.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

The principal was a part of the team, so she was interested in it and she encouraged us. She was a part of the team so of course she worked with us to get the project done.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

Well, I can see the benefits of working together with math and letting students

understand that it's not just science, it's all the other things that are involved in learning too. Math is a part of science, the grammar part, when you write the reports, and things like that.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

We had a computer person who was the only technology component of the activity. It was great working with the new network that we had. It was a good learning experience for me. I had not worked with Virginia's PEN before the project, but have used is since. It was a good experience for me, because I was not aware of some of the things.

4-A. How do your feel about interdisciplinary teams which include mathematics, science and technology education?

It worked well with us for each one of us to contribute. Our part together.

4-B. How do you feel about interdisciplinary activities which include mathematics, science, and technology education?

I think it's good for students to see them work together. I think a lot of times in the classroom a student will say, "This is science, I can forget everything else." So to realize education includes all of these aspects. You use all of these in the classroom. Science in the science classroom is not just science. You need time to put it all together.

Technology Education Teacher: July 12, 1994.

1-A How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

The school environment is set up for computers - so it was easy for me. I have the math and science teacher' students twice or three times per week, depending on the week. The science teacher directed the construction of the kites in his classroom. I mostly facilitated the research of the kites, and I put the activity on Virginia's PEN. I used an overhead and projected the computer onto a screen in both the math and science classrooms so the students could follow along. We had several students using Virginia's

PEN by the end of the project.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

Our principal traveled with us to the workshop in Blacksburg. I don't think she recognized that I had worked with Virginia's PEN prior to that. I know she was disappointed that we don't have an actual technology lab - for building and such, our school is smaller.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

I felt like a guest in the science and math classes. The kids were very respondent to my presentations. I think they began to tie my computer lessons into their other classes, after the project. If anything, I felt more like a regular teacher than a part time computer or "special hour" teacher. By that I mean, the kids see me as a relief from the school day. Them seem a little more rambunctious. I wonder if they don't recognize that computers are school too, just like math and civics.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

We, like I mentioned, don't have technology education in our school. They do have that as an elective in the high school. My son has taken a few construction classes. I know he enjoys them.

4-A & B. How do your feel about interdisciplinary teams and activities which include mathematics, science and technology education?

I enjoyed working on the team. It made my lessons more real to the students. They were actually applying their math, at least, while drafting and designing their kites. It was good exposures too, when we were outside flying the kites. We had a perfect day for it. The day was special. It was education, middle school, the last two weeks before summer. It was bigger than that though. All of the subjects, together really, in a field. There must've been

over 100 kites flying, and some not flying, that they had designed - studied the scientific aspects, the math, designed it, built it. I remember at the beginning of the planning we thought we should give awards to certain kites; most creative design, biggest, you know. It wasn't necessary. I think it would've ruined the beauty of it. That teachable moment with 100 smiling faces.

Team Eight: Balloon Launch Activity

Mathematics Teacher: July 14, 1994.

1-A. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

The hardest thing was finding the time for an extra project within the school day. We choose to do it through the student's exploratory time block because they were all in their technology time at the same time. That meant the science and math teacher, me being the math teacher, had to give up our free time for about two weeks to work with the students. Now that doesn't really sound like a lot, but in the course of the school day, it gets to be tiring . If there were a way to work out a time that we were all free to work with the students, it would have been more convenient. But, because all of the students were already working with the technology education teacher, it worked out pretty well.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

The administrators were not very involved in the project. However, they were very supportive. They agreed to supply the materials we needed, they gave us rooms to work in, they provided us with the ability to take the kids off the school grounds too, when we went to launch the balloons that the kids constructed. So they facilitated us anytime that we asked them too and that was a big help.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

I guess that the biggest influence was that I wish we could do more of that, but I think that it would take a lot of retraining of teachers mainly just to break old stereo types. New ways of thinking as well as new curriculum materials that would provide you with new ideas that would bring the different subjects together. It all sounds good and people get excited when the see it but to actually sit down and try and plan a way to bring the subjects together is a difficult thing to do along with maintaining your current course load and paperwork and everything else.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

I thinks it's excellent, I think that's the force of most of the students' interest. I think that it's something that the students need to be exposed to. The students need to see how technology uses the other subject areas, which may increase their interest in science and math, but it [technology] is the source of their original interest. It's probably some of the most useful information that they'll learn.

4-A & B. How do your feel about interdisciplinary teams and activities which include mathematics, science and technology education?

Well, we worked very well together, and we came up with a project that worked well with the three subjects, the balloon launch. When I see these projects. There are two categories, there are the one's that have been done and the one's that seem too far fetched. I'm sure that there are great ideas out there. If somebody, or a team of people, could get together and say, "Look here, ideas that you could do." Kind of write a text book or a course manual that would show ideas of how you could bring science and math into these different projects. I think that it would be very helpful because you're beginning to see rocket launches and balloon launches a lot. Some of the other projects that I saw seemed kind of far fetched. They didn't seem very practical. And I think that the useful ideas and that the objectives of science and math that would be covered by those ideas would be very helpful.

Technology Education Teacher: July 14, 1994.

1-A. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

The technology lab is fairly small so we were limited in space. I had kids working in other classrooms and even in the hall. It was fairly disruptive on a few of those final days, but we managed just fine. The kids knew it was a special project, so they seemed to behave. But, you always have a few though, nothing serious.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

Our principal didn't get involved because he retired at the end of that school year, 1993 right? I know he was busy looking for a replacement because he worked in the summer too. The team was self-supporting. I had most of the materials that we needed around the lab. The science teacher also had a lot of the supplies we needed.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

I didn't realize how advanced some of the students can get in seventh grade math. I always have some students are bright, but the students who don't take my seventh grade offering are sharp! They added a neat balance to the groups of students. I often forget how many students are involved in the other elective subjects. It was the first time that I have worked with over 60% of those students.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

I have pushed to have technology as a required short course for all seventh and eighth graders. They are at an experimental age. I would like to capitalize on their imaginations and expose them to the different areas of technology. Many students enjoy the computers that I have with the Lab 2000. It's only a small part of what I actually teach.

4-A & B. How do your feel about interdisciplinary teams which include mathematics, science and technology education?

I would enjoy working on a team again with the math and science teachers. The activity drew in parents, other grade level teachers, and the school administration. Our vice principal was very pleased with the results. We even had the newspaper here.

Team Nine: Airplane Business Activity

Mathematics Teacher: July 18, 1994.

1-A & B. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

The 7th graders were thrilled to be a part of an experimental activity. At the beginning of the airplanne project, I explained to them how important their activity participation was in paving new ground. They were asked to go home and get their parents involved too. That was really a key to the success of the project. The principal was helpful as well. When we asked him for materials, he was eager to get involved and be a part of the team. I think he enjoyed taking part in the workshop, maybe it was a first for him, because he was new to our school that year.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

It was the first time I had worked on an interdisciplinary project. I spent my first two years at the school trying to get my bearings and be creative with math. I felt that I was ready to work with the science and technology teachers when we went to the workshop and started planning the activity.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

The technology part was the glue that held the activity together. The seventh graders gave rave reviews about the technology lab.

4-A. How do your feel about interdisciplinary teams which include mathematics, science and technology education?

The teams, with the three subjects, are innovative. I recognized the content has a lot of commonalities. I know the science teacher struggled to find a unit she had not covered already, so it takes many hours of planning to make it useful for all teachers.

4-B. How do you feel about interdisciplinary activities which include mathematics, science, and technology education?

Like I said, the technology lab made it fun for my students. I know that it was the first time they recognized they were doing math in an actual project. Sometimes I think they only recognize the simple addition and subtraction they do to buy things. During the project, especially in the technology lab, they were getting into some fairly complex problems. I would do it again, just to see that.

School Science Teacher: July 18, 1994.

1-A. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

The school environment is always hectic at the end of the year. In the last few years, I've found it harder to plan any major, long term units in science after the first of May. That project was no different, we had students running in every direction for any number or reasons. When we started the project, we were just coming down from the science fair. My students do quite well every year.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

Our principal was great. Toward the end of the year, it's always hard to requisition equipment and supplies. We usually have to be conservative with our materials. With this project, because it was something new, I suspect, we received additional materials, which was a relief. You'd hate to plan something, like the airplanes, and then not have the materials to build them. We did ask families to contribute. A lot of families had the scrap wood that we needed. I'm wondering if some families didn't go out and buy the balsa wood though. I can't think of too many garages with large stack of balsa wood lying around. Can you?

2. How has the participation on an interdisciplinary team influenced you as a teacher?

I was most impressed with how the technology teacher got the parents involved. When something is tangible, like the planes, it becomes more of an event at school. You would rarely see a parent come in to my science class to share an hour of science. The technology teacher gave this open invitation to share the time with parents. We saw a few moms and dads in the construction days and several on flight day. It was something. I know the principal appreciated the exposure.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

The activities wouldn't be as innovative without the technology teacher. The technology classroom has the tools and equipment needed to build. The technology teacher understands the development stages of the students. He recognized who needed help and which students were managing alright. It was a joy to see, really.

Technology Education Teacher: July 14, 1994.

1-A. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

The middle school is always such a fun environment to try new ideas. I think the project was so well received because the kids were so excited about it. The smartest thing that we did was to get the parents involved right away in the beginning - right at the planning stage. We sent home requests for household supplies. I made the assignment kind of like a scavenger hunt.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

The principal was very supportive of our project. He helped us order additional materials when our budgets were depleted at the end of the year. I think the science teacher

and the math teacher were very pleased with our progress. It brought good closure to the end of the school year.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

The next time we do a project together, we will know how much additional planning time it requires. Although we began the planning stages in March, we didn't get started until the beginning of May. By then, the kids were scattered around, with practices for spring concerts and sports events.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

The technology education teacher should be a part of the core team planning every year. When I worked with the science teacher and the math teacher, I came to the core teachers' planning meetings. I don't think the reading or language arts teacher and the history teacher realized how much applied science and math I actually teach. In fact, I don't think most of the teachers knew what I had been doing in the lab for the last five years.

4-A. How do your feel about interdisciplinary teams which include mathematics, science and technology education?

The teams with the three subjects are very practical. I was reading a teacher's journal over the long weekend and I saw that elementary students today will probably have 12 different jobs in their lifetime. Now I can't remember if that meant 12 jobs or 12 different careers, but it still means they must understand the importance of being flexible and accepting change. I have been a technology teacher for a total of 11 years. I started out in the high school in industrial arts and later moved to the middle school. There again, into an industrial arts role. Then the technology movement was absorbed by our school. I've had to change my mind set. We have more girls in my classes, less construction, more mathematics, and I have to depend more on the students' creativity, rather than packaging projects like I used to. I have enjoyed the changes over the last five years, especially, very

much.

4-B. How do you feel about interdisciplinary activities which include mathematics, science, and technology education?

The interdisciplinary activities are great. My students only spend one trimester with me, so some of them were not in my class to do the building part of the project. They all seemed to enjoy it.

The teams wouldn't be as innovative without the technology. The project would stop short it were only math and my class together. What I mean is, you could design something on paper, or plan it, but it would never be as real.

I watched the students during the week that we worked with the airplanes. They had their plans on the tables at lunch, they talked and planned between classes, even after school. They were in the library and the encyclopedias in my room. The team could've easily been expanded to the media specialist. She did a lot of work too.

Team Ten: Bee Hive Activity

Mathematics Teacher: July 13, 1994.

1-A. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

Our school was not designed to get what we needed. From one place to another. The distance between my class and the technology lab, were at opposite ends of the building from me. So our school is not built for that kind of thing at this point and time. Materials were purchased. They weren't things that the school had. Mainly because the school had not done anything like this before. And so we had to purchase our materials and things like that. The only time that we had was our own. The science teacher and I shared the same time, but the technology education teacher's was not the same. So we tried to catch him in between teaching and even while he was teaching class. It wasn't ideal, but we did what we could. And of course, we met before and after school.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

The administration was not as supportive of the project as we hoped he would be. When we started the project, the principal was fine - but he didn't really show an interest in the project. In other words, he understood what we were doing and that was fine. But, when we asked him to come see it and when the newspapers came, to take pictures, none of the administration showed up. I mean, we had the kids there, which was great but, you didn't have. You felt liked you worked hard, not that you wanted a pat on the back, yet you didn't see the enthusiasm when the project was completed.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

It is something that I feel is more of a worthwhile project. But, with it, one of the things that we feel we would try in doing it again. Maybe doing more on your own. Making it a smaller team first and then inviting people onto the team. One of the teachers and I work

together often, I teach math and she teaches science. But I think that when we have a third person, it actually is harder to find something that the three of us can do. We may try to include them later.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

I think that it's greatly needed. I think that it's probably one of the problems that we ran upon. I think that the technology education teacher was not as interested and available as we would have hoped because he taught other grades than sixth. So the curriculum that he was involved in and his requirements didn't enable him to be as involved as directly as we would have liked.

I think that the technology has a lot to offer. I think that it's a really worthwhile effort. It's just that it our school environment was not set up for the technology education teacher to be that helpful. That's something that could be worked on it we do it again. You would change that and hopefully it would work better.

4-A & B. How do your feel about interdisciplinary teams and activities which include mathematics, science and technology education?

I think that the three of them together is good. There is something to be said for all of them that given the ideal situation, the three could have the potential to work wonderfully together.

School Science Teacher: July 19, 1994.

1-A. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

Our school had never tried a teaming project. At first, we received a lot of support for the bee hive idea. It just seemed that the scheduling of planning time, with the technology teacher, became such an issue. What surprised all of us was the materials we needed. When you take on a project in your own classroom, you'd expect it to come out

of your budget. Where does the money for materials come from when there are three different teachers, different subjects working on one project? It is divided three ways? That was an unexpected issue.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

I don't feel like the principal ever was there for us. As I said before, we were concerned with ordering materials, we had to use or own budgets for that. I was not happy about that. He is always so supportive of other special events, maybe this one didn't interest him, I'm not sure. I think support from the school administration, anyone really, is important. Not just for recognition, but for supplies and planning time. It became a big undertaking.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

Our junior high and senior high are connected, so it was a long walk to the technology lab for us, with his class on the other end of the building. It became almost impossible for us to plan with the technology teacher. We found ourselves sending notes with students, it just wasn't a good setting.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

I thought the technology part was important, but it wasn't imperative. The math teacher and I could've easily completed this together. The next year we did do it, just the two of us. It wasn't anything to do with the team members, it was just easier to keep in on our end of the building.

4-A. How do your feel about interdisciplinary teams which include mathematics, science and technology education?

Teams are a wonderful way for teachers to share ideas. It takes a lot of planning to make a team click. Teams that work well together are usually information, self-directed,

for a short time. It's not too often that you'll find a whole group of teachers who can stop their units to create a problem or project like this one.

4-B. How do your feel about interdisciplinary activities which include mathematics, science and technology education?

I think an important issue is content versus application. The focus of this project because such that the building, or technology part became the intent. It was hard to keep students on track about the science aspect of it. It didn't have the dazzle. I don't know how the math teacher worked that out. I had the feeling that I was preparing the students for the technology part.

Technology Education Teacher: July 20, 1994.

1-A. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

The environment is not, or hasn't been supportive of technology, in general. The team approach, with technology was set up to fail, in a way. Don't get me wrong, I enjoyed working on the team and with kids that I rarely see even. The technology lab is set up in the high school, old industrial arts area. I love it because it's such a large area with fairly modern equipment. But it doesn't really seem like a part of the middle school much. My student are those that don't take band, orchestra, chorus, or other exploratory classes. As far as the team went, I work with different kids, only a handful of sixth graders, on an opposite end of the building.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

The principal, our administrator, wasn't a part of the process. I don't know how much support we asked for, in his defense.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

I spend a lot of my prep time in the high school because I'm right there. This was

a good opportunity for me to work with middle school teachers. I enjoy the sixth grade staff. They are caring people. I recognize how much additional effort the math and science teachers put into it. I know they used the project again last year. I'm glad for them. I just couldn't fit it in this past year.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

Technology is a good way to get kids interested in school, learning. The students that I had, seventh and eight graders, seem to have a tougher time with "book learning" or lectures. My class is always about teamed approaches to solve problems. I try to make it very applicable. I use math and some science in my classes every day. I couldn't get through the day without it. Technology is interdisciplinary by it's own nature.

4-A. How do your feel about interdisciplinary teams which include mathematics, science and technology education?

The theory behind an interdisciplinary team is understandable, but its the planning that takes it toll on the team. The travel from my classroom to the math teacher's class is almost five minutes right there. You loose a lot of time simply by making that journey.

4-B. How do your feel about interdisciplinary activities which include mathematics, science and technology education?

The activity was exciting, but I don't think you have to form a team to be interdisciplinary. A creative teacher should have the ability to step away from a lesson and recognize that there is or can be other, supplemental subject matter within a unit. We use technology to solve mathematical problems, computers or simple calculators, and science and technology go hand in hand.

Team 11: Rocketry Activity

Mathematics Teacher: July 15, 1994.

Due to a typing error, the mathematics teacher's interview transcription was deleted. The researcher could not locate previous versions of the transcription. The original interview was taped over to allow for later interviews.

Technology Education Teacher: July 20, 1994.

1-A. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

It worked out so we all had the same planning period. Usually I work with teams or committees and we have to plan after school. I was really pleased by how much we accomplished during those 40 minutes meetings. The science teacher was very organized, that helped speed up the process.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

Unfortunately our principal doesn't get too involved with classroom projects. I felt because this one, the rockets was going to be an exception because we made such a big event out of it at the end of the school year. We sent an open invitation to parents and the community to come. It was exciting. It surprised me when the principal didn't attend. I thought he might even say a few words to the students about the extra effort they had put into the whole process.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

I'm glad we did it, but I wish we would've received more support from the principal. I took home a lot of work to keep up with the other classes. It just didn't seem like we were rewarded. The students did appreciate it. I guess that's the bottom line.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

The math teacher and the science teacher came to my lab for two days to help out.

It was fun to be in my jeans and on the floor with the kids. It was thrilling for me to work the math and science teacher in my lab.

4-A. How do your feel about interdisciplinary teams which include mathematics, science and technology education?

Teaming is very positive for me. I often feel like I'm on the outside of curriculum planning, looking in. I think the other teachers, even those who weren't on the team, saw technology in action for the first time.

4-B. How do your feel about interdisciplinary activities which include mathematics, science and technology education?

The activities take a lot of planning. They're risky, in that you're not sure with each group of kids how they're going to work the project. The year that we did the rockets, we had a great bunch. Last year, I don't know if we could've pulled it off. They were wild. Maybe I'm getting older and I have less tolerance for the squirreliness. I don't think of myself as a crabby old teacher. Who knows? Every year is different.

Team 12: Home Construction and Rafter Testing Activity

School Science Teacher: July 18, 1994.

1-A. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

We had a hard time with planning because we didn't have a common planning time. We had to meet after school. And of course, some people would have duties, like bus duty, and that would interfere.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

He was very supportive. He was constantly making sure that we had the proper materials. And one time we miscalculated the number of materials and that was not a problem. He quickly corrected that and he picked up the rest of the materials.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

It's very useful. It enables the children to transfer knowledge. We think that's more important because they get to see it in more than one class.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

Very important. Because technology and science really need to work hand in hand because just as science runs technology, technology runs science.

4-A. How do your feel about interdisciplinary teams which include mathematics, science and technology education?

I think it's fine. But, I think you need to have a common planning period. In the middle school, with the exception of the exploratory teachers, the regular core teachers had two planning periods. Where the exploratory teachers, or the technology education teacher, only had one. And that was designated as their personal planning time. And I think in order to be effective, that person would have to plan with the team.

4-B. How do you feel about interdisciplinary activities which include mathematics, science, and technology education?

I think they are wonderful. The more activities you can do the better because it reinforces the science and basic math skills. And it helps students who are all a higher level, who don't necessarily take the technology because they have the foreign language, the band, or their music. It helps those students understand how important technology is to them. It may spark an interest there so they can investigate that route and of course it helps the lower students because of course it enforces the math and science. And it makes the technology class more important and they will concentrate more in their class.

Technology Education Teacher: July 18, 1994.

1-A & B. How did the school environment and the school administration affect your team's ability to develop and implement the interdisciplinary activity?

Our principal worked with us from beginning to end. He was helpful in getting the school involved. When we were actually working the with rafter construction, he helped us determine what we needed and drove to the lumber yard to get it. I was so impressed with how he helped us, it made us feel needed.

The school isn't known for building partherships or teaming with the teachers. The preparation periods with the grades are all staggered so there isn't a lot of shared planning. That concerns me really. You talk to those teachers that you see the most.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

It was most influential for me to be part of a team with core teachers. I haven't had the opportunity to work with them before. I had to relearn several science principles. It was interesting for me to learn about lumber farms in our region of the country. Not to mention the eco-system lesson that we presented. The math for me was a lot more common sense.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

Technology is interesting to middle school kids. They enjoy the practical, hand-on applications. I see it every day. But, there is a danger in saying hands-on activity is a superior way to present to middle school age students. They need foundational skills, solid skills in math and English to get to a place where they can participate on a team and function fully. Hands-on activities are fun and exciting, but they integrate foundational skills.

4-A. How do your feel about interdisciplinary teams which include mathematics, science and technology education?

I only worked on this team. This one was a good combination of personalities.

4-B. How do your feel about interdisciplinary activities which include mathematics, science and technology education?

The activities are interesting to develop because they allow kids to bring the same topic from classroom to classroom. They don't shift gears every hour.

It's important for teachers to have a lot more time to plan. We were only together after school. To me that didn't seem like enough time. I share bus detail with another teacher before school, so that prevented us from meeting before school. Some of the first nights that we spent planning got to be pretty late. We should've anticipated more planning time. It's a lot harder for science and math to coordinate their classes to teach construction. I think they enjoyed it, it was new for all of us.

Team 13: CO_2 Car Activity

Mathematics Teacher: July 6, 1994.

1-A. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

Well, we had a good environment. We were restructuring and were trying many new things. So we had a good environment. We had common planning time. We had what was called team planning time. The science teacher and I had the same planning time, and it just happened that the technology teacher had the same planning time.

The core teachers, the social studies, English, math and science teachers at the eight grade level all had common planning time.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

They scheduled an elective, as was written in the school write up. For kids to take the interdisciplinary unit. And they generally let us do what we wanted to do.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

It made me bite my tongue sometimes. One of the guys was a first year teacher and I have been teaching for twenty years, so I had to not keep saying, "That's not going to work and let him keep trying by himself. It was hard to back off and let them do the things that I thought I could get across better in my classroom. The main problem that I saw during the teaming was discipline. I felt that the other teachers were not as good of disciplinarians as they could have been when the large group of kids got together for the project.

I learned a lot of science that I had forgotten. I was neat to watch the kids. You know, kids interact differently to different teachers. And I think on the whole, the kids learn more because the one's that wouldn't ask one of them questions asked me. And if I didn't answer it the way they wanted, they turned around and asked another guy.

I think that a lot of learning went on. We had a new computer program for this

project, and it we would not have had the three adults present, with all of those kids, it would have been impossible. We just kind of circulated and answered questions, and tried to get them out of spots, and guided them. It was very fast paced once the kids got into that program.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

I think it's vital. It let's you spend more time. It opens up new avenues for students and allows them to ask new questions and go off on different tracks. It's an exciting age, especially for science. If you can get them interested. They just go. I had forgotten how excitable those kids are.

4-A. How do your feel about interdisciplinary teams which include mathematics, science and technology education?

It depends on the personalities. As to how well they'll work. I think it's a good idea, but I don't think that it should be adopted unilaterally. I think you need a good mix of personalities or else you'll have writers, or one person doing all the work on an interdisciplinary team.

4-B. How do you feel about interdisciplinary activities which include mathematics, science, and technology education?

It was hard to find one activity that included all three subjects on the same day. A lot of the times, I would have to give them the background math, and then the students would do the science experiment, and then we would go to the technology classroom and do the experiment in the lab there. It takes a lot of research.

School Science Teacher: July 6, 1994.

1-A. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

During the 1992-93 year, we began a major effort to become a functioning middle

school. Prior to that time, we were a junior high. Then we added the sixth grade and the ninth grade went to the senior high. It was helpful, especially when the new senior high was built, to structure then. We got a new principal who had a middle school background. He helped us a lot with the transition. The changes.

With the new middle school approach, we built pods of students and teachers. We had 127 students in my pod that year. With those kids we tried several new approaches to teaching. We did attempt a few interdisciplinary projects other than this one, but they didn't include technology.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

The new principal was very supportive. He's a young man, a teachers' advocate. We enjoy him. He's very responsive to issues like scheduling. He's a little conservative about the exploratory classes, like foreign language, much and even technology. Still it's been a welcome improvement, the transition to middle school.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

We had all of the kids together in the technology lab. It was too many kids - even for the three of us to handle. I think our most important lesson was to separate the kids into teams, and not have so many together at once.

Maybe this was a little overwhelming for the technology teacher too. He came in as a new teacher that year. He has come a long way since that time. I think it was important for him to work with the pod teachers the first year.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

Technology is an important part of the teams. It was a needed course offering at the middle school here. The technology teacher was very open to adjusting his plans - whereas it was harder for us, the math teacher and I, to develop a project that wouldn't

interfere with our schedules.

4-A & B. How do your feel about interdisciplinary teams which include mathematics, science and technology education?

Teaming is wonderful. I have worked with several teams, or other teachers at last, since this project. It's important for teachers to be able to pick their own team though. I've found it much easier to casually pair up with another teacher. It's not as exciting, as far as the race day, to CO2 cars, but students seem to enjoy it.

I remember one student, Michael, clearly. Throughout the whole year, I felt like I couldn't reach him. He seemed so bored. We sent him to the enrichment classes and he was always reading. He went after this project, like a fish to water. He had a beautifully designed car. We did a smart thing, allowing the students to work on teams, or to create the cars on their own. I know that his dad worked with him at home. This was a very positive experience for him.

Our courses may seem fragmented to students like Mike, this was a great opportunity for him to apply his creative side. I have heard that he is doing well in high school. It's hard to believe he'll be a sophomore this year.

Technology Education Teacher: July 15, 1994.

1-A. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

It was my first year, not only in the system, but as a teacher. The activity was timely because the school was in transition. The teachers were starting to develop pods of students, with standing homerooms and more assemblies, and that type of thing. It was the first year that we had a regular career exploration day each month too.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

The new principal put a lot of research into creating the new style. The middle

school, I mean. He had to do a good sales job on the teachers that had been with the junior high. It was hard for them to make the adjustment, to move the ninth grade to the senior high, and bring the sixth grade up to the middle school, but we survived. Also, it was clear that the technology concept was new to all of them. The principal built an exploratory hour into each students' day. We used that hour to work on the cars.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

I enjoyed working on the team. It was my first year, but by then, the dust seemed to settle. I know that the math teacher was concerned about having such a large group of students together at one time.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

Like I said, I enjoyed it. It's necessary.

4-A & B. How do your feel about interdisciplinary teams which include mathematics, science and technology education?

I would hope we can work together again. The kids seemed to enjoy the acitivies. I would say it was worth the extra time.

Team 15: Flight and Ballon Launch Activity

Mathematics Teacher: July 15, 1994.

1-A. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

The environment was ok. The life science teacher that attended the workshop handed off the project to the physical science teacher. He was excited to be a part of the team, but it took him awhile to get up to speed. The planning with our busy schedules was a problem though. We were always trying to track each other down. The technology teacher was especially hard to plan with because he doesn't have the same students. In fact, I think he only had one of my classes, about thirty of my students.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

I was disappointed by the principal. I thought he would help us more with ordering the materials. When we were measuring out the supplies for the balloons, we did it all ourselves. He wasn't there. Luckily the technology teacher had most of the materials that we needed. The principal didn't show up for flight day. I was surprised, I guess, because we expected him.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

I learned a lot about technology. I haven't worked with the technology teacher other than coach the soccer team. It was a certainly a first for me to be in the technology classroom. I learned some physical science. When were planning the project we had to go over what each other was teaching. I tried to reinforce some of the science in my classroom.

Teaming takes a lot of effort, for the teachers. We were together planning in the morning, and after school. I hadn't expected it to take so much time away from my other work.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

The technology teacher worked hard along with the rest of us. I know the students enjoyed the practicality of building the balloons.

4-A. How do your feel about interdisciplinary teams which include mathematics, science and technology education?

The team worked well together because we were friends before we stared the activity. That was important to the team. I've worked with other teams of teachers, the core team, weekly for two years. We don't always see eye to eye. Not like this team. It would've been helpful if the principal had been more supportive.

4-B. How do your feel about interdisciplinary activities which include mathematics, science and technology education?

The activities are practical. Math and science and technology are all intermixed. Sometimes I think were loosing kids by the time they get to us. We're sending the non-band and choir students to technology. That sends a message in our school. I know the students, my students, probably hadn't set foot in the technology lab. It's important that our students get all three subjects, or activities like this one, so they can see how they work together.

School Science Teacher: July 6, 1994.

1-A. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

I am a life science teacher and what we did was more physical science. So, basically what I did is wrote up the unit and gave it to our physical science teacher. And whether he used it or not, I don't really know. What we did not suit my classroom exactly. The technology teacher did make the balloons and we talked about it in class and we watched them set off the balloons.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

He helped us when we went to the workshop, but otherwise there wasn't much to do with the administration. But, other than that nothing was done in the school. The administration did not help us with ordering extra supplies or when we needed extra planning time. Our principal, I don't think had anything to do with it. I don't think that the three of us asked him to do very much. He's not particularly a science person.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

You have to be able to work with other people. You have to be broader minded and go outside of your exact discipline to fit in with other things. It makes you more broad minded.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

I think that it probably makes it real practical. It works well.

4-A. How do your feel about interdisciplinary teams which include mathematics, science and technology education?

It can be very beneficial to the students. I teach life science and I think that it is a little bit harder to apply things in life science than it would be to apply it to a physical science. In life science, we teach plants and animals. Maybe it's just me. In technology and math, your working more with measurements and light, space that kind of things. It applies more to physical science.

4-B. How do you feel about interdisciplinary activities which include mathematics, science, and technology education?

It's practical for students and worthwhile for the right team.

Team 16: Moon Settlement Activity

Mathematics Teacher: July 7, 1994.

1-A. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

Cooperativeness among the teachers. I think we really did not have that with the teachers who went to the conference. I think it's a problem. We need to talk honestly and openly and we didn't have that.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

He encourages it but he didn't get personally involved with it. He is thrilled that we tried to do anything with it. I don't think that he could've done anything more for us. There are just some personality conflicts, now with that team being split, I think we're all better off.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

I really enjoy it. I've got a very effective team this year and the past year. We work on interdisciplinary activities quite a bit. Even over the summer. We got together today and we get together a few more times. Our new team gets along very well and we enjoy each other personally.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

I think the unit was good and it's something that I can share with my new team, and encourage the technology education teacher to join us now. I think an openness existed that wasn't there before.

4-A. How do your feel about interdisciplinary teams which include mathematics, science and technology education?

Right now, the technology is not a part of the new team. And that's something that

our team would like to encourage on our own - not make it official. The team concept is maybe something that we could work with the technology teacher on. But, I think that the teams are new at our school. And we're trying to introduce a few things at a time, and I don't know if we're really ready for technology to be added.

4-B. How do you feel about interdisciplinary activities which include mathematics, science, and technology education?

I think we just needed a little more time to broaden it to technology any further. We've talked about the technology teacher joining in, but right now we've added in the inclusionary teacher into the team. So that's a big step for the team concept. Children who were otherwise out of the classroom.

Technology Education Teacher: July 7, 1994.

1-A. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

Our school promotes teaming, but personally, I'm seldom involved with the core teachers. There is the core team and the exploratory team, but we only meet once a year to talk about the school's mission. That's usually at the beginning of September. The science teacher who work on the Moon project didn't see the value of including the technology at first. That was a setback for awhile. But now the teams are different.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

The principal wasn't a part of the team so we didn't see much of him. He likes to see teaming and creative curriculum projects. I know he recognizes the value in putting technology in the core groups, but there never seems to be the time to add it. Teams that get too big are hard to keep tabs on. Teams with more than three teachers just aren't possible anymore. Schedules, and students are different with each teacher.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

I haven't worked with the core teachers much, not before the project or since then.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

I did see a lot of value in technology being on the team, we all did. It's the school. It's that we've been charged with creating a teaming environment. The core teachers are off and running. I see them planning for next year already this summer.

4-A. How do your feel about interdisciplinary teams which include mathematics, science and technology education?

The teams that include the three subjects just won't happen in our school. To be honest. The core teachers already have a wonderful series of projects on hand. I may be asked to facilitate them, I know I won't be a part of the planning.

4-B. How do your feel about interdisciplinary activities which include mathematics, science and technology education?

The activity we developed was innovative. We did some research to use each of the subjects. That's what too bad about this, I guess. It was such a great project and we're not using it this year. The students seemed to take off in my lab. We had fun, both the teachers and the students.

Team 17: Satellite Activity

Mathematics Teacher: January 16, 1995.

1-A. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

We used our planning time to write up the activity. It was good that we had the same planning time. If we do it again this year, we'll have to put it together after school or in the morning. The technology teacher had used Virginia's PEN before we stared, which was a time saver. I haven't use it.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

The principal helped us with the opening day presentation. He always helped us find the supplies. He did work with the high school to get us on the satellites and free up the linked classroom. We appreciated his help. He's usually pretty good about that.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

The technology teacher had some great ideas. He was skilled in the use of satellites. I think he has one at home because he lives so far out. I had never realized the opportunities, the math content, that's available on the educational channels. I didn't realize how much science relates to satellites.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

The technology teacher seems to have a very applicable, hands-on approach to teaching. The students go on and on about what's happening in the lab. We need to do more projects like this.

4-A. How do your feel about interdisciplinary teams which include mathematics, science and technology education?

Our team was very active, mostly because the principal was supportive of the workshop and the project when we got back to school. We enjoyed using the technology

lab. It was all exciting.

4-B. How do your feel about interdisciplinary activities which include mathematics, science and technology education?

We need to do more activities like this, I think. Middle school students are so creative. Activities bring that side out of them. Sometimes the book work gets redundant, the students need to be creative and show off a little bit.

Technology Education Teacher: January 18, 1995.

1-A. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

Actually we had a real good environment for that because we all had the same planning time. I guess probably, the hardest part of the whole project was that it was hard to get to the computers with a modem. We only have two within the entire school.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

He did every thing he could to help us out. He was very supportive.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

I think it's great. We need to work together. It's neat to have the teachers pulling together to work on a project. I was very pleased. I think it's most beneficial to the special ed. students. They are so often left out. When they have projects that they can participate in that are more hands-on, it is definitely to their benefit.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

I think it's good. I think that students should do more hands-on type things. They have a chance to do more practical things. The more these kids have a chance to tie school into everyday life, the better off they are going to be. Especially kids who are middle school age. Middle school kids hate to sit, they can't be lectured to, and they can't take notes well

at that age. So the more you can combine these things and give them the opportunity to show their stuff. You get a better participate and more interest.

4-B. How do you feel about interdisciplinary activities which include mathematics, science, and technology education?

Well, they definitely tie in. It's about time we start teaching kids the practical aspects of it. So many of the kids, you tell them something about science in math class and they say, "This is math, this isn't science, why do we have to hear that in here?" The more you can get across that all of these things cross over and tie in to your everyday life. That's what makes life. It's not compartmentalized. So the more you can tie them in together, the better off you are.

Team 18: Hydroponics Activity

Mathematics Teacher: January 18, 1995.

1-A. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

It was a headache. It was a barrier only. It was very difficult to work around it. We finally did the very best case scenario we could do. We did the project as we had written it up for the Make The Connection. We implemented it in one class only, of 25 students. And I don't call that interdisciplinary. It was a struggle. It was a struggle.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

Pretty much, it was hands-off. He was aware we were doing it and he did not disapprove. But did not assist in terms of, perhaps, asking related arts to give up a few kids, or to be flexible so that we could get the kids together to work with more than one class, and to actually work with the teams. Because I was with one group of kids, and the science teacher was with another group of kids. Ideally, we wanted to do the math and science components together with the kids. We could not. We got no assistance and no understanding.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

First, when you use the term interdisciplinary team, that concept has not permeated into curricular issues. It is interdisciplinary, merely in organization, in the structure. There were four teachers: math, science, language arts, and social studies, who worked with the core group of kids. They structured it that way. Occasionally they might be able to link a few things. In language arts they might be reading a novel, and they might study about social studies in that time period. To me, that's not interdisciplinary. So, I found it most frustrating that, in theory, we're a middle school, in practice we're a junior high. It was frustrating. In fact, I'm no longer in the classroom.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

I think it's necessary. It should be mandated, it shouldn't be an option. It should be an integral part of the curriculum to the point where its transparent.

4-A & B. How do your feel about interdisciplinary teams which include mathematics, science and technology education?

In theory, its the only way to go. To present everything from a math, science; from a content approach. It makes sense to the kids. Life is pretty much integrated. We should approach projects in school that way. I presented my project on hydroponics. I don't want to approach it necessarily from a science point of view in the project. It could've been from a broader unit such as the environment or survival. You bring in your disciplines through this project. And you don't go to your little rooms and shut the door. It's all done around a project.

As far as I know, it's not in practice. And you don't see it around here. It's a lot of talk and a lot of hype. But it's rhetoric. It ain't happening.

School Science Teacher: January 18, 1995.

1-A. How did the school environment affect your team's ability to develop and implement the interdisciplinary activity?

Well with the way the school is, it's not very easy to implement at all. At the time of the project it was much different. However, we were able to get a couple of classes to work together; with the tech ed and the science to do the project. But, not since that time.

1-B. How did the school administration affect your team's ability to develop and implement the interdisciplinary activity?

When the schedule permitted, they were behind us 100 percent. But, with the change in the larger environment and classes, I just think they had other concerns.

2. How has the participation on an interdisciplinary team influenced you as a teacher?

I don't really feel like we got into it long enough to make any long range plans. The way it was scheduled, we could only work it into part of our classrooms and not all. Even at best.

3. How do you feel about including technology education in interdisciplinary activity development and implementation?

I think it helps a lot. The kids enjoyed it. They were into it 100 percent.

4-A & B. How do you feel about interdisciplinary activities which include mathematics, science, and technology education?

They compliment each other. But, the planning and the development take a lot of work.

Vita

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