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Achieving comprehensive curriculum reform: An analysis of the implementation of a mathematics and science education policy

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ACHIEVING COMPREHENSIVE CURRICULUM REFORM: AN ANALYSIS OF THE IMPLEMENTATION OF A MATHEMATICS AND SCIENCE EDUCATION POLICY

BY

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ABSTRACT

The 1983 Educational Reform Act in Florida mandated the development of the Comprehensive Plan for Improving Mathematics, Science, and Computer Education in Florida. The plan set strategic goals and provided pragmatic recommendations so that the State of Florida could be more competitive in a world increasingly dependent upon science and technology. In the plan, eight overall goals provided a framework for improving mathematics, science, and computer education during the ten-year period from 1989 to 1999. Those goals were to strengthen the curriculum, to make learning mathematics and science more exciting, to use state-of-the-art instructional technology to enhance learning, to better prepare and enhance mathematics and science teachers, to encourage students from under-represented populations in mathematics and science, to re-design student and program assessment models, and to promote productive partnerships with schools, businesses, industries, community members, and parents.

The purpose of this study was to provide a systematic statewide profile of what has been done in schools, districts, and the State of Florida to reach the goals of the Comprehensive Plan and to determine key issues pertaining to statewide and local implementation. A set of

indicators of progress in mathematics and science education were constructed and provided a frame for data collection and analysis.

Three levels were identified as being important in this evaluation: state, district and school. Studies were conducted at each of those levels and subsequently synthesized to generate a profile of what has happened with respect to Comprehensive Plan implementation across the three levels. The state level study consisted of interviews conducted with state officials with responsibilities for implementation of mathematics, science, and computer education initiatives and analyses of data routinely collected by the state. Data for the district level study came from questionnaires and telephone interviews of district-level curriculum coordinators with responsibilities for mathematics and/or science supervision. Eighty six curriculum supervisors participated in the study, representing 41 of the 67 school districts in the state. The school level evaluation consisted of questionnaires sent to K-12 teachers, site visits, and classroom observations. ALso participating in the study were 747 K-5 teachers, 87 middle school science teachers, 91 high school science teachers, 108 middle school mathematics teachers, and 110 high school mathematics teachers.

Findings of the study illuminate state, district, and local level happenings with respect to each of the eight goals of the Comprehensive Plan. It can be interpreted from the findings that the degree of implementation of this plan varied greatly both within and between the three levels studied. Topics such as coordination within and between levels, vision of how the plan could be implemented at each of the levels, desire to implement the plan at each of the levels, and technical assistance in plan implementation provided an analytic frame for understanding implementation issues. It was noted in this study that curriculum reform of the magnitude recommended in the plan had not occurred to the degree expected in original implementation plans. Although some change was noted in state, district, and school practices over the first two years of plan implementation, there was little evidence to indicate change also occurred with respect to the underlying principles of the plan, which emphasized the importance of active student involvement in constructing mathematical and scientific knowledge.

The results of this study should be of use to school district officials, mathematics, science, and computer education program implementors, and state policymakers in evaluating current efforts and planning future endeavors towards fully implementing the goals of the Comprehensive Plan during the seven remaining implementation years. Implications from this study suggest that comprehensive statewide change may be facilitated by: 1) coordinating mathematics, science, and computer education programs and initiatives at the state level and the creating linkages between state programs and those at districts and schools, 2) providing the resources neccessary for both state and local implementation, and 3) assisting teachers and local administrators in understanding the the intentions of comprehensive reform policies through focused professional development opportunities.

CHAPTER 1

MOVES TOWARDS CURRICULUM REFORM

This dissertation focuses on state-initiated efforts taken by the State of Florida to improve mathematics and science education. Although not unique to Florida, there has been considerable interest in dramatically improving the teaching and learning of mathematics and science in recent years by both educational scholars and policy makers. The study reported here stems from Florida's campaign to improve mathematics, science and computer education via the development and dissemination of a set of goals with coordinated recommendations. In reaction to national and local concerns in these subject areas, the Florida Department of Education charged a group of Florida educators and business liaisons to develop a comprehensive plan for improving mathematics, science, and computer education to lead Florida into the twenty-first century. This study is an analysis of the implementation of that plan and a look at the extent to which state policies can impact student learning at the local level.

As a way to frame the evolution of the Florida plan, one must understand the context in which it was developed. In a recent issue of Educational Policy, Papagiannis (1991) identifies the Florida policy-making community as national leaders in addressing educational problems. As early as the mid-1970s, Florida policymakers were taking a national leadership role in implementing policies to set the Florida school system on track for educational excellence. When the flurry of educational reform reports began to appear in 1983, Florida had already put into place many of the recommendations found in those reports. In the nine years since those first major reports, a host of reform possibilities have been recommended to combat the apparent slide in student achievement.

Concern about what students are learning and how they are learning it continues in 1992 as educational scholars and policy makers proceed to grapple with declining student achievement and increasing public dissatisfaction with the nation's schools. However, the 1992 approaches to these problems are different from the ones taken in 1983. Whereas the earlier efforts attempted to stretch the existing system, the latest efforts are seeking fundamental and pervasive changes in policies as well as classroom life. The reform efforts are often referred to as "waves of reform."

Waves of Reform

Scholars such as Odden and Marsh (1987) have characterized the waves of reform as consisting of four interrelated yet distinct efforts, each with a different set of foci. The four waves are delineated in Table 1.

Table 1

Characteristics of the Waves of Educational Reform

Wave Type	Characteristics
Wave I	High standards, increased high school graduation requirements, more traditional academic courses.
Wave II	A return to the 'traditional' high school, better courses, new model curriculum standards, better textbooks, curriculum alignment, beginnings of new teacher roles, educational program quality indicators, reduction in dropouts.
Wave III	More radical curriculum change, curriculum integration across content areas, greater emphasis on writing and communication, higher order thinking skills, problem-solving skills, broader uses of technology, interpersonal small group skills.
Wave IV	Teacher professionalism, teacher decision making, national standards board, career ladders, policy trust agreements to augment traditional collective bargaining, restructured schools, more parental choice, system incentives, merit schools.

The publication of A Nation at Risk (National Commission on Excellence in Education, 1983) marked the beginning of an era in education that is often referred to as the "first wave" of reform. The boundaries between Waves I and II are blurred. Taken together these waves are considered the "back to basics" movement. Across the nation educational scholars and influential legislators called for schools to alter curricular guidelines to promote basic reading, writing, and arithmetic skills, and increase graduation requirements.

Many of these early 1980s reform efforts were viewed with skepticism by scholars such as Cuban (1984) due to their top-down nature, i.e., initiatives stemming from state education agencies and legislatures and not from local schools. The ability of the state to greatly influence what happens in local school districts and classrooms in order to improve the teaching and learning environment is at the heart of the skepticism. However, many of these reform efforts were considered successful in the sense they were embraced and implemented at the local level (Firestone, 1989; Murphy, 1990).

Since that first wave of reform efforts, subsequent concerns shifted to a more systemic and comprehensive focus on school improvement. Odden and Marsh (1987) indicated that reform policy implementation became more complex and demanding as the reform movement moved from conquering the basics in Waves I and II to radical curriculum reform and school restructuring in Waves III and IV. The primary emphases changed from a firmer grounding in the basics to an overhaul of the entire curriculum which centered on active learning, problem-solving skills, applications of technology, and small group interpersonal skills. In addition, teacher education activities began to center on professionalizing teaching and restructuring school organizations.

Focusing on Mathematics and Science Education Reform

Improving mathematics and science education is receiving high priority on national and local fronts. For example, having United States students be world leaders in mathematics and science achievement is included as a national education goal in the America 2000 plan (U.S. Department of Education, 1991). Likewise, a number of states have drafted or enacted similar goals emphasizing excellence in mathematics and science. Recent years have seen considerable interest in improving the state of the mathematics and science curriculum, especially in the elementary schools. Most of this interest stems from a plethora of reports such as the NAEP and international assessments indicating that students in the United States of America are deficient in their mathematics and science knowledge and skills. Lack of student ability to compete in mathematics and science with students from other industrialized nations has often been cited as an indicator of present mathematics and science curricular weaknesses (Jacobssen, 1986; McKnight, Crosswhite, Dossey, Kifer, Swafford, Travers, & Cooney, 1987). Scholars and policymakers alike have given special attention to National Assessment of Educational Progress reports which document that most students are reasonably proficient in computational skills but are unable to apply the basic skills even in the simplest problem-solving situations and that both basic understandings and higher order reasoning have not improved (Romberg, 1988).

Higher standards and more intense instruction in mathematics and science were among the conclusions of many of these reports. Recommendations for better mathematics and science education often included longer class periods and more credits to be earned as well as a curriculum which emphasized "concepts rather than isolated facts, thinking and the creation of meaning rather than passive knowing, and problem-solving and expression so that knowledge could be used to address meaningful problems" (Marsh & Odden, 1991, p. 219). A corresponding shift in teaching and learning strategies which promote active learning were also noted. Rather than improved direct instruction, a variety of instructional strategies were advocated which could foster inquiry, group cooperation, and social negotiation of meaning.

One of the earliest major reports that focused on both mathematics and science education was Educating Americans for the 21st Century (National Science Board Commission on Precollege Education in Mathematics, Science and Technology, 1983). That report has had far reaching consequences in the sense that it might be considered to be a focal point for the renewed interests in improving mathematics and science education. Subsequent reports by national groups responded to the call for reform heralded in this report. Some of those subsequent reports are reviewed in the next sections of this chapter.

Recent Mathematics Education Reform Reports

Recent reports on mathematics education have lamented the lack of student's problem-solving abilities. According to a series of reports such as New Goals of Mathematical Sciences Education (Conference Board for the Mathematical Sciences, 1983), Everybody Counts: A Report to the Nation on the Future of Mathematics Education (National Research Council, 1989), and Curriculum and Evaluation Standards for School Mathematics (National Council of Teachers of Mathematics [NCTM], 1989), a solution for improving mathematics education involves the encouragement of students to "think mathematically" rather than learn isolated facts by rote. The more recent reports are summarized in the following paragraphs.

Everybody Counts represents a landmark in the efforts to reform school mathematics. The report cites alarmist-style statistics such as three-quarters of all students stop studying mathematics before they finish high school and that there is a great demand for mathematically literate adults in the work force (National Research Council, 1989). To combat these negative statistics, the report provides a set of recommendations for changing mathematics education. The primary change emphasized is moving away from computation and rules towards problem solving and mathematical thinking. The report also lambasts the excessive use of texts and tests as constraints to a problem-solving oriented curriculum.

Specific recommendations are provided in Everybody Counts for elementary and secondary schools. For the elementary level, the report suggests moving away from an emphasis on accuracy of calculation to efforts that will promote students' "number sense." The report also supports the use of calculators at this level. For the secondary level, the emphasis appears to be geared to encourage schools to move away from mathematics courses that have a primary purpose of preparing students for college calculus to courses that have a common core of broadly useful mathematics. The report advocates the elimination of tracking but also acknowledges that college bound students will need a greater preparation than non-college bound students. The report suggests that this can be accomplished by a more holistically-oriented curriculum rather than the addition of specific courses. Finally, a strong emphasis in Everybody Counts is the notion that all students should study mathematics every year they are in school.

In a fashion much less alarmist but nonetheless consistent with the National Research Council report, the National Council of Teachers of Mathematics also published a document that has had major impact on the practical side of mathematics education reform. Curriculum and Evaluation Standards for School Mathematics was the product of a commission established by NCTM. The set of recommendations has been widely endorsed by education and mathematics groups such as the Mathematical Sciences Education Board and the American Mathematical Society.

The report sets goals and provides specific recommendations for reform of the K-12 mathematics curriculum. Each standard in the document is grounded in the assumption that all students can learn mathematics and they do so best by actually doing mathematics. The Standards say that "*what* a student learns depends a great deal on *how* he or she has learned it" (p. 5). To that end, the report sets new goals for students: 1) learn to value mathematics, 2) become confident in one's own ability, 3) become a mathematical problem-solver, 4) learn to communicate mathematically, and 5) learn to reason mathematically. To achieve these goals, corresponding recommendations center on changes in curriculum, instructional practices, and evaluation techniques. NCTM also suggests that calculators should be available to all students at all times and that computers be available in every classroom.

Recent Science Education Reform Reports

As in mathematics education, many reports have recently been issued concerning apparent weaknesses in the field of science education as well as providing recommendations for improvement. In general, the science reports are analogous to the mathematics reports in that they stress ideas and thinking over rote learning. Arguably, the science education reform report that has received the most attention is Project 2061: Science for All Americans (American Association for the Advancement of Science, 1989). Published in 1989, the report provided much needed guidance at a time when many states were debating where to go with their science education programs.

The report was the first phase of Project 2061 and emphasized the importance of developing a scientifically literate society. To accomplish that goal the report encouraged designers of science curricula to include notions that can support students: 1) being familiar with natural world, including the recognition that there is great diversity, 2) being aware of the ways mathematics, science and technology are inter-related, 3) knowing that mathematics, science, and technology are human enterprises, have a rich historical background, and, as such, knowledge in these is subject to continual scrutiny and change, 4) in developing scientific ways of thinking, and 5) in using scientific knowledge to inform personal and social choices. The report stressed that the accomplishment of these goals was not likely until substantial and systemic changes were implemented in traditional science curricula.

The second phase of Project 2061 is under way now. In phase two alternative curriculum models are being developed and implemented in several sites across the United States. The alternative curricula models are based on the assumption that "less is more" (Rutherford, 1991, p. 5). In addition, many state educational specialists are using Science for All Americans as a philosophical guide for reforming science education in their states. Although not intended as a curriculum guide, the learning goals set forth in Science for All Americans have become the basis of curriculum frameworks in states such as Michigan, Maryland, and California (Project 2061, 1992).

Science for All Americans has stimulated much thinking in the efforts towards science education reform. From the Project 2061 updates sent out monthly from the American Association for the Advancement of Science, it appears that there is considerable national consensus as to course goals and instructional strategies which should be a part of all science courses. In fact, the Winter 1992 issue of 2061 Today reports that the National Science Foundation (NSF) found that many states used the ideas of Science for All Americans as a guidepost while developing their proposals for the NSF's Statewide Systemic Initiative Program.

Several other reports have been influential in stressing the need for science education reform in recent years. In a series of reports by the National Center for Improving Science Education, syntheses of desired curriculum changes for science in the elementary, middle, and high school are reported. The center's report on elementary science, for example, specifically recommends that science instruction should focus on fewer topics in more depth and promote the skills needed to investigate and solve problems (National Center for Improving Science Education, 1989). The National Science Teachers Association (NSTA), also has a report that appeared in 1989. Their report, Essential Changes in Secondary Science: Scope, Sequence, and Coordination (NSTA, 1989), called for greater coordination among the ideas in high school science courses. In their plan, formal science instruction would begin in grade seven and progress until graduation. The approach would emphasize an integrated curriculum with scientific concepts becoming more abstract in the later high school years.

State-Stimulated Reforms in Mathematics and Science

Attention to improved mathematics and science curricula is not a phenomenon associated solely with the reports of the 1980s. Although there have been many reform efforts which specifically focused on an improved curriculum during the past 30 years, the National Science Foundation supported science education curriculum projects of the 1960s and 1970s exemplify the direction most improvement efforts have taken. Marsh and Odden (1991) contend that although many of the national curriculum packages were sophisticated, they often did not fit state or district curriculum priorities, nor most testing or textbook policies. Furthermore, teachers, in some cases but not all, attended summer institutes to assist them in implementing programs in their schools. Atkin and House (1981) and Sarason (1982), in reporting about the apparent failure of many of these early curriculum reform efforts, have contributed the idea that failure often stemmed from the lack of understanding of program objectives by key players at the school sites such as principals and curriculum supervisors, and a lack of will to fully implement reform ideas by these players as well as teachers.

Implementation lessons from some of those curriculum reform efforts in "early" years can be useful as states and districts attempt to implement thinking skills-oriented curricula, alter teaching as a profession, and restructure the organizational aspects of schools. Several new dimensions have been added to understanding local implementation from studies of more recent mathematics and science curriculum reform efforts, such as the California Mathematics and Science Frameworks and the Florida Comprehensive Plan.

The California story. California's curriculum reform initiatives can be viewed as representational of many of the reform movements that call for changes that see students learning content with greater depth of understanding and applying content knowledge to seek solutions to issues and problems. The California mathematics and science frameworks explicitly stated a vision of teaching that encompasses thinking, problem-solving, and application. The frameworks required that teachers learn new content and ways to teach it. Mathematics content reflected the moves away from basic arithmetic algorithms to concepts such as number sense, measurement, and statistics. Marsh and Odden (1991) studied the implementation of these frameworks in a select group of California school districts. They concluded that change of the scope indicated in the frameworks was beginning to take hold in schools and promised to be a systemic change due to parallel reform activities that were also taking place in the state.

In addition to the frameworks, California concurrently launched general reform efforts such as change in textbook adoption criteria, development of a statewide school improvement program which emphasized local adoption of "good" curricula programs, provision of mentor teachers at the school level to assist in the development and implementation of new curricula units, creation of curriculum centers across the state to assist teachers in curriculum development and learning of new pedagogical practices, and the creation of a statewide system of professional development that utilized curriculum reform and change as its focus. These integrated efforts supported change in all curriculum areas, especially in the areas of mathematics and science (Marsh & Odden, 1991). Success in local implementation was noted and credit was given to the massive, fundamental, and systemic nature of these reforms.

The Florida story. Florida has been another state that has attempted to enact a statewide reform package for mathematics and science education. Responding to crisis situations lamented by many educational critics, the Legislature of the State of Florida passed landmark legislation in early 1980s in which the condition of mathematics and science education was a major focus. The 1983 Educational Reform Act mandated that specific competencies be generated which would guide the improvement of mathematics and science education throughout the state. Three products came from this effort: 1) a revision of the list of minimum standards, 2) a list of "standards for excellence," and 3) course frameworks.

During the later 1980s, Florida again responded to the crisis situation in mathematics and science education by developing a statewide plan to coordinate all of the proposed and enacted initiatives in mathematics, science, and computer education. Called A Comprehensive Plan: Improving Mathematics, Science, and Computer Education in Florida (Task Force to Improve Mathematics, Science, and Computer Education, 1989), this statement was made public in April of 1989 as a result of the efforts of a collaborative group of members of the business and educational communities. The broad mission of the group was to prepare recommendations to make Florida a world leader in mathematics, science, and computer education by the year 1999. The Comprehensive Plan listed both strategic goals and practical suggestions for their attainment. In short, the document highlighted the immediate need to develop and implement efforts to ensure that students in Florida have the best opportunities to learn mathematics, science and to use computer technology.

As indicated in the document itself, the Comprehensive Plan is results-oriented. Restructuring the curriculum, making learning more exciting, preparing outstanding teachers, reaching out to all students, and adjusting the way learning is assessed are some of the results intended by the Comprehensive Plan. Many Florida school districts have used the Comprehensive Plan as a guide for curriculum reform and improvement, but to what extent have the recommendations of the Comprehensive Plan been implemented in Florida schools as a means to achieve radical curriculum reform?

The broad issues of how state policies and plans can enhance local curriculum reform efforts and the impact of those policies in classrooms were the foci of this study. To accomplish these purposes, a case study of the implementation of the Florida Comprehensive Plan was conducted. Reports of the findings and recommendations of this study have been prepared for and submitted to the Florida Department of Education (e.g., Dana, Tobin, Shaw, & Engler, 1992). The chapters of this dissertation are based on the reports submitted to state personnel. The reports have had an impact on the development and refinement of mathematics and science education policies in the State of Florida. Specifics of how this study is impacting policy-makers and decision-makers is presented in the final chapter of the dissertation.

Significance of Study

It is important to know the extent to which a policy such as the Comprehensive Plan is effective after it is fully implemented. However, knowledge of the extent to which initiatives and ideas associated with the plan are being implemented are important as an interim process. Unless one knows to what extent the recommendations in the Comprehensive Plan are being implemented, there may be little reason to expect it to produce the desired outcomes. According to Patton (1990):

> Where outcomes are evaluated without knowledge of implementation, the results seldom provide a direction for action because the decision makers lack information about what produced the observed outcomes (or lack of outcomes). Pure pre-post outcomes evaluation is the 'black box' approach to evaluation.

Accordingly, this study of the implementation of the Comprehensive Plan was undertaken in order to determine the extent to which the recommendations of the plan are being enacted by school personnel and, in a broader sense, ascertain the state of mathematics and science education in Florida schools.

Scope of the Dissertation

The chapters of this dissertation are arranged according to themes that can be found in the Comprehensive Plan. After Chapter 2, an overview of the procedures used in this study, the chapters focus on one or more of these themes. Chapters 3, 4, 5, and 6 are about the themes of strengthening the curriculum, making learning more exciting, preparing and enhancing mathematics and science teachers, and reaching out to students. Data relevant to specific indicators are presented and interpretations are made in each of those chapters. In Chapter 7, a synthesis of the findings and recommendations from the evaluation study which led to this dissertation is presented. That chapter is based on a "mathematics and science education report card" previously submitted to the Department of Education. Finally, Chapter 8 contains an analysis of implementation issues and a discussion of relevant observations and implications for continued implementation of the Comprehensive Plan.

CHAPTER 2

STUDY PROCEDURES

The evaluation of the implementation of the goals and recommendations of the Florida mathematics, science and computer education Comprehensive Plan required a complex set of procedures. The purpose of this chapter is to present the procedures used to plan and implement the study. A team of researchers that ranged from one to approximately fourteen people participated in varying degrees and varying capacities throughout the duration of this study. This chapter presents an overview of the procedures and may not capture the specific actions of each research team member.

The chapter is organized into three major sections. The first section is about the development of indicators for this study and previous research on mathematics and science education indicators. The next section highlights the various data collection procedures at the state, district, and local levels. The third section presents demographic information about the school-level teacher respondents.

Development of Indicators of Mathematics and Science Education

In order to assess the implementation of the far reaching recommendations in the Florida Comprehensive Plan, a complex set of indicators was developed. The indicators were designed to be of assistance in assessing the rate at which progress was made in improving the quality of science and mathematics in Florida schools and were categorized by the eight goals of the Comprehensive Plan. The indicators used in this study are listed in Appendix A and provide a framework for ensuing chapters, where the findings of the study are presented and discussed. Previous national and local work on mathematics and science education indicator models was of great assistance in the development of the indicators for this study.

The National Science Foundation has supported several projects aimed at developing a set of indicators. Shavelson, McDonnell, Oakes, and Carey (1987) produced a document in cooperation with the Rand Corporation, the primary purpose of which was to provide a discussion regarding pertinent issues surrounding the planning of a system of indicators. Weiss (1987), in addition to developing a set of indicators, used indicators of mathematics and science education in a national survey of science and mathematics teachers. Raizen and Jones (1985) and Murnane and Raizen (1988) analyzed the quality of indicators available and made recommendations for their improvement. Recently, the Council of Chief State School Officers (CCSSO) initiated the State Science and Mathematics Indicators Project (Blank & Dalkilic, 1990). The CCSSO project builds on the previous work on indicators and was designed to assist national, state, and local decision-makers in assessing the condition of mathematics and science education. Blank and Dalkilic (1990), as a part of the CCSSO project, specified six categories of indicators: student outcomes, instructional time/participation, curriculum content, school conditions, teacher quality, and equity.

The CCSSO indicators were useful in determining the set of indicators that would be feasible in this study of the implementation of the Comprehensive Plan. However, the evaluation team decided to develop an unique set of indicators specific to the Floridan context based on the goals and recommendations in the Comprehensive Plan. This process began with an analysis of the Comprehensive Plan text. A preliminary list of indicators for each goal was developed and compared to the indicators specified by the CCSSO. An analysis of the lengthy list eliminated indicators that were judged to be superficial and would not provide a sufficient level of detail to make judgments on the progress of implementation. The ideas and interests of the Department of Education were also captured by the indicators list after several consultations with DOE personnel. As a consequence, many of the school-level indicators were added to the list in order to develop a profile of what teachers do in their classrooms (previously uncollected information) and many state-level indicators were refined based on the types of data available from the state at the time of the study. The set of indicators that appears in Appendix A is the list that was used to organize data collection for this study.

Three Levels of Study: Three Types of Procedures

Using the indicators as a guide, sets of procedures were developed to collect data. Due to the variety in the types of data required, multiple procedures were used in this evaluation of the implementation of the Comprehensive Plan. In the following sections, procedures specific to each of the three levels are presented.

State Level Study

There were two components to the state level study. One component required the development of a sub-list of indicators that could be answered with data which are normally collected by the state. The next component involved in-depth interviews with approximately fifty key state personnel responsible for implementing and monitoring initiatives related to the Comprehensive Plan. The interviews were conducted and transcripts were analyzed by a sub-team of researchers. The interview data, while an important part of this study, are not included in this dissertation.

Data linked to the indicators were collected at varying points in the study. Personnel at the Department of Education were very congenial and assisted in the retrieval and compilation of many of these data. Personnel from the Office of Policy Research and Improvement (now Policy Research and Accountability) and the Office of Instructional Programs were especially helpful in collecting and organizing data. Furthermore, personnel in these offices offered their own interpretations of the data, providing triangulation for interpretations made by the evaluation team. Their insights into the current conditions of mathematics and science education provided a context for making sense of the state, district, and school data.

District Level Study

The Florida Department of Education was especially concerned about ensuring that the data collected were both valid and reliable, and represented the perspectives of the many types of Florida school districts (rural/urban, small/large, etc.). In response to their concern, two sources of data were used as a basis for ascertaining a district perspective on the implementation of the Comprehensive Plan. First, questionnaires were developed and sent to curriculum supervisors with mathematics and/or science responsibilities in the school districts. The questionnaires are provided in Appendix B. Second, telephone interviews were scheduled with 19 supervisors to obtain qualitative data on the ways in which the Comprehensive Plan was implemented. The telephone interviews also provided curriculum supervisors with an opportunity to "brag" about the "wonderful things" they were doing in their districts. The qualitative data also provided a set of vignettes to illustrate the varying degrees of plan implementation and progress towards achieving the goals.

Curriculum supervisor questionnaires. Items for the questionnaires were developed using the set of indicators constructed from the CCSSO report and the text analysis of the Comprehensive Plan conducted by the evaluation team. A panel of 5 science educators and 2 mathematics educators generated items to be included on the questionnaires. Drafts of the survey instruments were reviewed by representatives from various divisions of the Department of Education to help ensure that the survey would meet the information needs of state-level personnel. Consequently, the needs and interests of the DOE are reflected in the final versions of the questionnaires. The questionnaires had the following sections: a) Background/ demographic information; b) Trends and changes in science/ mathematics education; c) Information about science/mathematics education resources; d) Federal and state initiatives; and e) Availability of qualified teachers. The questionnaires were administered in the summer of 1991.

Prior to administration of the questionnaires, each school district was telephoned to determined exactly who was responsible for what levels of mathematics and science education. In many instances, the curriculum supervisor provided information directly. The telephone contact provided an opportunity to introduce the purpose of the study and inform the supervisor that he/she would be receiving a questionnaire. The questionnaires were mailed to every person with mathematics and/or science supervisory duties in all 67 counties. Mathematics supervisors received one version while science supervisors received another. Curriculum supervisors with responsibilities in both areas received both questionnaires. Eighty six supervisors representing 41 districts responded. Forty-four supervisors with mathematics responsibilities and forty-two supervisors with science responsibilities returned questionnaires. These supervisors represent all grade levels with 60% of the supervisors having the responsibility of K-12 general curriculum supervision.

Items on returned questionnaires were manually coded and data were entered on a personal computer and uploaded to the mainframe for statistical analysis. Non-quantitative items were also entered into a word processing document where responses from all questionnaires were aggregated for analysis. The data analysis consisted of a computer analysis of the response frequencies for each of the questionnaire items, and for qualitative items, listing exemplar responses and interpreting what those responses mean for the implementation of the Comprehensive Plan from the district perspective. The interviews provide a context for considering the responses to the questionnaire. The analyses of the questionnaire data were organized by the eight goals of the Comprehensive Plan.

School Level Study

This section of the chapter will describe the nature of the school-level portion of the evaluation of the implementation of the Comprehensive Plan. The school level study was the largest portion of the study and most of the analysis time has been devoted to making sense of the data collected from the schools. Seven types of questionnaires were designed to collect data from teachers and department heads. Teacher questionnaires were customized for elementary, middle school science, middle school mathematics, high school science, and high school mathematics. The following sub-sections of this chapter describe the sample design, instrument development, and response rates.

Sample design. The school level evaluation of the implementation of the Florida Comprehensive Plan involved a statewide probability sample of regions, districts, and schools in grades Kindergarten through 12. The sample included public elementary school teachers (K-5), middle-level and secondary mathematics and science teachers, and corresponding department heads.

The sample selection procedure was designed to select teachers representative of the teacher population in the state. The Department of Education wanted to ensure that estimates could be made for various sub-populations such as those in particular geographic regions. Accordingly, multi-stage cluster sampling was employed with regions of the state as the first stage sampling unit, school districts as the second stage sampling unit, and schools as the third stage sampling unit. It was decided that a random sample of teachers would not be likely should decisions about an additional stage of sampling be left to school principals as has been done in other studies (e.g., Milton, Herrington, Arthur & Owens, 1989). It was questioned in other studies whether principals selected teachers randomly or whether teachers were selected because they could answer the questionnaire in such a way as to make the school "look good." To avoid this problem, we chose to select all teachers in a particular school (elementary) or particular school department (middle and high school mathematics and science -- both teachers and department heads).

Aside from helping establish the sample criteria, the research team had very little control over the sample selection. The Department of Education controlled the exact procedure used in sample selection. The sampling frame, as well as the final representative sample, was provided by The Office of Policy Research and Improvement, and Management Information Services of the Florida Department of Education.

An additional step was chosen mainly to follow proper protocol. Administrative personnel in each school district were telephoned to ask permission to send questionnaires to teachers at the schools selected. This provided an opportunity to determine how many questionnaires would be needed and to secure the name of a contact person at each school. The contact person, generally a teacher, was then contacted and asked to facilitate the distribution and return of the questionnaires at that school. Although a time consuming process involving as many as five or more phone calls to a school district, this step of the procedure ensured nearly a 100% return rate for teacher questionnaires from individual schools in the sample. However, this step did not serve to increase the general return rate from all schools in the sample.

Instrument development. Since the primary purpose of this study was to assess to what degree the goals of the Comprehensive Plan was being implemented in Florida schools, the process of instrument development began with an analysis of the text of the plan. A panel of 5 science educators and 2 mathematics educators conducted the analysis, constructed the list of indicators, and generated items to be included on the questionnaires. Instruments were constructed to collect data from: a) elementary teachers, b) middle school mathematics teachers, c) middle school science teachers, d) high school mathematics teachers, e) high school science teachers, and f) middle and high school department heads (one for mathematics and another for science). The department head questionnaire, while developed and administered, was not used as a source of data in the study since in most schools the department head was also a teacher and completed the teacher questionnaire.

Drafts of the survey instruments were reviewed by representatives from various divisions of the Department of Education to help ensure that the survey would meet the information needs of state-level personnel. Questionnaire drafts were also reviewed by a panel of 9 teachers and 4 teacher educators. The instruments were revised based on the comments from the reviewers, field tested by elementary, middle, and high school teachers, and revised again.

The final versions of the questionnaires had the following sections: a) Background/demographic information; b) Information about your classroom; c) Trends and changes in mathematics/science education; d) General information about mathematics/science at your school; e) Access and use of instructional technologies; and f) Staff development opportunities. The questionnaires were administered to the sample very close to the end of the school year during May 1991.

Response rates. Permission to distribute questionnaires to teachers for the purpose of evaluating the implementation of the Comprehensive Plan was denied by Dade, Broward, and Palm Beach school districts. The remaining school districts each gave permission. For the teacher survey, questionnaires were mailed to 1521 elementary teachers, 234 middle school mathematics teachers, 227 middle school science teachers, 196 high school mathematics teachers, 193 high school science teachers (see Table 2 through Table 6). The overall return rates were 49%, 46%, 48%, 56%, and 47% respectively. Although these are reasonable response rates for lengthy questionnaires, the overall return rate is misleading as it represents the number returned in relation to the number sent to each school. A record keeping sheet included with the packet of questionnaires to the contact person in each district clarified the actual number of questionnaires put into the hands of teachers. Using those figures, the overall return rates were approximately 65%.

Table 2

Description of Elementary Teachers in Sample

		Number	Percent
Grade Taught	K	132	17.1
	1	147	19.0
	2	131	17.0
	3	133	17.2
	4	105	13.6
	5	99	12.8
Background	African-American	90	10.9
	Asian	1	0.1
	Caucasian	715	86.5
	Hispanic	12	1.5
	Other	9	1.1
Age	Under 30	145	17.5
	31-40	289	34.8
	41-50	256	30.8
	over 51	140	16.9
Experience	1-2 years	138	16.6
	3-5 years	177	21.3
	6-15 years	290	34.9
	16-25 years	158	19.0
	over 26 years	67	8.1
Sample Total		834	

Table 3

Description of Middle School Science Teachers in Sample

		Number	Percent
Course Taught	Life	22	25.3
	Physical	29	33.3
	Earth/Space	24	27.6
	Other	12	13.8
Background	African-American	5	4.7
	Asian	0	0
	Caucasian	96	90.6
	Hispanic	2	1.9
	Other	3	2.8
Age	Under 30	16	14.7
	31-40	31	28.4
	41-50	48	44.0
	over 51	14	12.8
Experience	1-2 years	46	42.6
	3-5 years	24	22.2
	6-15 years	26	24.1
	16-25 years	10	9.3
	over 26 years	2	1.9
Sample Total		110	

Table 4

Description of High School Science Teachers in Sample

		Number	Percent
Course Type	College Prep	61	67.0
	Non-College Prep	30	33.0
Background	African-American	3	3.3
	Asian	0	0
	Caucasian	84	91.3
	Hispanic	2	2.2
	Other	3	3.3
Age	Under 30	11	12.0
	31-40	28	30.4
	41-50	34	37.0
	over 51	19	20.7
Experience	1-2 years	9	9.8
	3-5 years	22	23.9
	6-15 years	35	38.0
	16-25 years	19	20.7
	over 26 years	7	7.6
Sample Total		92	

Table 5

Description of Middle School Mathematics Teachers in Sample

		Number	Percent
Background	African-American	12	11.1
	Asian	0	0
	Caucasian	93	86.1
	Hispanic	0	0
	Other	3	2.8
Age	Under 30	4	3.7
	31-40	45	41.7
	41-50	46	42.6
	over 51	13	12.0
Experience	1-2 years	27	25.2
	3-5 years	16	15.0
	6-15 years	46	43.0
	16-25 years	18	16.8
	over 26 years	0	0
Sample Total		109	

Table 6

Description of High School Mathematics Teachers in Sample

		Number	Percent
Course Type	College Prep	84	76.4
	Non-College Prep	26	23.6
Background	African-American	10	9.0
	Asian	1	0.9
	Caucasian	95	85.6
	Hispanic	1	0.9
	Other	4	3.6
Age	Under 30	13	11.7
	31-40	26	23.4
	41-50	50	45.0
	over 51	22	19.8
Experience	1-2 years	11	9.9
	3-5 years	10	9.0
	6-15 years	51	45.9
	16-25 years	34	30.6
	over 26 years	5	4.5
Sample Total		111	

CHAPTER 3

STRENGTHENING MATHEMATICS AND SCIENCE CURRICULA

The purpose of this chapter and the next three chapters is to present the detailed findings of the evaluation of the implementation of the Comprehensive Plan. This chapter is designed to provide an overview of the findings associated with Goal One of the plan and to provide an organized forum for discussions of the interpretation of those data. The next chapters are organized by Goals Two through Eight of the Comprehensive Plan. In each chapter, there are sub-sections for state, district, and local findings. These findings are keyed to specific indicators of progress as listed in Appendix A. At the end of the discussion about the findings, a recommendation is presented for consideration in future Comprehensive Plan implementation.

Goal 1 of the Comprehensive Plan was concerned with improving the quality of the mathematics, science, and computer curriculum. Specifically, the goal was stated:

> To strengthen the K-12 curricula in mathematics, science and computer education. The emphasis should be on student learning rather than merely content coverage so that students are prepared to succeed in a society requiring a high degree of technological and scientific literacy.

The Comprehensive Plan specifically recommended that:

- Elementary, middle and high school curricula should reflect an integrated approach to learning so that students develop a depth of understanding of basic and advanced mathematics and science concepts and computer skills.
- A coordinated K-12 curriculum is needed to promote meaningful understandings of technological, scientific, and mathematical principles.
- Classroom learning activities should emphasize "hands-on/minds-on" and problem-centered learning.
- The integration of technology should be emphasized in all subject areas.

State Level Data

Indicator: Changes In Course Enrollments

One way to monitor the implementation of the recommendations towards a strengthened curriculum was to analyze course enrollment data. In Florida, the course enrollment data were categorized by a hierarchy of course levels for both mathematics and science. Level I courses were considered "basic" or "fundamental" courses, Level II courses were considered "regular" courses, and Level III courses were honors or advanced placement courses. A short listing of course titles typically found at each level is provided in Table 7. These courses were typically offered to high school students.

Data trends that would be consistent with the intentions of the Comprehensive Plan would see lower level and remedial courses decrease in enrollment while higher level course enrollments increased. Districts would be expected also to increase enrollments in applied mathematics and science courses. One of the goals in Florida had been to encourage school districts to eliminate Level I courses and increase enrollments in Level II and Level III courses. Course enrollment data from the 1988-89 school year through the 1991-92 school year (inclusive) were compared to determine the extent to which the recommendations of Level I course elimination and Level II and Level III enrollment increases were being implemented. In raw numbers of students, enrollments in Level I courses in both mathematics and science have generally decreased since 1989 while enrollments in Level II and Level III courses have generally increased. Those figures are reported in Table 8. The percentages in parentheses represent the number of students enrolled in a course level as a proportion of the total student membership of grades nine through twelve.

As can be noted from Table 8, course enrollments were slowly changing in a manner consistent with the goal of encouraging students to take higher level courses. The recommendation to eliminate Level I courses appeared to be unheeded as the numbers of students in those courses remained high in 1991-92. The primary purpose of increasing enrollments in upper level courses was based on the premise that a large number of students elect not to take the most challenging mathematics and science courses as part of their minimal high school graduation requirements (Task Force to Improve Mathematics, Science, and Computer Education, 1989).

Table 7

A Sample of Level I, II, and III Course Titles

Course Level	Mathematics	Science
Level I	Pre-Algebra General Math I Consumer Math	Fundamentals of Biology Fundamentals of Physical Science Fundamentals of Earth/Space Science
Level II	Algebra I Algebra II Geometry	Biology I Chemistry I Physics I
Level III	Algebra I Honors Trigonometry Calculus	Biology I Honors Chemistry II Advanced Placement Physics

However, there is no guarantee that enrollment in Level II and Level III courses alone will require students to engage in "higher-order thinking" as envisioned by the Task Force. At present, the state has no way to monitor the quality of instruction in these courses. By 1994 however, eleven remedial (Level I) mathematics courses at the secondary level will be eliminated and replaced with four courses that are being designed to reflect new mathematics standards.

Table 8

Changes in Levels I, II, and III Course Enrollments

Course Level and Title	1988-89	1989-90	1990-91	1991-92
Level I				
Mathematics	207,633 (42.5%)	205,009 (42.1%)	199,975 (40.7%)	188,762
Science	66,973 (13.7%)	63,436 (13.0%)	55,433 (11.3%)	50,933
Level II				
Mathematics	190,932 (39.1%)	185,927 (38.2%)	190,025 (38.7%)	206,332
Science	290,101 (59.3%)	285,771 (58.7%)	288,375 (58.6%)	295,232
Level III				
Mathematics	49,458 (10.1%)	51,548 (10.6%)	56,488 (11.5%)	65,740
Science	72,778 (14.9%)	74,637 (15.3%)	85,071 (17.3%)	95,776
Grades 9-12 Membership	488,919	486,488	491,658	n/a

An analysis of courses taken showed that while there were noticeable increases in enrollments in advanced level courses, lower level courses still had high enrollments. The 1983 reform act in Florida required students to take more science courses. Florida is likely no different than other states in that expanded enrollments in the lowest level courses were a direct effect of the early reform movements (Clune, 1989). In both mathematics and science only a small number of students in grades 9-12 were taking the most advanced level courses since 1989. Districts should be encouraged to eliminate or reduce the number of Level I courses in mathematics and science as a way to encourage enrollment in advanced courses. However, viable curriculum models for advanced courses that would be appropriate for a range of students do not exist in most Florida school districts. The lack of a set of alternative curriculum frameworks is a contributing factor to the slow progress in strengthening the curriculum.

Indicator: Curriculum Guidance Resources.

Four different types of documents and two different curriculum projects guided mathematics and science education in the state from 1989 to 1992. These guides were developed by different Department of Education (DOE) offices. The guidance materials available to districts were:

1. Student Performance Standards
2. Standards of Excellence
3. Course Frameworks and Standards (Grades 6-12)
4. District Curriculum Guides
5. K-5 Model Curriculum in Mathematics

6. NSF Elementary and Middle Grades Science Restructuring Project (Statewide Systemic Initiative)

These materials became available to districts at different times and accordingly may have been confusing to district level officials conscientiously trying to implement them. The materials differed greatly in intent and scope, but tended to have the same purpose of providing a framework for instruction. The primary purpose of these materials was to provide assistance in improving mathematics and science instruction. However, some district officials cited too many contradictions between the different materials. One district supervisor's comments were typical:

> . . . I realize that the DOE is in transition and a lot of philosophies are changing. But at the same time the DOE has come out and said that you need to teach these standards or we will test or we will do that or we'll fund this project and here is a grant for that and so on. Then they turn around and remove all of that, pull out directives from under you once you have told all the teachers that this is the way we will be doing it. I guess my plea is to come up with a policy and stick to it. A tremendous amount can be done if there is some sort of clear direction signal from the DOE.

It should be of great concern that district level administrators have doubt about the curriculum guidance being provided by the state. The supervisor's comments support the notion that a clearly articulated curriculum plan, such as the Comprehensive Plan, was needed in Florida. However, a systemic reform of state policies and practices was also needed to eliminate potential sources of contradiction and encourage reform.

New sources of curriculum guidance that consolidate existing frameworks and use the Comprehensive Plan as an organizing principle are needed in Florida. The state should establish a priority for curriculum reform and retire all other documents that sought to influence mathematics and science curricula. Documents such as the Minimum Student Performance Standards and the Standards of Excellence are being used by some schools to a great extent and by others to a lesser extent. There was a lack of consistency in terms of the documentation that was driving curriculum reform in districts. The Department of Education, in conjunction with state organizations for mathematics and science teachers and supervisors, may want to establish one document or unified guidance system for mathematics, science, and computer education. Having one document would provide a focal point for continued curriculum reform efforts and a common basis for assessing reform progress.

Indicator: Blueprint for Career Preparation Schools

An improvement in student grades, enrollment in higher level courses, and promotion rates was documented at pilot *Blueprint for Career Preparation* high schools. These schools emphasized career exploration and involved students in taking applied mathematics and science courses rather than lower level courses. Fewer than one-third of all districts offered Applied Mathematics and fewer than one-sixth offered Principles of Technology during 1990-91. Only 1,942 students out of a statewide junior class of 114,293 students (less than

2 %) took Applied Mathematics I in 1990-91, and only 320 students took Principles of Technology I at non-Blueprint schools. The implementation of new advanced courses such as Applied Math and Principles of Technology requires a substantial commitment from a school district in terms of resources and teacher education. Lessons learned from course implementation at the Blueprint schools need to be made available to other districts wishing to phase in advanced level courses.

Indicator: Student Achievement Tests

State and national examination scores were collected to determine student achievement trends. Scores on the Florida High School Competency Test (HSCT) have been declining steadily for the past seven years from 87% in 1984 to 75% in 1991. A major portion of this examination is devoted to mathematics competency. The College Board noted an increased gap between top students taking the SAT and the larger group of middle students. Nationally, the average scores for students who also took the Board's Mathematics Achievement Tests were nearly 100 points higher than the national average. In Florida the mathematics scores of students who also took the Achievement Tests were 144 points higher than the average mathematics score in Florida.

District Level Data

Indicator: Subject Area Integration

Efforts were made at the district level to encourage the integration of mathematics and science, particularly at the elementary level. Approximately 90% of the curriculum supervisors responding to the questionnaire indicated they had encouraged both elementary and secondary teachers to integrate mathematics and science into other subject areas in the past two years.

The supervisors provided many diverse examples of their attempts at encouraging integration of mathematics and science with other subjects. Principal among these were references made to the role that additional funds from state-supported teacher staff development programs such as Mathematics/Science Teacher Education Training (M/STET) and Title II, had in facilitating teacher workshops that stressed integration. Curricular resources such as AIMS, 4-Rs, Project Wild, LEGO LOGO, and Voyage of the Mimi also were mentioned as a source of ideas for integration by the curriculum supervisors. Two different districts mentioned that summer camps and inservice institutes focused on integrating themes such as science, technology and society. Two elementary supervisors made specific mention of an integration approach that involved teaching elementary science by building on themes from childrens' literature.

Indicator: Influence of Documents or Guides

Although many of the changes noted in other parts of this study are consistent with the intentions of the Comprehensive Plan, publication of the NCTM's Curriculum and Evaluation Standards for School Mathematics has been a significant factor in encouraging school districts to consider reforms of mathematics curricula. One supervisor noted the local influence of the NCTM document:

> The NCTM standards have made quite an impact on our curricula. We have endeavored to change in order to adhere more closely to the new standards. These results will not be apparent until the end of this year (at the earliest).

Although the Comprehensive Plan was intended to be prominent in planning local reform, it appears that the NCTM standards have been more influential than the Comprehensive Plan in some parts of the mathematics education community. Another supervisor stated:

> The NCTM standards have been adopted by our school board and inservice programs for the past two years have focused on these standards. The curricula has become more problem-solving, uses manipulatives and projects to teach key concepts and is more student-as-learner oriented.

As a driving force behind mathematics education reform, the NCTM standards have been reported as useful to several district curriculum supervisors. Science education reform documents did not receive the same attention by science curriculum supervisors in terms of local influence. The lack of a document analagous to the NCTM standards in science may be an explanation as to why supervisors did not cite any similar changes in their science curricula.

Indicator: Use of Themes in Curricular Guides

Noting the inclusion of themes such as "the environment" in curriculum guides may signal that supervisors and teachers are trying to implement more relevant and holistic views of science. Based on the responses to the supervisor questionnaires, two-thirds of school districts used the environment as a theme in some level of science courses. However, it can be assumed that there was considerable diversity in the way this theme was applied and it was not clear the extent to which the environment was the main theme of particular science courses. Since Florida's NSF/Statewide Systemic Initiative is using the theme of Florida's Fragile Environment to promote science education reform at the K-8 level, knowing to what extent the environment is included as a theme in present curriculum guides should be of assistance in determining the impact of the SSI project.

Science curriculum supervisors indicated more involvement in using the environment as theme than mathematics supervisors. Curriculum materials such as Project Wild, the 4Rs (Recycling) curriculum, Project Learning Tree, and Waterways were cited as useful in accomplishing integration of an environmental theme. Several supervisors also indicated that local nature centers were used by students during environmental studies units. Again there was great diversity among respondents with one supervisor noting that "environmental education is infused throughout all courses at all levels" while another offered that the environment was used "not as a central theme except as it flows with instruction."

Indicator: Changes in Mathematics and Science Curricula

A review of comments from supervisors suggested that most change in mathematics and science has occurred at the elementary level during the past two years. This was evidenced by fewer comments regarding the middle and high school levels than the elementary level. The elementary curricula changes were noted primarily in these areas: 1) increased use of problem-solving, 2) increased emphasis on use of manipulatives, 3) increased attention to active learning, 4) increased use of technology, 5) increased use of calculators, 6) increased attention to environmental education, and 7) increased attention to mathematics topics such as estimation, mental mathematics, and critical thinking.

Changes in curricula at the district level were used to judge the extent to which state curriculum reform ideas are being influential in setting local policy. The middle and high school mathematics and science curricula were stagnant in comparison to the changes indicated in the elementary curricula. Secondary supervisors noted changes such as increased emphasis on using calculators and adding advanced courses. However, the changes at the elementary level, by comparison, were more far reaching with change being noted in subject area integration, cooperative learning, and active learning approaches. These types of changes were consistent with the intent of the Comprehensive Plan.

Indicator: Policies on Time Spent for Mathematics and Science Instruction

According to district curriculum supervisors, there was little change in district policies regarding time spent on mathematics and science instruction in the past two years. In a few districts, an increase in required time allocated to science instruction at the elementary level was noted. Many supervisors of elementary grades also indicated that because of teachers' adoption of thematic instructional units, it was difficult to place a numeric value on the number of days or length of lessons in those grade levels. In addition, the supervisors of elementary grades have indicated that due to thematic teaching, science lessons were more common in elementary classrooms in the past two years than they were for several years prior. Of course, this indicated nothing about the quality of the science lessons or whether science was just a theme for language arts lessons or whether there were meaningful science activities taking place. Data on the quality of the elementary lessons, which were not collected as a part of this study, would have added a useful dimension to the time spent data.

Responses by district level curriculum supervisors about mathematics lessons were similar to the responses about science. In responding to a question about time spent on instruction policies that might be present at the district level, one supervisor specifically noted that:

> The minimum recommended time for elementary mathematics lessons was about 60 minutes per day. Secondary mathematics teaching time was dictated by the bell schedule.

Although this supervisor was able to give specific time recommendations, other supervisors indicated that there was no official policy for duration of elementary lessons and supported the notion that thematic teaching has blurred time allocation lines in mathematics as well as science in recent years.

Considering the responses by all of the curriculum supervisors, there was great diversity in supervisors' responses to questions about time-spent-on-teaching policies. Many district supervisors indicated that the trend in recent years has been to remove reference of numbers of minutes for certain subjects from local policies governing elementary instruction. Several elementary supervisors noted that there were no longer formal "time spent" policies for science at the elementary grades. One supervisor elaborated on that statement by suggesting that because no one in the district monitors elementary science teaching, science is not taught for more than 90 minutes per week on average.

Interestingly, the elimination of time spent policies was not the case for secondary courses. Nearly all supervisors portrayed their secondary science program by stating the official "state" line for time required in secondary science courses: Three credits by graduation, each a full-year lab course representing 180 hours of instruction, 72 of which is lab time. The indication of specific numbers for hours of instruction among secondary supervisors came in support of state funding rules which requires schools to have that configuration if they are to receive additional financial support for science education.

The issue of strengthening the curriculum may have little to do with the actual numbers of minutes that are spent on instruction. Even though time spent data have been considered an essential indication of strength in the past, the quality of mathematics and science lessons may be a better indicator as to the strength of the implemented curricula. In the literature on mathematics and science education indicators, there are no measurable indicators of lesson quality at the classroom level (Blank & Dalkilic, 1990). Since many reform researchers have used this literature to support their work, it might be concluded that a substantial piece of the "big picture" on curriculum reform may be missing. Qualitative data that support rich desciptions of implemented mathematics and science lessons would add a needed dimension to the quantitative data generally found in the literature.

School Level Data

Indicator: Curriculum Change to Limit Breadth and Superficiality

A recommendation in the Comprehensive Plan was to implement curricula that have fewer topics that can be learned with a greater depth of understanding. From the school-level study, less than

10% of high school teachers noted that their curriculum has changed in the past two years to one which required them to teach fewer topics with greater depth. Likewise, across grades K-12, an average of 48% of mathematics and science teachers perceived that the curriculum has changed over the past two years to cover a greater number of topics with less depth. Figure 1 provides a summary of teacher responses to the question of limiting superficiality and teaching fewer topics with greater depth.

Qualitative data also supported the assertion that few changes in narrowing the breadth of the curriculum have occurred. A middle school mathematics teacher summed up the feeling of several colleagues with the statement:

> The largest complaint of the math teachers at our school, by far, is that there is way too much to cover, in depth, in the time allotted. Particularly with our change to a middle school last year. We have gone from 60 minutes classes to 50 minutes classes this year. That's 50 minutes per week less than last year -- and the curriculum hasn't changed.

Another mathematics teacher responded, "I wish the curriculum allowed me to cover fewer topics in greater depth!" Mathematics teachers weren't alone in this opinion, however.

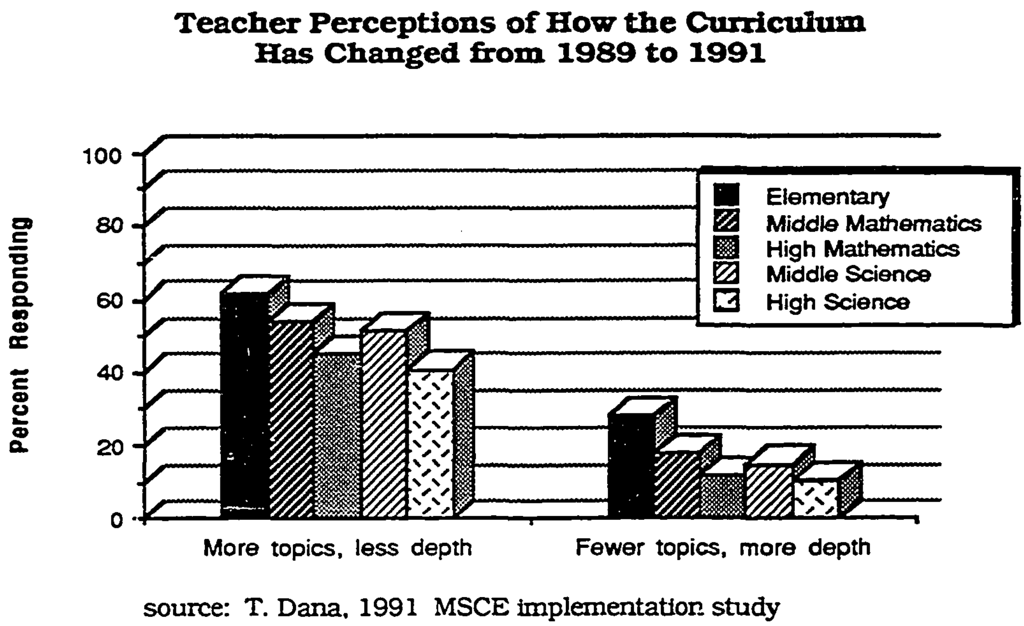


Figure 1. Teacher Perceptions of How the Curriculum Has Changed from 1989 to 1991.

A middle school science teacher lamented the fact that earth/space science had been added to the requirements he was expected to teach in the sixth grade classroom without eliminating the other curricula requirements that were already in place. Feeling the pressure of too many topics may also constrain the quality of the science curriculum. As another middle school science teacher stated:

> The curriculum objectives for 6th and 7th grade have too many topics. This is the reason why I refuse to cover STS and career opportunities in those classes.

High school science teachers had many comments as well. One biology teacher blasted the school district for an outdated curriculum:

> Curriculum revision is desperately needed in the biological sciences . . . There have been so many changes in the field of biology in the past fifteen years (i.e., molecular biology) that a majority of students will never know about because it's not in the curriculum (and other teachers don't know it either!).

Another high school science teacher commented that:

> The state science curriculum requirements are not being reduced making it nearly impossible to do a good job complete with laboratory activities. There simply is not enough time in the school year to cover all of the requirements.

Finally, in an interview, a high school chemistry teacher indicated that teachers in his school were required to follow the local curriculum guide which was based on state standards. Teachers also were required to document how each and every lesson, assignment, reading, movie, laboratory activity, etc. supported the objectives in the curriculum guide. He said that he believed that this was a necessary activity to ensure that all teachers covered all of the objectives by the end of the year.

In a similar vein, a middle school science teacher stated that, "I believe everyone should teach from the Standards of Excellence." That person also went on to say that he or she was confused about the state of those standards because "they appear to be out of vogue now." This statement supports a district-level finding that the state needs to develop a consistent curriculum framework policy that eliminates contradiction and supersedes all present curriculum guidance materials. A unified set of curricular goals might also serve to assist the state, districts and schools by providing a common ground for discussion about limiting topic superficialty and promoting conceptual understanding. A conclusion that can be drawn from the statements above supports the notion that present mathematics and science courses place too much emphasis on a breadth of topics and that teachers feel constrained by curriculum guidance materials to follow and implement specifically the objectives in those documents. The Department of Education may want to consider the comments made by these teachers as they develop new curriculum guidance materials.

Indicator: Computer Integration into Mathematics and Science

From an analysis of the survey data, mathematics lessons in grades K-5 were more likely than science lessons to include student use of computers. At the elementary school level, 71% of teachers integrated computers into mathematics lessons on a weekly basis while approximately 20% of elementary teachers integrated computers into science lessons on a weekly basis. These differences in the use of computers for mathematics and science might be explained by the greater availability of mathematics software than science software at these grade levels. Elementary school teachers reported that they had more mathematics software than science software available in their classrooms for student use. Furthermore, elementary teachers reported that computers were most typically used for drill and practice and for computer games when they were used as a part of mathematics or science instruction.

In middle and secondary schools, teachers reported that computers were rarely, if at all, integrated into mathematics and science lessons. Three-quarters of mathematics and science teachers indicated that their students did not use computers as part of their daily learning activities. Of the 25% of the teachers who indicated their students did use computers, computers were integrated into class learning activities about once a month. Figure 2 provides a graphical representation about the extent to which computers were used to enhance mathematics and science learning at the different grade levels. Additional information about the use of computers and other technology as tools to enhance mathematics and science learning are presented in Chapter 4 of this dissertation.

Indicator: Integrating Themes into the Mathematics and Science Curriculum

Over 51% elementary teachers reported they used science themes in lessons in other curriculum areas. The emphasis on theme teaching might be attributed to the whole language movement. Several teachers noted that the move to whole language actually encouraged them to teach more science. It was not clear from those statements, however, what those science lessons were like, but comments made by teachers about their science lessons have led to the conclusion that science provided the theme for a set of learning activities that ranged from mathematics to social studies. Teachers also reported that curriculum integration was much easier to achieve when one utilized the whole language approach.

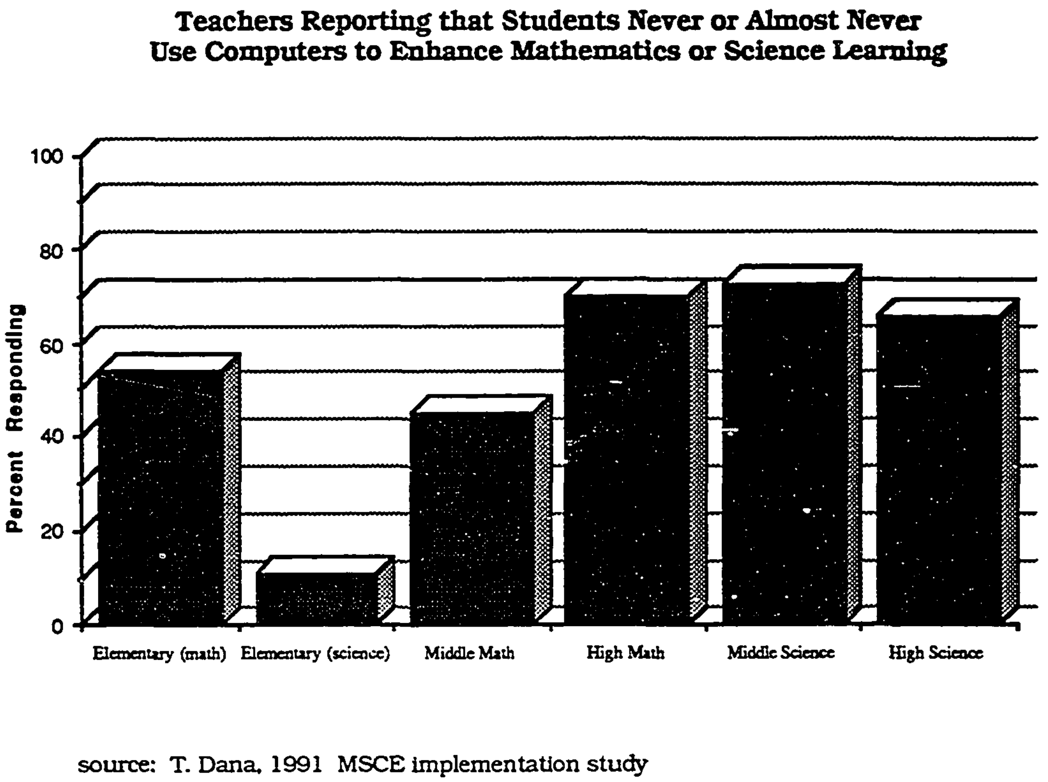


Figure 2. Teachers' Reports of Students Never or Almost Never Using Computers to Enhance Mathematics or Science Learning

Theme teaching and curriculum integration appeared to be mainly an elementary school phenomenon. From an analysis of the questionnaire data, elementary teachers integrated mathematics and science into other areas of the curriculum more frequently than middle and high school teachers. Half of middle and high school science teachers reported that they related their subjects to other curriculum areas at least once a week and 35% of middle and high school mathematics teachers related their subject to other areas at least once a week. A distinction needs to be made, however, between "relating" and "integrating." To the secondary teacher the primary topic to be taught was either mathematics or science and that topic could be "related" to other subject areas. Elementary teachers generally were responsible for several subject areas allowing them to integrate all subject areas into a holistic "big picture."

The use of theme teaching was a prominent activity in many classrooms. Slightly more than 50% of elementary teachers and secondary science teachers increased their use of science-technology-society topics and their use of "the environment" as a theme in their lessons over the past two years. Themes of historical developments in mathematics and science were included by 95% of science teachers at least once a year in their courses and were almost never included in 52% of mathematics classes.

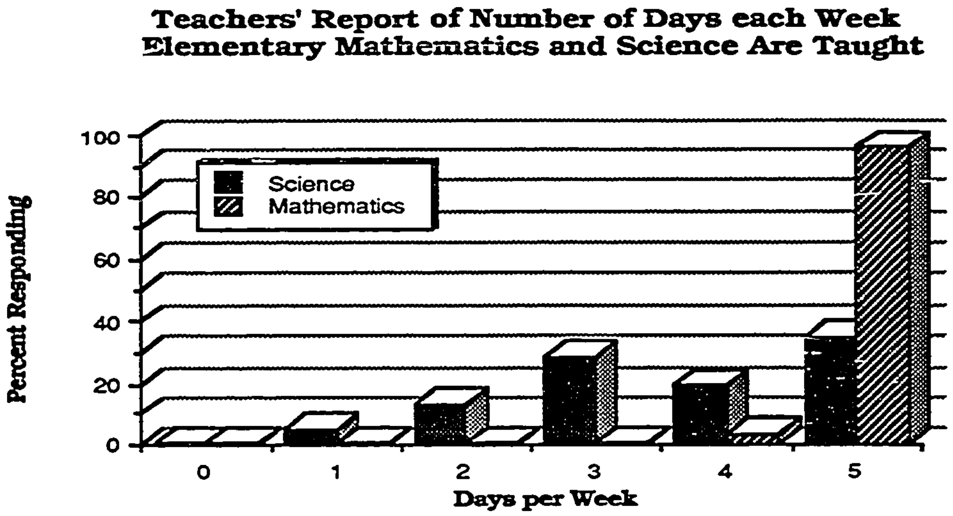
Indicator: Time Spent Teaching Mathematics and Science

Although less of a factor in the middle and high school classrooms because they were generally run by a "bell schedule," time spent on teaching was an important consideration in elementary classrooms. National statistics have been often reported for this indicator. The 1985-86 survey of a sample of elementary teachers showed that the average teacher in kindergarten through grade three spent 19 minutes per day on science and 38 minutes on mathematics while the average teacher of grades four through six spent 38 minutes on science and 49 minutes on mathematics (Weiss, 1987).

Based on the sample of elementary teachers in this study, mathematics was taught with more frequency and for longer periods of time than science in the elementary school. Mathematics lessons occurred 5 days per week in nearly all elementary classrooms and were nearly one hour long. In comparsion, science lessons were taught 3.9 days per week in elementary classrocms and the average science lesson was about one-half hour long. Figures 3 and 4 show the difference in time spent for mathematics and science lessons at the elementary level.

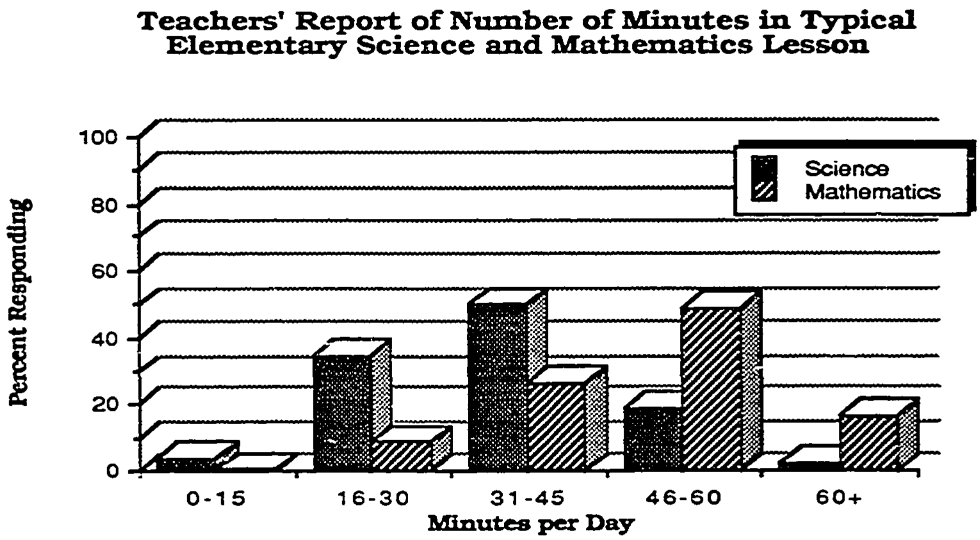
Discussion

Schools and teachers may require special incentives to encourage their implementation of recommendations that can strengthen the curriculum. One major barrier in schools was the domination of textbooks as the primary instructional tool. Heavy reliance on textbooks, as reported in the next chapter in more detail, served to broaden the curriculum rather than reduce the number of topics in the curriculum. The problem of not approaching fewer



source: T. Dana, 1991 MSCE implementation study

Figure 3. Teachers' Reports of Numbers of Days Each Week Elementary Mathematics and Science Are Taught



source: T. Dana, 1991 MSCE implementation study

Figure 4. Teachers' Report of Number of Minutes in Typical Elementary Science and Mathematics Lesson

topics with greater depth may be due to teachers' and curriculum supervisors' lack of alternatives for teaching mathematics and science. A lack of alternative strategies for teaching may have contributed to teachers' lack of integration of computers into the mathematics and science curriculum, teachers' lack of integration of mathematics and science into other subject areas, teachers' lack of integrating historical, environmental, and science-technology-society themes into the curriculum, and teachers' continuance to teach more topics with less depth instead of the recommended less topics with greater depth.

Furthermore, many K-12 teachers indicated that they did not have the kinds of materials needed to teach an activity-centered curriculum. Although there is no guarantee that having more materials available will lead to an activity-centered classroom, their availability may facilitate trying new instructional approaches that require their use. In addition to manipulatives and other resources, updated microcomputers and appropriate software need to be available to all teachers for instructional purposes for similar reasons. Flexibility in the way funds are allocated and spent might resolve part of this problem. Texts, manipulatives, and instructional technology might be best considered all to be instructional materials and funding targeted to those three separate areas might be pooled and spent in a manner determined by local needs and preferences.

In addition to materials, teachers may need opportunities to make sense of what it means to learn with understanding and to develop a vision of what good mathematics and science teaching can look like. Throughout the year, on-going formal and informal professional development opportunities may need to be made available for K-12 teachers to assist them to learn ways to integrate computers into the mathematics and science curriculum, integrate mathematics and science into other curriculum areas, integrate historical, environmental, and science-technology-society themes into the mathematics and science curriculum, and, in general, plan for and teach a hands-on/minds-on curriculum.

CHAPTER 4

MAKING MATHEMATICS AND SCIENCE MORE EXCITING

Improving mathematics, science, and computer education requires more than strengthening the curriculum. Also needed are fresh approaches to teaching these subjects which move away from the idea that information is dispensed from the teacher or textbooks to one where the students are actively engaged in exploring and understanding natural phenomena. The Comprehensive Plan addresses the need to improve the way teachers teach and the opportunities students have to learn. In order to revitalize the learning environment, Goal 2 of the executive summary of the Comprehensive Plan recommended that schools make mathematics, science, and computer education more exciting. Specifically, the Comprehensive Plan recommended that:

- Mathematics, science and computer applications should be exciting, challenging, and rewarding to learn.
- Posing problems and working out sclutions allows students to develop broad insights and understandings into their world.
- A student-centered, active-learning, classroom environment must be established which includes innovative teaching methods, laboratory-type activities, and cooperative learning.
- Teachers need resources and support to make mathematics, science and computer education exciting.

- A variety of instructional technology should be available and used by both teachers and students.

Why make learning more exciting? There are likely many answers to this question. The Comprehensive Plan recommended that teachers adopt a " 'spirit of science' approach to teaching that would engage students in activities, assumptions, and attitudes of real scientists" (p. 25). With this approach, it was assumed that students would be thoughtfully engaged in developing and testing solutions to problems. Similarly, in Science for All Americans, Rutherford and Ahlgren (1990) stated that students of mathematics, science, and technology needed to have many varied opportunities to engage in the thoughts and actions that are typical in the field. They recommended that good teaching began "with engaging students in posing questions and seeking solutions to phenomena that are interesting and familiar to students, not with abstractions or phenomena outside their range of perception, understanding, or knowledge" (p. 188). The kind of learning called for in both the Comprehensive Plan and Science for All Americans is not typical in most schools at present. These ideas about teaching and learning require most teachers to reconsider what it is they do in the classroom. In many cases, teachers' roles would need to be reconceptualized in order to be more consistent with the notion that the teacher is a facilitator of learning rather than a disseminator of knowledge.

The purpose of this chapter is to present findings and interpretations associated with the goal of making learning more exciting. As with the previous chapter, findings are arranged by levels: state, district, and school. Within each level indicators are listed, data are presented, and interpretations are made.

State Level Data

Major indicators at the state level were concerned with budgetary considerations, the Legislature, and policies. Also of interest were categorical programs and initiatives that might have impacted the ways in which mathematics and science could be made more exciting.

Indicator: Expenditure of State Funds for Mathematics and Science Education

Providing funding for districts to implement programs that were consistent with the goals and recommendations of the Comprehensive Plan was an important role of the state during the past two years. Although there was no coordinated funding package that accompanied the Comprehensive Plan to facilitate its implementation, it was believed by legislators that current funded programs would meet districts' needs in implementing the plan. However, recent funding cuts in response to a weakened economy have impacted state and local efforts to improve mathematics and science education. Many of these cuts came in areas that were designed to enhance the learning opportunities for students. For example, the 1990 Florida Legislature appropriated almost $40 million for categorical programs in mathematics and science education. Those appropriations included:

- $10 million paid to districts as an incentive for increasing student enrollment in upper level mathematics and science courses.
- $25 million for science laboratory construction and renovation. This was approximately 5 percent of the total need estimated in a 1989 science laboratory facilities study. Middle schools were to receive priority according to this study.
- $25 million for districts to purchase lab equipment and materials for courses that included 72 hours per year of hands-on laboratory experiences. Half of this money was not spent by districts in 1990-91 and was returned to the state cofers.
- $1.44 million to cover partial costs for approximately 7000 students (less than 0.4 percent of the total student enrollment for fall 1990) who participated in mathematics, science and computer summer camps at a cost per student hour ranging from 73 cents to $8.11.

Unfortunately, the 1991 Legislature cut or reduced all of the programs listed above except for the $25 million for laboratory construction. The incentives and high cost laboratory materials received no appropriation for 1991-92, and summer camps received $644,983, less than half of the previous year's appropriation.

On a more positive note, in 1991 the National Science Foundation (NSF) awarded Florida a $7.8 million grant to restructure science education in grades K-8 and lower level university. This statewide project has the primary purpose of achieving systemic curriculum reform and comes at a time when local dollars are not readily available for educational needs. One potential problem, however, is that one of the criteria for receiving this grant was the commitment of matching state and local funds for project implementation. The 1992 Legislature has indicated a willingness to support this effort but final allocations will not be known until a state budget is passed some time later in the year.

In addition to the NSF funding, the state has other federal monies as well to assist in efforts to improve science and mathematics education. The Eisenhower Mathematics and Science Program (Title II) awarded Florida $5.1 million for fiscal year 1991 and increased the allocation by 64% to $8.4 million for fiscal year 1992. The additional amount was to be targeted to improving elementary mathematics and science education. It has been recommended by certain Florida Department of Education personnel that the expenditure of these monies be leveraged against the NSF Statewide Systemic Initiative project to encourage the kinds of changes that are envisioned by the state.

Indicator: Blueprint for Career Preparation Schools

The state was supportive of the implemention of Blueprint for Career preparation schools over the past two years. These schools were designed to emphasize "real world" applications of mathematics, science, and technology. Special funding was available to districts that wished to implement the Blueprint curriculum. As of the 1990-91 school year, 75 schools in 25 districts have been funded by the state to implement Blueprint for Career Preparation. An additional 123 schools were funded by districts to implement Blueprint in 1990-91, and 15 additional districts were funded for the 1991-92 school year. The 1991-92 appropriation for Blueprint implementation was $3.8 million.

Indicator: Participants and Winners of Science Fairs and National Competitions

One of the ways to judge success with mathematics and science eduction on a statewide basis was to monitor the number of students that competed in national mathematics and science events. A small percentage of Florida's students was receiving national recognition in mathematics and science, but that number has been declining. The following points serve as evidence of the decline:

1. Florida's four member national MathCounts team was ranked in the top ten in the nation for four years out of the five from 1985 to 1989. For 1989 the Florida team was ranked 6th in the nation.

2. The number of Florida students who won awards in the Westinghouse Science Talent Search was at an all time low in 1989 with only 19 winners from Florida in the top 300 and only 1 in the top 40, as compared to 1988 with 87 winners from Florida in the top 300 and 14 in the top 40.

3. Florida's students received 11.15% of the total national and international awards at the International Science and Engineering Fair, while the number of Florida students participating (78) was only 10.5% of the total participants. This was the highest number of Florida participants ever, but the number of award winners was down from 70 in 1988 to 28 in 1989.

Indicator: Support for Increasing Instructional Technology

Within this indicator it was important to analyze state data on the number of instructional microcomputers in schools, expenditure of funds for microcomputers and associated technologies, school reports on computer use, and activities of the Florida Instructional Technology Grant Program.

Florida public schools reported to the state a total of 131,367 microcomputers being used for student instruction during the 1990-91 school year. This represented an increase of 22.5 percent over the previous year for instructional microcomputers. The number of computers available represented a ratio of one instructional microcomputer for every 14 public school students. In addition to microcomputers, the number of computer workstations more than tripled in three years from 5,258 during the 1988-89 school year to 19,639 during the 1990-91 school year. Instructional systems were defined as comprehensive hardware/software curriculum packages based intended to supplement a broad curriculum.

During the 1990-91 school year, districts had available $5.055 million from the state for the purchase of approved computer software. This averaged about $2.70 per student for computer software. Other funds available to schools concerned teacher education aspects of using instructional technologies. During the 1990-91 school year the legislature appropriated $3 million for teacher education activities to promote the use and integration of computers and related technology in the classroom. Teacher workshops were developed at four different levels of computer experience and held at sites around the state for a total of 2700 participants. Due to overwhelming interest, all the workshops were expanded to include more than twice the number of participants that were planned for originally. The appropriation for this activity was cut completely for the 1991-92 school year, leaving the question of what formal staff development experiences will be available to teachers in coming years.

The state also collected data on how schools are using computers. During both the 1989-90 and 1990-91 school years the top five subjects reported by schools in a self-report survey regarding their use of microcomputers for instruction were, in order of most to least frequency of use: computer literacy, mathematics, language arts, reading, and science. According to the school reports, 54% of students used computers for computer literacy, 51% used computers for mathematics, and 32% used computers for science.

In addition to funding computer and software purchases for schools, the state also ran a prgram that permitted selected schools to design projects that would impact local instructional technology implementation efforts. Twenty-four districts were selected by the state for grant awards under the 1990-91 Florida Instructional Technology Grant Program for a total of $6.9 million. The projects were designed to address the ways in which technology could be used to enhance learning in highly localized settings. Of the award winning projects:

- All projects were based in elementary schools.
- Thirteen projects targeted minority and at-risk students.
- Eight projects featured improving science learning.
- Seven projects featured improving mathematics learning.
- Eight projects focused on developing higher order or critical thinking skills.
- Two projects emphasized cooperative learning.

The Legislature set the 1991-92 appropriation at $6.04 million.

District Level Data

Several indicators were used to organize data collection at the district level. District policies regarding active learning and policy changes in the past two years were foci for data collection and analysis.

Indicator: Promoting Hands-On/Minds-On Learning

There were several indicators used to make an assessment as to whether school districts were promoting hands-on/minds-on learning. The issue of district commitment to purchasing necessary manipulatives and district policies and supervisor opinions about using active learning approaches were focal points in determining the extent to which school districts valued and promoted active approaches to learning mathematics and science.

Questionnaire items for curriculum supervisors included items about both instructional materials and policies. A majority of supervisors indicated that materials acquisition for both mathematics and science instruction has increased in the past two years. Just over 85% of the mathematics and science supervisors reported an increase in the amount of hands-on materials available to elementary schools. Likewise, 67% of supervisors reported an increase in the amounts of materials going to secondary schools. While the majority of supervisors reported increases in materials, three percent of district supervisors indicated that there were decreases in the amount of materials available to teachers for instructional purposes over the past two years. It was surprising to note such widespread reports of increases in this area particularly as many supervisors also complained about having insufficient funds to maintain an effective hands-on/minds-on science program. However, it is not known exactly what an increase in materials means. It could be that a certain school, teacher, or program received some materials and others did not. It was not evident from the data the extent to which needs in the area of manipulative materials have been met or to what extent the acquisition of materials was beneficial to overall program improvement.

A corresponding trend to the general increase in materials was an increased emphasis on teaching practices that promoted active learning, particularly at the elementary school level. An increased district emphasis on encouraging the use of cooperative learning strategies was reported, again particularly at the elementary level. With respect to elementary mathematics and science , approximately 83% of supervisors reported an increase in district-level attention to instructional strategies that promoted active learning. Although the pattern was less pronounced at the secondary level, there was evidence from supervisor questionnaire responses and telephone interview transcripts that suggested cooperative learning was being emphasized to a greater extent at that level as well. Nearly 57% of science supervisors and 55% of mathematics supervisors with secondary supervisory responsibilities reported an increased attention to these types of teaching strategies in the past two years. In both the cases of elementary and secondary schools, the support came mainly from the types of staff development that were provided for teachers.

Supervisors commented that local professional development experiences for teachers focused on promoting hands-on/minds-on learning. One supervisor stated that, "All inservice programs focused exclusively on promoting alternative instructional techniques." Another supervisor also mentioned the effectiveness of local teacher workshops. That supervisor commented that there was a district emphasis on hands-on learning and that "the district has sponsored workshops that encouraged [active learning] strategies for mathematics instruction."

Another indicator of making the curriculum more exciting was the amount of instructional materials districts made available to schools as well as the funding trends for purchasing those materials. More than 50% of supervisors indicated that there were more funds to purchase equipment in science in 1991 than 2 years ago. Similarly, 46% of the supervisors indicated an increase in available funds for the purchase of materials in mathematics over the past two years. Slightly more than 10% of district level respondents reported a decrease in funds for instructional materials for mathematics and science.

Interviews with district level personnel indicated that in some cases M/STET and Eisenhower funds were used to purchase materials in conjunction with teacher professional development activities. For example, in an interview with a science supervisor it was pointed out that Eisenhower funds were used to provide elementary teachers with materials kits. That supervisor stated that:

> . . . we packaged kits with materials needed [for elementary science], they were just common materials, but never the less the principals and curriculum people at the schools have said that they have been tremendously valuable, having everything packaged and at hand. The teachers have used that very nicely.

> The kits contained materials like plastic beakers. In some cases it is supplies like bags of rice and things that are used in measuring and volume studies. But everything is packed in plastic tubs and the teachers, to do a particular activity, all she has to do is go and pull that off of the shelf and there is everything there. The testimony is that they are using it, loving it. It is not sitting on the shelves.

The availability of kits of materials seemed to be a useful resource for teachers, particularly in the small school district cited above. In some cases the materials in kits were not associated with teacher education funds and it became the responsibility of the district to design the kit and maintain the supplies. The following excerpt from an interview with a Director of Elementary Mathematics Education provided some indication of how one district approached kit use and maintenance:

> [The district got] some kind of a grant, and got the money to build the kit, and we have been using it for four or five years now. There just is not enough hours in the day for it to be on the road. It goes from both sides of the county and when things need to be replaced, usually the high school teacher looks at it and says oh well I have got that in the lab and she fixes it up. It is something that kind of regenerates itself.

Based on the data from supervisors, many districts supported teacher instructional needs by providing a variety of materials.

A concern that was expressed by some supervisors is the high cost associated with materials acquisition and maintenance. Districts have little flexibility in state allocated funds for instructional materials in the sense those funds are earmarked for more long-term features like textbooks. Furthermore, there appeared to be local pressure to limit the costs involved with running "hands-on" programs even though local funding has increased in the past two years. Several district supervisors alluded to the benefits of locally developed and maintained kits of simple manipulative supplies. It seems likely that the trend of having simpler materials available will continue -- a trend that would be consistent with the intent of the Comprehensive Plan. However, it is not clear what influence state and local funding policies will have on this trend.

Indicator: Policies on Textbook Use

The way textbooks were used was an issue in determining whether mathematics and science were becoming more exciting. The Comprehensive Plan can be interpreted to suggest a reduced emphasis on textbooks is needed in order to make mathematics and science more exciting and the curriculum more relevant to the needs and interests of students. Data from district supervisors indicated mixed opinions as to the place of textbooks in mathematics and science teaching. Several examples selected from written comments on the supervisors' questionnaires represent the range of views on textbooks and policies in relation to textbook adoption and use:

> The textbook is one of many instructional aids. Teachers are encouraged to use a variety of resources but there is a district-based buy in.
>
> Textbooks are intended as a resource to teaching in a hands-on-based learning approach.

> Standardized textbooks are in use in most/all areas. Teachers are also encouraged to utilize all county approved instructional materials to meet the varying needs of students.
>
> Our elementary course of study encourages general adherence to the scope and sequence of the adopted series (text) but encourages teacher creativity where strategies and activities are concerned.
>
> The science series are to be used as tools. District created grade specific hands-on science experiments are just as important.

While the majority of supervisor comments were like the ones above indicating general support for texts having a less dominant role in mathematics and science instruction, there also were examples of supervisor comments that might be inferred as being contrary to the intentions of the Comprehensive Plan. Some of those comments were:

> Each student must have access to an approved textbook.
>
> The only policies we have are that all elementary teachers must use the same text. This is also true for the middle schools. High school teachers in the county must use the same text for given courses.
>
> There is a single book adopted by the county teachers. Special permission must be obtained to use anything else.
>
> Students complete one grade level textbook before going into the next level. District developed mastery tests per grade level must be administered and successfully passed before going onto the next textbook.

These varying opinions can be interpreted as meaning that a variety of messages are being sent to teachers around the state with respect to scope and sequence, textbook use, and hands-on/minds-on learning activities. The comments also support the notion that implemented mathematics and science curricula may be driven strongly by texts (National Center for Improving Science Education, 1989).

Reform in the areas of strengthening the curriculum and making learning more exciting might require a closer examination of the role texts and other instructional materials currently play in day-to-day classroom activities. From a policy perspective the intentions of the Comprehensive Plan are being implemented in all school districts with equal enthusiasm. The supervisor data should be of great concern to Department of Education personnel who wish to see districts use the Comprehensive Plan as a local policy tool.

School Level Data

Indicator: Using Teaching Strategies that Promote Active Learning

No matter what district or state policies dictate about promoting active learning, what happens in classrooms is what ultimately counts. A set of indicators were chosen for this study about teacher use of instructional techniques that supported active learning. Specifically, data were collected about teacher use of hands-on/minds-on approaches, problem-centered learning, and cooperative learning. Data were collected on this indicator via questionnaires. In addition to the numeric responses, many teachers also included comments about using these approaches with their students. Both types of data are presented here to document what happened in classrooms over the past two years.

With the exception of high school science where many districts required teachers to engage students in formal laboratory activities so they could receive additional state funds, the use of active learning strategies was greatest at the elementary level. Hands-on approaches were reported as used more frequently with mathematics lessons than science lessons at the elementary level. This was evidenced by teacher reports of student use of manipulative materials for mathematics and science and teacher reports on how their use of active learning strategies has changed over the past two years. Almost 50% of elementary teachers indicated that nearly all of their mathematics lessons involved the use of manipulatives and nearly 25% said the same for science lessons. Furthermore, nearly 75% of elementary teachers reported an increase in their use of active learning approaches with students over the past two years.

In contrast, just over 17% of middle school science teachers in the study reported that they engaged students in hands-on activities in nearly all of their lessons. However, it was encouraging to note that 38% reported that their use of these strategies has increased in the past two years. Three-quarters of high school science teachers reported that nearly all of their lessons involved active learning approaches. Like the middle school science teachers, 40% of high school science teachers indicated that there was an increase in active student involvement in the past two years.

Teacher comments documented the perceptions of teachers. One middle school science teacher noted that he or she has changed the approach to laboratory activities by making them more inquiry- and collaborative-based:

> While we may do one lab a week, it is now an open-ended, inquiry-style lab, sometimes lasting the whole week. So while we may actually be in the lab room only 2 days of the week, the students may be in their groups to graph, evaluate, or write conclusions the rest of the week.

Other teachers were not as positive. A high school science teacher indicated that labs are never done anymore in lower level classes because of student misbehavior. That person said:

> One year I had all the basic students and we did 3 to 4 labs per week. That year it worked because we had a good after-school detention program. We also had small classes (20). Unless those situations exist again I will not do labs with those science classes. It has been my experience that the children would rather destroy equipment than use it.

Having proper materials also was an issue for some teachers. All teachers indicated that a lack of suitable materials was preventing them from using manipulative materials in lessons.

For mathematics, the story was much worse than science. In middle school mathematics, just over six percent of teachers indicated they used hands-on/minds-on approaches with nearly every lesson. High school teachers' reports were about the same with just over seven percent of them reporting use of active learning strategies with nearly every lesson. Interestingly, nearly three-quarters of the middle school mathematics teachers indicated that they have given increased attention to hands-on/minds-on approaches in the past two years while almost none of the high school teachers admitted to increased attention.

Teacher use of problem-centered learning was another indicator that signified moves towards active learning strategies. Fifteen percent of all teachers indicated an increase in their use of problem-centered learning activities over the past two years. A greater number of mathematics teachers indicated this change as compared to science teachers, with the majority of those mathematics teachers being from the middle school level. Also, nearly 50% of elementary teachers indicated they involved students in more problem-centered learning opportunities during 1990-91 than in the two prior years.

One of the more popular strategies that teachers incorporated into their repertoires was cooperative learning. Cooperative learning strategies were employed by approximately 90% of all teachers at some time during the school year. It was noted that cooperative learning was reported to be used more in secondary science classes (98%) than in secondary mathematics classes (79%). Again this focus in science may be due to mandated laboratory activities associated with supplemental funding. At the elementary level, 96% of teachers reported the use of cooperative learning strategies with their students at some point during the school year.

Interestingly, the issue of the way teachers make sense of classroom control may be influencing the implementation of active learning strategies. Many teachers indicated that involving students in active learning was giving up their control over the classroom. One middle school science teacher commented that while she believed in cooperative learning, she would "only let students work together during the second semester." Along similar lines, an elementary teacher reported that cooperative learning "made the class too loud, but it is OK on Friday."

Comments such as these lend support to the notion that "top-down" policies which call for changes in the way teachers teach may be met with only limited success (Firestone, 1989; Sarason, 1982). Teachers who do not understand the intent or rationale for changes will not be likely to implement those changes (McLaughlin, 1987; Tobin, 1991). In this study, teachers' comments regarding the implementation of cooperative learning strategies to teach mathematics and science may be a good example of the limited success of top-down reform. Although scholars such as Slavin (1987) and Johnson and Johnson (1989) attest to the benefits of cooperative learning and Wheatley (1991) asserted that cooperative learning was a vital ingredient to the promotion of active learning in mathematics and science education, teachers' perspectives on cooperative learning are the driving forces behind how it is implemented in a classroom. Although a large percentage of teachers reported implementing cooperative learning strategies at least once during the school year, teachers' comments indicated that although they may use cooperative learning, it may occur as a Friday afternoon "add on" while traditional types of science and mathematics instruction are the norm during the rest of the week.

For this reason, it is imperative to build in strong teacher education components to all policy changes that are expected to influence classroom practices. Professional development activities which encourage teachers to consider the rationale behind an innovation, to create a vision of what it could look like in their classroom, to construct a commitment to implementing the innovation, and to reflect on what ways the innovation is and is not working has been reported as being a successful model by researchers into teacher learning such as Tobin and Jakubowski (1990), and Shaw and Etchberger (in press). Further implementation efforts associated with the Comprehensive Plan through 1999 should take into consideration what is known about teacher learning by increasing teacher involvement in implementation at the local level.

Indicator: Availability of Instructional Materials

A complement to using active learning approaches was the reported availability of a variety of instructional materials. Some of the data in the previous section contributed to the notion that many teachers believed that active learning was more of a hands-on process than a minds-on process. Accordingly, the perceived availability of instructional materials may have influenced the kinds of activities that were implemented in classrooms.

Basic instructional materials were accessible by nearly three-quarters of all teachers. Based on teacher reports, three points can be made:

1. The majority of middle and high school science teachers had easy access to general science equipment such as inclined planes, chemicals, glassware, and batteries, and limited access to costly equipment such as lasers and projecting microscopes.

2. Two-thirds of middle and high school mathematics teachers had easy access to metric measurement devices and geometric models.

3. Ninety-five percent of elementary teachers reported access to some type of science and mathematics instructional materials.

Indicator: Use of Manipulative Materials

Similar to the two previous indicators, this indicator focused on manipulative materials. Based on questionnaire data, manipulative materials were used more frequently for elementary mathematics lessons than science lessons. Three-quarters of elementary teachers in this study reported involving students in hands-on lessons to a greater extent recently than they did two years ago.

Conversely, manipulative materials were used more frequently for middle and high school science lessons than mathematics lessons. Again, this was likely due to mandated science laboratory activities at the secondary level and the traditional approach of providing a separate lab component for high school science classes. Nearly 80%

of middle and high school science teachers reported they incorporated the use of manipulative materials into lessons at least once a week, 50% of middle school mathematics teachers involved students in using materials at least once a week, and 29% of high school mathematics teachers had students use manipulative materials at least once a week. Figure 5 summarizes the responses of all teachers to the question on the use of manipulative materials with students.

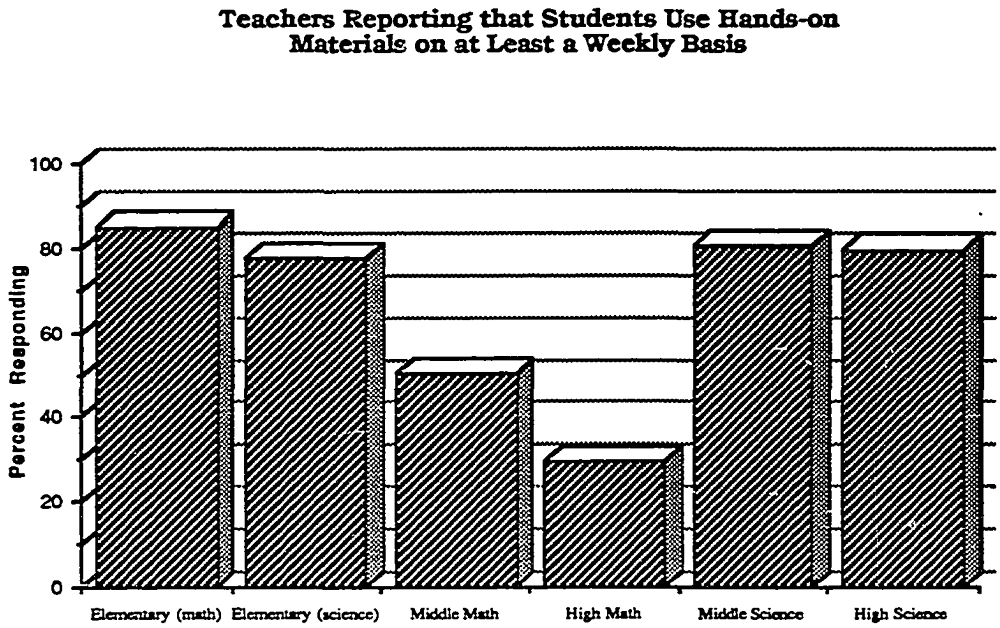


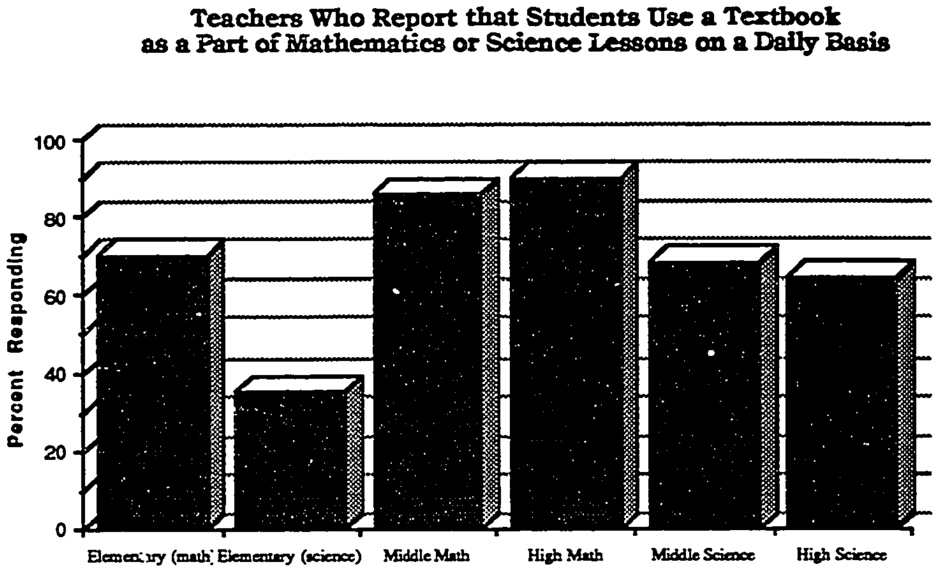
Figure 5. Teachers Reporting that Student Use Hands-On Materials on at Least a Weekly Basis

Data collected from a question regarding suitability of manipulative materials to enhance learning indicated an interesting trend. Although not a very large number, 19% of middle school mathematics teachers and 15% of high school mathematics teachers reported that use of manipulative materials such as measuring equipment was not applicable to their teaching. These figures support the notion that teachers' beliefs strongly influence what happens in the classroom. Teacher education activities that assist teachers to identify, evaluate, and possibly re-construct beliefs seemed to be missing from reform activities in most school districts.

Indicator: Teacher Use of Textbooks

Textbooks were the mainstay of mathematics and science lessons at all grade levels, although they were more of a dominating feature in secondary classrooms. As a trend, use of textbooks on a daily basis increased with an increase in grade level. Figure 6 summarizes the responses of teachers from all grade levels towards their use of textbooks.

Based on data collected from teachers, textbook use was greater in mathematics lessons than in science lessons. The biggest difference between mathematics and science textbook use was in the elementary grades where mathematics texts were used twice as often as science texts as part of lessons. Mathematics textbooks were used by just over two-thirds of elementary teachers and nearly all high school mathematics teachers.



source: T. Dana, 1991 MSCE implementation study

Figure 6. Teachers Who Report that Students Use a Textbook as a Part of Mathematics or Science Lessons on a Daily Basis

Several teachers also provided comments on their use of texts with their classes. These comments provided a descriptive dimension to the quanitative data. One middle school science teacher indicated that texts were used "primarily for homework assignments" while another said "for taking notes during class." A high school mathematics teacher said that only a "class set of the text was available for students to use during the class period and occasionally for homework." These comments, coupled with the quantitative data confirm that texts were held in high regard by most teachers as the organizer of the curriculum This was clearly not the intention of the Task Force that designed the Comprehensive Plan. Continued reform effforts will need to identify the ways texts are currently being used and use that information as a base for improvement.

Indicator: Use of Field Trips and Out-of-Classroom Activities

Placing mathematics and science in a context may be one way to make it more exciting to learn. Accordingly, data regarding field trips to museums, environmental centers, farms, and cities were collected as an indication of some ways that a context for learning may have been established. Field trips and other out-of-classroom events were used more often by science teachers than mathematics teachers. In this study, students in lower grades were more likely to have both mathematics- and science-related field trip experiences than students in higher grades. Furthermore, mathematics teachers had the lowest response rates for use of field trips and nearly all of the middle and secondary mathematics teachers indicated that these kinds of experiences were not applicable to the learning of mathematics.

Many teachers commented that they would like to take field trips with their students but cited district policies as a limit to this opportunity. Some teachers cited district policies regarding liability and lack of proper insurance. In other cases links were made to budgetary considerations. In fact, 22 elementary teachers wrote the same comment: "No Money." Other teachers wrote that they used the school yard, the school courtyard, and the playground as locations for out-of-classroom activities. However, the number of teachers using field trips, on and off the school grounds, was small in comparison to the total number of teachers in the study.

Indicator: Availability and Use of Instructional Technology

The Comprehensive Plan stated that knowing how and when to use information technologies was a requirement for children and adults in our technological society. It was further recommended that technologies should be used for a variety of functions in schools. The intent of this Comprehensive Plan goal goes beyond having students know about computers and other modern technologies to one in which those technologies are used to enhance instruction and provide new educational experiences. This section has sub-indicators of hardware availability and use, software availability and use, calculator availability and use, and video availability and use.

Hardware availability and use. School-based data generally supported the state data that indicated computer availability was quite good and getting better in Florida schools. Over 60% of the elementary teachers and nearly 75% of middle and high school teachers reported that they had access to a computer. Middle and high school teachers had more access to computers than elementary school teachers and, at the middle and high school levels, mathematics teachers had easier access to computers than science teachers.

While availability of hardware was an important consideration, use of computers ranked higher on the scale of importance in determining what was happening in classrooms since it was a more telling sign about how computers were being used to make learning more exciting. The data from this study supported an assertion that computer use is infrequent by students for both mathematics and science and declined with grade level advancement. In comparison to the percentage of teachers indicating availability, it was shocking to note that approximately 75% of all teachers in this study reported that they almost never involved students in using a computer during the school year. Reasons for the high numbers of non-use were not clear. However, computer use may be controlled by a number of factors from lack of teacher knowledge about use and how to integrate into the curriculum to the lack of appropriate software.

As important as computers themselves may be the peripherals that enhance how computers are used in classrooms. Large group display panels on an overhead projector can allow many students to see what is happening on one classroom computer. In addition to display panels, computer use in a classroom can be facilitated by networking hardware that allows several computers to be linked together so users can share applications and files. Modems can permit this kind of sharing by accessing computers at remote sites via telephones lines. Having access to each of these peripherals increases the possible ways computers can be used to enhance learning. Data from this study support the assertion that access to large group computer displays, networking hardware, and modems was quite low in most schools. Over 75% of teachers indicated that these types of peripherals were not at all available at their schools.

Software availability and use. The ways computers were used, when they actually were used, depended on the types of software available. The findings of this study indicated that there was very little software that promoted higher-level thinking available in schools. Drill and practice and tutorial software were the kinds most frequently used by students according to teachers. In general, software availability and use declined with grade level advancement. Some of the specific findings associated with software availability and use were:

1. There was more mathematics computer software available than science computer software at all grade levels.

2. All teachers had easiest access to games and drill and practice software.

3. Teachers had students use drill and practice software most often with the exception of high school mathematics teachers who had students use programming and graphics applications.

4. Problem-solving software for science and programming software for mathematics were the next easiest available types of software.

5. Eighty five percent of elementary, 75% of middle mathematics, 64% of high school mathematics, 50% of middle school

science, and 53% of high school science teachers reported some degree of access to a variety of software.

One of the potential problems associated with software found in this study was the lack of control by teachers in choosing suitable software for student use. In addition some teachers indicated that control over computers was also a problem. One middle school mathematics teacher commented:

> All of the computers and programs are handled outside of our department and we have very little to do with them. The vocational education department controls everything to do with computers at our school.

Other teachers noted problems, too. One elementary teacher wrote, "I ask for primary software each year and get nothing." One high school science teacher may have summed up the lack of control teachers have over choosing both hardware and software when he/she stated that, "They bought me Mac computer and IBM software . . . Go figure!"

Video availability and use. One last sub-indicator under using technology to make mathematics and science more exciting was the availability and use of video technology. Over ninety-five percent of teachers had access to film projectors and VCRs. Science teachers reported using film projectors and VCRs with greater frequency, about once a week, than mathematics instructors. Nearly all science teachers reported that they used videos and films in their classrooms. However, only 10% of mathematics teachers used videos. Also, teachers of lower grades are more likely to show films and videos than secondary teachers.

Videodisc players were among the latest video technology to enter Florida schools. Each school in Florida was scheduled to receive a videodisc player during 1991. However, 64% of middle and high school science teachers reported that videodisc players were not available at their school. Even those who indicated that a videodisc player was available reported not using this type of technology.

Discussion

Several themes emerged from an analysis of the data regarding what is happening to make mathematics, science, and computer education more exciting. One of those themes was the effect of budget cutbacks. The state budget for categorical programs in mathematics and science was cut by almost 50% during the past two years. In districts this concern was translated into an inability to pursue mathematics and science reform as many district supervisors linked the availability of resources to change and improvement. It can be concluded that if funds are not appropriated to stimulate future change, then some districts will be unlikely to embark on any reform of mathematics or science.

One solution that has been recommended to the Department of Education as a result of this study was to link state and federal funds for mathematics, science and computer education to the implementation of specific goals and recommendations of the

Comprehensive Plan. This focusing of funds could result in effective utilization of resources with better coordination between different programs. This procedure would also insert a level of accountability into the system so that the impact of funds and programs can be more closely monitored.

Another theme that emerged from the data was the limited involvement of students in mathematics and science activities, both inside and outside the classroom. Sometimes the best programs are outside of the classroom. The Department of Education is quite concerned about the poor showing of Florida students in national and international mathematics and science competitions. Perhaps recognition of programs that reward a large number of students for sustained effort and improvement, such as MathMania, should be promoted, and smaller and more diverse schools should be encouraged to prepare teams and individuals for mathematics, science and computer competitions.

Several classroom-based barriers emerged from the data as reasons that may limit the extent that students find mathematics and science exciting. Those barriers were:

1. The textbook was the primary instructional source across grade levels. The instructional focus was on disseminating textbook information rather than emphasizing personal enjoyment or application to the topics under study.

2. Local emphasis on state and district curriculum standards such as the Minimum Performance Standards and the Standards of Excellence supported teachers' perceptions of needing to cover many topics in a specified period of time.

3. Use of cooperative learning, problem-solving, hands-on materials, field trips appear to be limited by two factors: teachers' perceptions that these activities take too much class time and will not allow all of the specified curriculum to be "covered," and teachers' fear of teaching with an approach they have not experienced and with which they are not comfortable. The fear, in several cases, was attributed to a belief that some control over both students and content might be lost.

Like other approaches which encourage active learning, there was difficulty in incorporating instructional technologies into learning opportunities being provided for students. Barriers regarding the use of instructional technology also emerged from the data:

1. Enhancing the curriculum with technology to make it more exciting was viewed as requiring special funds in order to be implemented for both initial acquisition and teacher education.

2. Districts focused on hardware acquisition. Although the computer to student ratio decreased, hardware use lagged behind in comparison. Districts, and consequently teachers, lacked a comprehensive approach to integrating instructional technologies into

existing classroom structures to enhance mathematics and science instruction.

3. Teachers' lack of knowledge of how to integrate technology into their classrooms was a paramount problem.

4. Some types of instructional technologies, such as computers or videodisc players, were perceived by teachers as not easily available. Due to this perception, such equipment was not integrated into classrooms as often as equipment to show videos which were more easily available.

These two sets of barriers represent a major obstacle in achieving the goal of making mathematics and science more exciting. The barriers can be overcome by helping both supervisors and teachers in planning instructional practices that actively involve students. On-going formal and informal staff development should be planned and implemented to assist all supervisors and teachers in learning ways to utilize a variety of learning activities using both manipulatives and computers. Appropriate professional development opportunities should be developed and implemented for both teachers and supervisors to learn about innovations such as use of hands-on strategies and materials. In addition, supervisors may need assistance in conceptualizing that many of the recommendations in the Comprehensive Plan may require education of teachers rather than the acquisition of additional resources solely.

Finally, schools can be encouraged to utilize the goals of the Comprehensive Plan as they draw up their School Improvement Plans during the Spring of 1992 and in the future. The school accountability movement is likely to have a profound influence on the ways innovations take hold in schools. By encouraging schools to develop a comprehensive improvement plan that includes items that would make mathematics, science, and computer education more exciting, it may be more likely that change in the desired direction will occur in schools.

CHAPTER 5

PREPARATION AND ENHANCEMENT OF MATHEMATICS AND SCIENCE TEACHERS

The Comprehensive Plan emphasized the need to provide structures, resources, curriculum, and support systems to allow mathematics, science and computer teachers to develop exciting opportunities for meaningful student learning. To that end, the revitalization and professionalization of teaching was a major priority of this plan, both at the prospective teacher education and practicing teacher education levels. According to the plan, a professional environment was required which assisted teachers in making decisions about how to best meet local and state goals for educating students. Furthermore, the plan also recognized that elementary, middle and high school teachers needed to know more about mathematics, science, and the use of computers about the variety of teaching strategies which could be used to promote learning with understanding.

With respect to initial teacher preparation, two major indicators, teacher supply and demand and teacher quality, have been monitored closely on a national level (Blank & Dalkilic, 1990). National data on supply and demand indicated that there was not as severe a shortage of mathematics and science teachers as was predicted in the early 1980s, and that shortages were highly variable by state. Teacher quality, on the other hand, is a variable that is not well defined nationally. The Council of Chief State School Officers (Blank & Dalkilic, 1990) recommended collecting data on number of certificates awarded and number of teachers teaching out-of-field as part of a data set that provided an indication of teacher quality. Data of this nature are somewhat limiting as they do not provide any information about teacher knowledge and skill or actual teaching practices. In this study, the concept of teacher quality was extended to include teaching practices. Self-report data were collected from teachers as to their perceptions of their teaching practices.

This chapter focuses on issues associated with the education of prospective and practicing teachers of mathematics and science. Of particular interest are issues they relate specifically to the implementation of the Comprehensive Plan. A series of indicators was used that combined data collected about teacher education by the state and data collected directly from teachers. As with other chapters, there are three major sections in this chapter, one each for state, district, and school data.

State Level Data

This section focuses on data collected at the state level. The majority of the data were concerned with supply and demand issues. The state had a great interest in making sure there was a sufficient number of qualified teacher candidates to fill vacancies in mathematics, science, and computer education. Also of extreme interest was the continued professional development of teachers in the field. Therefore, data regarding what the state referred to as "teacher updating" is also presented in this section.

Indicator: Teacher Supply and Demand

One of the greatest concerns of the state was the availability of qualified teachers to teach mathematics and science courses. Based on state data, there was no shortage of mathematics and science teachers. For fall 1990 the number of mathematics teacher vacancies was 378 and the number of science teacher vacancies was 424 while there were just under 1000 new teaching certificates awarded in each of those areas in 1990. Table 9 presents the number of vacancies in relation to the number of certificates awarded.

State data on teacher supply and demand need to be more closely examined. In order to fully understand what is happening on a statewide basis, data are needed which indicate the number of graduates from teacher certification programs categorized by specific certification area, the number of vacancies in each specific science and mathematics area, the number of teachers teaching out-of-field for each mathematics and science area, and a tracking of how many newly certified teachers are choosing to take jobs outside the teaching profession or outside the State of Florida.

Table 9

Mathematics and Science Vacancies and Certificates

	Math Vacancies Reported	Math Certificates Awarded	Science Vacancies Repoted	Science Certificates Awarded
1989	418	2012	418	1674
1990	378	1222	424	1226
1991	NA	935	NA	978

Indicator: Expenditures for Mathematics and Science Staff Development

Approximately $33.2 million was appropriated from 1989 to 1991 by the Florida legislature specifically for staff development in mathematics, science and computer education. Table 10 summarizes appropriation levels since the inception of the Comprehensive Plan. Other funds were available as well to enhance professional development in mathematics and science. Another $18.2 million was allocated to the state for teacher enhancement over the same period by the Federal government through the Eisenhower Mathematics and Science Program (Title II).

Table 10

Appropriation Levels for Teacher Enhancement Programs in Mathematics, Science, and Computer Education

Teacher Enhancement Program	1989	1990	1991
Summer Inservice Institutes	$8.3 million	$7.4 million	$6 million
Elementary Math/Science (M/STET)	$2 million	$2 million	$1 million
Summer Honors Symposium	$500,000	-0-	-0-
Mentor Teachers	$250,000	$250,000	-0-
Teacher Stipends	$500,000	$500,000	-0-
TeacherQuest	$500,000	$500,000	$500,000
Instructional Technology (InTech)	-0-	$3 million	-0-
Eisenhower Mathematics and Science Program	$4.8 million	$5.1 million	$8.3 million

District Level Data

Two areas were of most interest in collecting data from district supervisors. First, was the issue of supply and demand of teachers, particularly as it related to supervisors' perceptions on the difficulty in hiring qualified teachers. Second, was the issue of what attention had been given to staff development at the district level.

Indicator: Difficulty in Hiring Qualified Teachers

A set of items on curriculum supervisor questionnaires focused on the difficulty school districts had in hiring teachers in specified content areas. These items indicated that hiring qualified teachers was most difficult in the areas of physics (76% reported difficulties), chemistry (63%), and honors/advanced placement science courses (57%). In contrast, relatively small percentages of district level supervisors reported difficulties in hiring qualified faculty to teach biology (7%), life science (7%), and physical science (11%). It also appeared that there was less difficulty in finding suitable teachers for mathematics. Thirty-seven percent of supervisors indicated difficulty in finding qualified teachers of mathematics, 60% for computer science, and approximately 50% for honors and advanced placement classes.

District level data on teacher supply and demand suggest that there is still a need to address the goal of providing more qualified teachers of mathematics and science throughout Florida even though there appears to be a surplus of teachers according to state data. Certain areas of science will require more recruitment effort than others, and all areas of mathematics and computer science require attention.

Districts should be encouraged to develop local plans for finding qualified teachers and apparently at least one district was doing this. One science supervisor noted:

> Using the Eisenhower funds [we] will add on a certification program ... for physics. We have about 25 teachers that want to add physics to their certification by going through that two year program.

Districts may wish to combine resources to develop a pool of qualified teachers who can be certified in areas where there are shortages.

Indicator: District Efforts at Professional Development

There were several state and federal programs that district curriculum supervisors indicated were helpful in local efforts at improving mathematics and science education. The most helpful programs can be categorized as ones that offered the greatest entitlement with the greatest flexibility in implementation. Nearly all supervisors of both mathematics and science indicated that Summer Inservice Institutes, Eisenhower Mathematics and Science Program (Title II), and Mathematics/Science Teacher Enhancement Training (M/STET) were most helpful in achieving local teacher professional development goals.

These funds were apparently very improtant to districts. In many cases, the only staff development in mathematics and science was facilitated through the use of Title II and M/STET entitlements, particularly when the staff development was for elementary teachers. One district science supervisor was especially enthusiastic about how

Title II and M/STET assisted staff development in the district. That person commented:

> We have a variety of things going on. We have some very successful summer institutes. Our science institutes are probably one of the best things that has happened in many, many years as far as improving science instruction. Currently we have two going on, and three finished up in June. We have been able to offer . . . many more science components to science teachers. Elementary and secondary use of Eisenhower or Title II funds have been a tremendous benefit. We have been able to send teachers to professional meetings and conferences which we had not been able to support. The Eisenhower funds enabled teachers to go to conferences and meetings and to go to training outside the district. That was a great help for a lot of teachers. It helped morale and motivation. They brought back tremendous amounts of material they could use and share. Other successes have been with our state M/STET funds. We have joked in the district in that we have said things like "for seventy thousand dollars or so we have gotten from the state in M/STET funds we probably have given them a quarter of a million dollars worth of staff development training." Our people really have jumped on those funds, combined them with other things that were available, to do some pretty good programs. What we have done with the M/STET funds is develop one year using a consultant, the other year using our own resource teachers [emphasizing] math/science integrated lessons, mainly around graphing and measuring, very neat hands-on science activities, incorporating the math and the graphing skills, the measuring skills, and mathematics.

Since the late 1980s, there were increases to the state from the federal government for Title II dollars and those increases were translated into more funding available to districts for elementary teacher enhancement. For example, one science supervisor noted that:

> We probably offer 80 to 90 percent of our science components of staff development at elementary. We do far more work with the elementary teachers in science than we do in training secondary teachers. [For grades] K through 5, we trained teachers for their

> own school. Then they go back and deliver the lessons at their own schools.

The trend of increased Title II money to districts had continued into the 1990s. Preliminary plans for allocating Title II dollars for 1992-93 indicated that those dollars again will be awarded to districts to enhance elementary and middle grades teachers, particularly in support of the goals of the state's NSF Statewide Systemic Initiative. Due to the nature and intention of Title II and M/STET funds, the majority of staff development in school districts have focused on improving elementary rather than secondary mathematics and science.

Indicator: Encouraging Teacher Collaboration

Many district curriculum supervisors indicated that they wished greater funding was available to provide more formal professional development opportunities for mathematics and science teachers, especially at the secondary level. These kinds of opportunities have traditionally centered around bringing an outside "expert" to the district to run the staff development experience. An alternative to the "expert" model of improving mathematics and science education is a model that supports teacher collaboration in order to develop lessons and strategies that students should find meaningful. Both mathematics and science curriculum supervisors indicated that collaboration has increased at both the elementary and secondary levels. The data indicated that the trend is stronger in science than in mathematics and stronger at the elementary level than the secondary school level. For example, approximately 86% of supervisors reported that increased attention had been given to teacher collaboration to improve mathematics and science at the elementary level compared to 58% of supervisors making that indication for the secondary level.

School Level Data

Indicators of improvement in teacher education activities for the school level focused on the nature and quality of professional development opportunities for teachers. Accordingly, this section is based primarily on self-report data on teacher involvement with professional development activities designed to enhance mathematics, science, and computer education.

Indicator: Professional Development Opportunities

One of the first factors to determine was the extent to which professional development opportunities were available to teachers. From questionnaires of all teachers in this study, it can be concluded that mathematics, science, and computer education professional development opportunities reached slightly less than 50% of teachers. Half of all teachers reported attendance at Summer Inservice Institutes in the past two years. Furthermore, 44% of elementary teachers, 57% of middle and secondary science teachers, and 50% of middle and secondary mathematics teachers attended mathematics, science, or computer education professional development workshops during 1989, 1990, or 1991.

The types of workshops attended were also of interest. Figure 7 graphically represents the staff development experiences of elementary teachers over the past two years while Table 11 provides a summary of the types of staff development attended by middle and high school teachers. In the questionnaire, formal staff development experiences were differentiated from informal ones. Formal meant that the school district provided the workshop and informal meant that teachers sought information on the topic on their own, generally in collaboration with other teachers. Knowing what formal workshops were available to teachers provided an indication of what extent districts were focusing on staff development in mathematics and science. The specific topics of mathematics and science related workshops provided an indication of the mathematics and science areas considered to be local priorities. Formal mathematics and science staff development topics indicated most often by the different groups of teachers were:

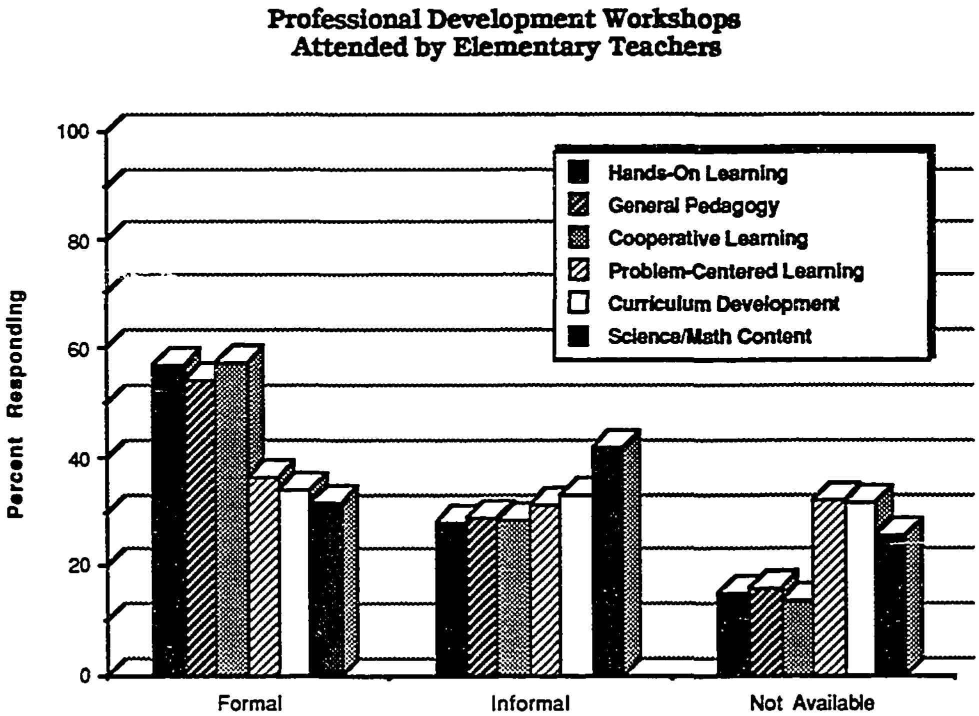
Elementary Teachers: mathematics manipulatives, hands-on science, and cooperative learning.

Middle School Mathematics Teachers: mathematics manipulatives, mathematics teaching strategies, problem-centered learning, and mathematics content.

Middle School Science Teachers: general teaching strategies for science, cooperative learning, and hands-on science.

High School Mathematics Teachers: calculators and mathematics teaching strategies.

High School Science Teachers: science teaching strategies, computer applications, science content, hands-on activities.



source: T. Dana, 1991 MSCE implementation study

Figure 7. Professional Development Workshops Attended by Elementary Teachers

Table 11

Percentages of Middle and High School Teachers Attending Professional Development Workshops

Professional Development Topic	Middle School Mathematics	High School Mathematics	Middle School Science	High School Science
Computer Applications	27.4	37.3	25.0	33.3
Calculator Use	25.0	45.6	3.2	1.3
Hands-on Teaching	41.1	32.0	50.0	46.9
General Pedagogy	43.8	41.4	40.0	35.0
Cooperative Learning	61.3	39.0	42.9	27.7
Curriculum Development	26.5	33.3	26.6	21.0
Special-Needs Students	21.6	8.1	18.7	15.2
Content	34.7	33.7	28.3	32.9
Fairs or Competitions	23.2	25.7	33.3	23.1
"Real World" Applications	17.7	22.2	15.1	21.5
Problem-Centered Learning	34.0	31.0	23.1	29.1

It can be concluded from the teacher reports of staff development experiences that hands-on or manipulative use was a

K-12 focus in science and a K-8 focus in mathematics. It is interesting to note that workshops on teaching strategies such as problem-centered learning and cooperative learning were attended largely by elementary and middle school teachers and not by high school teachers. Furthermore, approximately one-third of high school mathematics and science teachers reported that they did not attend any formal professional development opportunities in the past two years.

Some teachers commented about their professional development experiences in mathematics, science, and computer education. Those comments generally represented an enthusiasm for having useful staff development that included both workshops and classroom materials. Some examples from the comments are:

> I am really looking forward to the summer institute this year! (middle school mathematics teacher)
>
> The computer and science workshops have increased lately. (elementary teacher)
>
> I really appreciate having professional journals and other materials. I try to keep ahead on trends and advances. (elementary teacher)
>
> We need a strong, ongoing staff development program in the biological sciences as the majority of biology teachers have no preparation to teach any of the major developments (i.e., molecular biology) in the last fifteen years. (high school science)

In addition to these comments, other comments indicated that some teachers have strong feelings about the types of professional development experiences they prefer. Of these comments, teachers particularly mentioned that professional development activities on cooperative learning and other subjects that were practical and could be immediately implemented in classrooms were preferred. One middle school science teacher praised an on-going professional development project for having given opportunities to colleagues to avoid "falling back into the old ways of doing things." Lastly, a few comments were made about universities and their roles in providing professional development opportunities for teachers. One of those comments was from a high school science teacher who lamented that course times at a nearby university were not suited to a teacher's schedule and prevented attendance. Another expressed appreciation for a different university's masters degree program as a means to his or her further professional development.

The last sub-indicator under professional development had the purpose of determining the extent to which professional materials were available to teachers in schools. Most teachers reported they had access to some type of professional development materials. Professional development materials such as journals and curriculum materials were available to 85% of elementary teachers and to 75% of middle and high school mathematics and science teachers.

Indicator: Teacher Collaboration to Improve Mathematics, Science, and Computer Education

In addition to formal professional development experiences, collaboration between teachers can serve to improve mathematics and science teaching. In order to assess a degree of collaboration, teachers were asked about involvement in mentor-type programs, collaboration, and working with other teachers in their classrooms. An increase in participation in a mentor or lead teacher program during the past two years was reported by approximately 51% of all respondents in both science and mathematics. Collaboration among teachers was greatest over the past two years at the elementary level. Slightly more than 50% of elementary teachers reported increased collaboration in the past two years compared to approximately 35% of middle school teachers and approximately 25% of high school teachers. One factor in which nearly all teachers agreed was that they lacked opportunities to observe one another teaching.

Discussion

The bulk of this section is devoted to interpretations of the data collected regarding teacher professional development, especially as it related to achieving the goals of the Comprehensive Plan. It can be argued that achievement of the goals of a policy such as the Comprehensive Plan will be judged as successful when teachers are implementing the ideas in their classrooms. Since teachers were expected to do things differently in their classrooms as a result of the Comprehensive Plan, it was reasonable to assess how the state and districts were approaching the topic of assisting teachers to make changes.

It appeared to be the opinion of both state and district personnel that changes of the scope and magnitude recommended in the Comprehensive Plan might be able to occur overnight. Evidence for this assertion comes from the lack of any long-term planning for sustained implementation. The state did not commit any funds specifically earmarked for implementation of the Comprehensive Plan. Although there was funding for certain mathematics, science, and computer-related programs, state-run programs were disjointed, lacked coherence, and had no common objectives. In fact, Department of Education mathematics, science, and computer education programs were not even required to address how their programs were assisting the state in meeting the goals and recommendations of the Comprehensive Plan. Many programs supported one-shot teacher education activities with the assumption that the innovation being presented will be immediately implemented in classrooms.

Since state funding for improving mathematics and science was at an all time high level with over $52 million available just for staff development in mathematics, science, and computer education during the 1991-92 school year, it was expected that creative and long-reaching staff development might be occurring. This apparently was not the case. Staff development funds were administered by five different offices in the Department of Education and the various programs using these funds were not required to coordinate with each other or with any other staff development activities or initiatives for improving curriculum, student learning, or educational equity. In fact, only one of those offices actually had mathematics and science as their primary purpose, further supporting the notion that there was, and still is, a lack of a coordinated, long-term plan of action for implementing the Comprehensive Plan.

Similar conclusions can be drawn from the district data. District supervisors generally believe that only official programs with funding will be able to assist them in implementing the far reaching recommendations in the mathematics and science plan. In fact, several districts admitted to having innovative mathematics and science programs gave credit for their success to outside funding such as Title II and M/STET that were used to provide one-shot staff development programs. Furthermore, there was no evidence to suggest that there was a rationale for activities that supervisors chose to have as priorities other than the availability of funds. Most teacher education activities centered around improved teaching practices, supported Title II and M/STET allocations. But what about issues such as improved modes of student assessment and encouraging students from under-represented groups? It might be asserted that since special dollars were not available for these topics they have fallen by the wayside. None of the district supervisors indicated any evidence of a vision or long-term planning for local mathematics and science education. It might be concluded that many of the responses by supervisors reflected more of a reactionary stance to present situations than a sense of how the present is linked to the future.

A coordinated, systemic approach to teacher education with the express purpose of improving mathematics, science, and computer education as envisioned in the Comprehensive Plan could be developed to overcome some of the weaknesses noted above. A few points that might be considered with such an approach are:

1. Link with school improvement efforts by encouraging schools to incorporate mathematics, science, and computer education staff development into School Improvement Plans.

2. Pool state funds for staff development and leverage their use against programs that are going to assist the state in meeting the goals of the Comprehensive Plan.

3. Designate one DOE office to oversee mathematics, science, and computer education staff development, coordinating with the work of other bureaus and divisions as needed.

4. Build on successful methods which enable school-level leadership to identify, address, support and sustain professional development activities. This might require that planning and implementation of staff development activities is entrusted to teams of teachers in mathematics and science.

5. Develop strategies at the district level to promote an understanding of the rationale for change and assist supervisors and

teachers to construct a commitment to personally changing and improving mathematics, science, and computer education.

6. Plan and implement professional development opportunities which focus on improving mathematics, science, and computer education that reach more than 50% of teachers.

While the task of improving the quality of the teaching generally falls to school districts, the challenge of preparing certifiable teachers generally falls to universities. It is not clear as to what extent universities have been or should be involved in the reform of school science and mathematics and the implementation of the ideas in the Comprehensive Plan. In the design of this study, it was decided not to collect data on what was happening at the university level. Future studies of implementation will need to address this issue fully. Universities are the place most mathematics and science teachers learn the content they are expected to teach. Many national reports such as the Liberal Art of Science (American Association for the Advancement of Science, 1989) characterized the quality of science and mathematics teaching in universities as not promoting the spirit of inquiry approach called for by most reformers. If such is the case in Florida universities, and there is no reason to believe it is not, then the quality of beginning teachers in terms of their ability to engage students in active learning of mathematics and science is questionable.

CHAPTER 6

REACHING OUT TO STUDENTS AND GETTING RESULTS

Improving mathematics, science, and computer education requires a concerted effort on the part of many people. In Florida, the Comprehensive Plan addressed recommendations and set goals for a broad spectrum of people. Those people were legislators, Department of Education employees, district administrators and curriculum supervisors, school-level supervisors, teachers, students, parents, universities, and members from business and industry. In earlier chapters of this dissertation, issues such as strengthening the curriculum, making learning more exciting, and preparing and enhancing teachers were addressed. The foci of those chapters was mainly on what has happened with respect to state and district officials and classroom teachers. The purpose of this chapter is to consider to what extent goals and recommendations pertaining to educational equity, assessment, and partnerships were addressed.

This chapter is arranged in a slightly different manner than the other chapters of the dissertation. While state, district, and school level data are still presented, those areas do not serve as the organizing framework for the chapter structure. Instead, there are three major sections in this chapter based on the three major themes of educational equity, assessment, and partnerships.

The first major section of this chapter is concerned with issues of educational equity and reaching out to students. In the second section, data are presented as to what has happened throughout the state to address the ways students and programs are assessed. The third major section focuses on what has been done to build productive partnerships with parents, community resources, business, and industry. Within each of those sections data from the state, district, and school portions of this study are included. The topics of those sections are based on Goals 5, 7, and 8 of the Comprehensive Plan. Each of those goals will be further explicated in the corresponding chapter section. Data and interpretations associated with Goal 6 are not discussed in this chapter as that goal pertains to overall implementation. Those data will be presented and discussed in the next chapter.

Achieving Educational Equity

Improving mathematics, science and computer education requires that special attention be given to those groups of students who are traditionally under-represented in these areas. It was recommended in Goal 5 of the Comprehensive Plan that schools "provide greater motivation, incentives, and opportunities for minority, female, at-risk, disabled, and gifted students to pursue programs and careers in mathematics, science, and computer fields"

(Task Force to Improve Mathematics, Science, and Computer Education, 1989). To that end, the Comprehensive Plan suggested that a variety of strategies be adopted to ensure success in this area. A few of those strategies were: 1) support the development of magnet programs for the academically talented, 2) promote alternatives to tracking and ability grouping, 3) involve minority and female role models, 4) emphasize career opportunities, and 5) target students from under-represented groups that have promise for mathematics, science, and technical studies.

The state collected several types of data that can be used to assess equity in mathematics, science, and computer education. Of most use were data for course enrollments by race, ethnicity, and gender. Those data were not routinely collected by the state through the school year 1990-91. As a partial result of the need to collect these data for this evaluation of the implementation of the Comprehensive Plan, the state now requires school districts to report those kinds of data beginning with the 1991-92 school year. Other kinds of data were available, however. These data included: enrollment in remedial classes by race and ethnicity, achievement on tests by race and ethnicity, and objectives for funded mathematics, science, and computer education programs.

Indicator: Enrollment in Remedial Courses

The Equal Educational Opportunity office at the Florida Department of Education collected reports from school districts since

1988 on enrollment statistics in remedial mathematics courses across the state. Direct access to those data was not provided for the purposes of this study. However, that office reported that there was an over-representation of African-American students in remedial mathematics courses in every school district. One of the reasons for collecting these data was to monitor districts' efforts in providing equitable educational opportunities for its minority students. Districts were to have been implementing plans to change policies and approaches so that course enrollments represented groups of students proportionate to the districts' population.

Indicator: Test Scores

Districts administered a number of standardized tests to assess students' achievement in mathematics. The state required districts to report student scores on those examinations annually. At present the state does not collect any data from districts regarding student achievement in science. The data reported allowed scores to be crosstabulated by student race. Student scores from the Florida High School Competency Test were analyzed. The total number of students with passing scores on the High School Competency Test decreased since 1984 (see Table 12). The gap between the passing rates of African-American and white students increased from 23 percentage points in 1984 to 31 percentage points in 1991. The gap between Hispanic and white students has increased from 11 percentage points to 14 over the same time period. These data clearly were contrary to the notion that students from under-represented groups should be doing as well in mathematics as students not from those groups.

Table 12

Differences in Passing Rates for Florida Students on the High School Competency Test

	1984	1991
White students	92%	84%
African American students	69%	53%
Hispanic students	81%	67%

Another set of test scores that were analyzed were from the American College Testing Program. Although all students were not required to take the ACT and the scores were not representative of achievement of all students in Florida, the scores provided an indication of achievement levels of students who are primarily college bound. ACT collected demographic information about student test-takers and Florida student score information was requested but has not yet been received. However, the state collects ACT data on students from the four Blueprint for Career Preparation pilot high schools for the purpose of judging the success of those programs. Based on those ACT data, the schools can be judged as being successful in encouraging students from under-represented groups to do well in mathematics and science. At the Blueprint high schools, the gap between African-American and white student test scores was smaller than the national average in reading, mathematics and science. In mathematics the gap was less than half what it was nationally, and in science there was more than a seven point difference between the national results and Florida's students at the four pilot sites.

Indicator: Mathematics, Science, and Computer Education Program Objectives

There were several state funded programs with a focus on improving mathematics, science, and computer education available to school districts during the past two years. Generally, the funding for those programs was competitive and districts had to prepare and submit a proposal to the state indicating how they intended to use the funds. For the purposes of this study, 1991 proposals for the Mathematics and Science Teacher Enhancement Training (M/STET) program were analyzed to determine to what extent proposal objectives addressed the education of teachers about encouraging students from under-represented populations. Seventeen percent of the state's elementary schools addressed the goal for increasing the involvement and achievement of under-represented students as part of their M/STET proposals. This number of schools represents 14% of the elementary teachers in the state. The quality of these programs was not known, however. Also not known was the extent to which these objectives were implemented in programs. Due to inconsistent evaluation componenets of funded M/STET proposals, that data were not available. Future requests for proposals let out by the Department of Education may want to specify evaluation criteria so that local program effectiveness can be better tracked.

At the district level, questions were asked about local efforts to encourage under-represented students in interviews conducted with curriculum supervisors. During the interviews, district supervisors had very little, if anything, to discuss regarding the topic of under-represented students. Data collected at the district level have led to the assertion that assisting teachers to learn special strategies for teaching mathematics, science, and computer applications to under-represented students was not a priority in all school districts. Furthermore, the extent to which efforts were made to encourage under-represented students varied widely between districts.

Indicator: Equitable Access to Courses

Data about access to courses by race, gender, and ethnicity are not routinely collected by most school districts. However, one of the larger school districts in the state did collect these types of data on a regular basis. Based on the data of that district, access to mathematics, science and technology courses and materials was not equitably distributed. Specifically, the course 1990-91 prerequisites for the same computer programming course were different at each of the six comprehensive high schools in the district (see Table 13).

Table 13

Access to Courses Based on Prerequisites in One Large School District

School	Minority students as percentage of total school population	Requirements to enroll in basic computer programming course
A	15%	No prerequisite.
B	35%	Algebra 1 with a grade of C prerequisite.
C	38%	Algebra 1 with a grade of C prerequisite.
D	51%	Geometry corequisite.
E	53%	Geometry Honors prerequisite; Algebra II corequisite.
F	97%	Course not offered.

In questionnaire responses from this school district, the issue of equitable access was addressed by the curriculum supervisor. That person stated that "an equity committee reviewed records to determine disproportionalities and took the necessary steps to implement strategies to correct these areas." Other school districts are likely to similarly scrutinize access to courses in their districts as they compile these kinds of data for state review for the first time this year.

Indicator: Special Efforts for Students

Approximately 60% of district curriculum supervisors reported an increase in the special efforts or incentives used to encourage under-represented students to participate in science at the elementary and secondary levels. In contrast, 6% of the curriculum supervisors with a responsibility for science reported that such efforts had decreased over the past two years. The trend in mathematics was similar. Fifty-four percent of the mathematics supervisors for both the elementary and secondary levels reported increased efforts to encourage under-represented students. Also similar to science, approximately 5% of the supervisors with a responsibility for mathematics reported a decreased effort in this area.

Other data collected at the district level also provided insights into the special efforts that have been made in different districts. Questionnaire items associated with summer camps and science fairs provided an indication of how special programs that were intended to promote mathematics and science were perceived by supervisors. Approximately 80% of science supervisors found the summer camps very helpful or somewhat helpful. In mathematics, summer camps were seen as very helpful or somewhat helpful by 48% of the supervisors. Science fairs were perceived as very helpful or somewhat helpful by nearly 90% of science supervisors.

Particular school districts highlighted projects they employed to encourage under-represented students. In one mid-sized school district in the southern part of the state, pilot programs were implemented in four middle schools to increase the interest of females, particularly Blacks and Hispanics, by helping them enjoy mathematics and see the importance of mathematics in preparation for various occupations. Another district emphasized that it was important to encourage all students, not just those from under-represented populations. That district indicated that a youth motivator program was implemented in order to encourage greater student involvement in all areas of the curriculum.

In another district, the science supervisor commented on the value of involving role models to provide encouragement to females. That supervisor noted that a grant enabled his school district to reach out to females through a mentoring program. In an excerpt from a telephone interview, the supervisor summarized the success of the program:

> Women scientists are really wanting to take these girls under their wings, so to speak. Mentor them throughout the year. All sorts of graduate students and oceanographers are volunteering to go on the field trips with the students. There are different sites. They go to marine laboratories and go behind scenes at Living Seas [at Walt Disney World]. The girls have to have graduated eighth grade and be entering ninth grade . . . so they

> are going into high school and hopefully they will have a better background in science, be more interested in science, consider science careers, and hopefully will sign up for more advanced courses in science once in high school.

The concept of mentoring or providing role models was one that was recommended by the Comprehensive Plan. Yet, only this school district supervisor explicitly mentioned a program that was in place and apparently effective in achieving its goal. Four other school districts indicated they were in the planning phases of similar programs, each of which required partnerships with local businesses and industries in order to operate.

These findings may indicate that the few programs in place in most districts, summer camps and science fairs, are somewhat useful in encouraging students in mathematics and science and should be continued. The data may also indicate that efforts in the area of special programs may need to be stepped up. The indication that special programs may not be necessary for certain populations leads to the conclusion that not all school districts perceived a need to direct special attention towards this area. The issue seems to center on the notion that equitable means equal treatment for all rather than special treatment that will provide for equitable access and opportunities for all. In that regard, the state may need to take a leadership role in assisting all members of the educational and business communities in understanding the needs in this area.

Indicator: Special Programs/Policies to Educate Teachers about Special Needs Students

Other special programs varied greatly between districts. In one district, the supervisor indicated that extra funds were spent on economically deprived schools in the form of materials and first hand experiences for teachers' professional development. Another school district ran special workshops for guidance counselors to help them understand how to better direct under-represented students in science. The same district also made under-represented students a special focus in proposals for grants and gave special recognition to minority mathematics and science teachers.

Several school districts emphasized that they were approaching the topic of under-represented students through teacher enhancement activities. One supervisor stated that in his district "teachers are trained in using innovative teaching techniques to increase enrollment of female and minority students in science." Other professional development workshops were also geared to improving teacher knowledge in this area. Another supervisor stated that "teacher training was provided to get female and minority teachers more comfortable with math content and to provide career information about female and minority scientists." It can be interpreted from these comments that at least in the cases of these districts, teacher education was one vehicle being employed to encourage students from under-represented populations in pursuing mathematics and science.

Data regarding any special efforts schools were making to encourage under-represented students in mathematics and science were collected primarily to triangulate the statements made by district curriculum supervisors. From the district level data it was learned that several school districts have instituted programs for students while others are approaching the problem via the education of its teachers. From the school level data it can be asserted that schools are not making special efforts to encourage female and minority students to pursue mathematics and science. Just over sixty percent of middle and high school teachers indicated their schools are not making special efforts to encourage females and minorities to enroll in advanced science and mathematics courses. There is likely a close relationship between this phenomenon and the ability grouping of students at that level of school. At the lower levels of school, three-quarters of elementary teachers indicated special efforts are not being made at their schools to encourage females and minorities to pursue mathematics and science.

Other groups of students are also a concern. Students with physical handicaps are also considered to be under-represented in mathematics and science careers. When asked about special efforts for these students, over 67% of all teachers reported that students with handicapping conditions were encouraged to pursue mathematics and science. Another difference came in the general question as to whether the teachers perceived that there was equitable access to courses. Over eighty percent of teachers believed there was equal access for all students to pursue advanced mathematics, science, and computer-related courses, grades K-12.

Most teachers in this study failed to see the relevance of providing special incentives to encourage students from under-represented populations in mathematics and science. Accordingly, little positive action has been taken in this area. As with other goals in the Comprehensive Plan, this goal can be achieved by 1999 with a concerted effort on the part of the state, districts and schools to develop and implement incentives that are appealing not only to the under-represented students but to the teachers that will be implementing the incentives. Programs which involve bringing minority and female role models into schools appear to have much promise, are not very costly, and require little change on the part of administrators and teachers. The major obstacle to achieving this goal is the collective mindset that we already have an equitable educational system and that special incentives for under-represented students are not necessary. Leadership in this area is sorely needed in Florida. Businesses which complain that they want to hire minority engineers can continue to play a significant role in assisting schools and districts to encourage students by providing role models, summer programs, and financial assistance in order to increase the likelihood of success in this area.

Indicator: Alternatives to Tracking

Ability grouping is a practice which separates students into homogeneous groups based on academic ability for instructional purposes. In the Comprehensive Plan it was recommended that all students should have equitable access to high level courses and that the elimination of ability grouping might encourage under-represented students to pursue advanced courses in mathematics and science. Data collected from schools indicated that ability grouping was a common practice in most middle and high schools and was more common for mathematics instruction than for science. At the middle school, three-quarters of mathematics teachers reported that their classes were ability-grouped while 50% of science teachers indicated that classes were ability-grouped. At the high school level ability grouping was even more common with 8 out of 10 high school mathematics and science teachers reporting their classes were ability-grouped.

Although it appeared that ability grouping was a pervasive practice at the secondary level, one middle school mathematics teacher commented that there have been efforts to move away from tracking. That teacher wrote:

> At our school math classes are ability grouped on all teams except ours. The progress our kids have made is phenomenal. The county average on the midterm was 44; only 16 of our kids

> scored under the average -- most scored much above. We use cooperative learning, too! I feel very good about what we are doing.

It can be interpreted from these comments that success with some educational innovations, even a more commonly acceptable one such as cooperative learning, may be viewed with a skeptical eye by others. Testimony such as the statement of the middle school mathematics teacher cited above can be of great use in assisting other teachers and administrators in their attempts to re-conceptualize ability grouped classes.

Lessons in the benefits of not tracking might also be found in elementary schools. At the elementary school level there was an indication that ability grouping was not a common practice. Just over 80% of elementary teachers indicated that they did not ability-group students for science or mathematics lessons. From these data it appeared that students began to be tracked for mathematics lessons at the middle school level and for both mathematics and science at the high school level. There is a concern with this pattern as a mathematics course such as Algebra I is often a prerequisite for high school science courses such as Chemistry. If a student is tracked away from Algebra I into a course such as Business Mathematics, then that student has no opportunity to study chemistry or advanced level science courses if the conditions required by the prerequisites are upheld and followed.

Not all groups support the elimination of tracking, however. The National Council of Teachers of Mathematics (NCTM, 1989) confirmed that ability grouping was a concern for achieving equitable access to courses but also acknowledged that college bound students required both broader and deeper knowledge of mathematics that might not be possible without specialized courses. A teacher in this study also perceived that students needed to be grouped in order to facilitate their learning of certain subjects:

> Efforts are made [at our school] to encourage all students who are qualified to take advanced science courses. To place students into these courses merely because of race or gender and without regard for motivation or ability would ruin the courses for all students.

Like this high school science teacher, the majority of school districts included in this study perceived the need to maintain tracking in middle and high school courses. One of the intents of the Comprehensive Plan was to develop strategies that would increase the access of higher or advanced level courses to all students, especially those from under-represented populations. A stumbling block to achieving this goal is divisiveness that occurs as students are ability grouped beginning in middle school. Students are somewhat permanently placed in vocational or college bound course tracks. To be consistent with the intent of the Comprehensive Plan, districts should develop protocols which keep students' options open to switch between college-oriented and vocational-oriented classes at any point in their academic careers. This might be best accomplished by restructuring course sequencing or eliminating tracking to allow easier access to "advanced" courses. Furthermore, the quality of both college-oriented and vocational oriented courses in mathematics and science could be improved by de-emphasizing rote memorization of isolated facts and algorithims and emphasizing inquiry and problem-solving.

Indicator: Teachers

An indicator of encouraging persons from under-represented populations is the ethnic background of teachers serving the student population. The percentage of respondents from an African-American heritage in the school level study decreased from approximately 10% of the respondents at elementary school and secondary mathematics to about 4% of the respondents for secondary science. In general, most teachers who responded to the questionnaires were Caucasian, between 41 and 50 years old, and had been teaching in their school district for about 15 years. In making comparisons to national data collected in 1986 regarding teacher race in mathematics and science (Weiss, 1987), the Florida elementary schools in the sample had approximately the same percentage of African-American teachers as schools across the rest of the nation. When using the subject areas of mathematics and science as units of comparison, the schools in the sample had more African-Americans teaching mathematics at the middle school (11% compared to 6% nationally) and high school (9% compared to 3% nationally) than the rest of the nation. However, the trend was opposite for science. The Florida schools in the sample had fewer African-Americans teaching science at the middle school (4.7% compared to 6% nationally) and high school (3.3% compared to 5% nationally). Furthermore, these numbers were lower than the statewide average of approximately 12% for African-American teachers in all subjects areas in secondary schools.

The data on teacher ethnicity may indicate that African-American teachers are under-represented as science teachers in Florida's middle and high schools. While the percentages of African-Americans in middle and secondary mathematics and elementary schools were closer to the ratio in the population, a need still exists to bring a greater number of people from African-American and other minority races to the teaching profession, especially in science and mathematics education. Special programs can be arranged by school districts that perceive this need and the state can offer leadership by offering incentives to people from those populations to enter teaching, especially the teaching of science and mathematics.

Age and years of experience were two more variables where interesting comparisons were drawn. According to this sample, high school teachers tended to be older and had more experience teaching than their counterparts at the middle school. Sixty-five percent of the high school mathematics teachers reported they were over 41 years old whereas approximately 50% of the middle school mathematics teachers reported they were in that age group. Not surprisingly, 35%

of the high school teachers and 17% of the middle school mathematics teachers reported having 16 or more years of experience. Likewise, 28% of the high school science teachers reported having more than 16 years experience whereas only 11% of the middle school science teachers indicated such length of experience. The profile of age of middle school science teachers was not much different than that of high school science teachers with the majority of the respondents being in the 41 to 50 years old age group. It is interesting to note that middle school science teachers tended to be older but had fewer years experience teaching at their present grade level. These data may be interpreted to mean that middle school science teachers are experienced teachers who are moving from positions in the elementary or secondary levels to positions in middle level science education and that middle schools are a relatively recent educational phenomenon.

Indicator: Teaching about Career Opportunities

According to the Comprehensive Plan, students who learn about the variety of technical careers available may be more likely to choose those careers. An item on the teacher questionnaire asked teachers to indicate to what extent they assisted students to explore career opportunities in mathematics and science. The data may be interpreted to indicate that career opportunities were explored most often in middle and high school science classes than in mathematics or elementary classes, although the majority of all teachers reported that career opportunities were addressed at some time during the school year. Seventy-six percent of elementary teachers reported that they included in their lessons information about mathematics, science, or computer related careers at least once during the school year. Likewise, 78% of high school mathematics teachers and 84% of middle school mathematics teachers included mathematics-related career information in their lessons at least once during the school year. A larger number of science teachers reported teaching about career opportunities. Ninety-six percent of high school science teachers and 97% of middle school science teachers taught about science-related careers at least once during the past year.

It is questionable whether once a year is sufficient for teaching about career possibilities in mathematics and science. Teachers often complain there is insufficient time available to them to plan and implement all of the great ideas that others want them to do in their classrooms, such as including career information and role models. Districts can exert leadership in this area by providing teachers with opportunities to determine appropriate strategies, guest speakers, and incentives which might encourage female and minority students to pursue advanced mathematics, science, and computer courses. Furthermore, all of the strategies should be shared in some organized and widespread manner to assist other schools and districts to benefit from others' efforts. The problem of encouraging under-represented students, as well as increasing the appeal of mathematics and science to all students, is a problem that belongs to all educators, not just a select few that have the resources to solve the problem. Better communication about ideas that work and those that do not can maximize the resources available and make the goals of the mathematics and science plan more likely to be achieved.

Defining and Redefining Assessment

Statewide, district, and teacher assessments of students must be restructured to reflect the active learning strategies supported by the Comprehensive Plan. Current assessments which are based primarily on objective tests do not capture the scope and depth of students' knowledge as envisioned by the mathematics and science plan. The plan specifically set as a goal the re-examination and adjustment of the testing program to support the goals of the Comprehensive Plan. In essence, assessments should promote application, understanding, and problem-solving, should involve the use of technology, and should assess the outcomes of cooperative learning and teamwork. To that end, a set of recommendations were set forth to assist educators in restructuring assessment. Data were collected from the state, districts, and schools around the central themes of current assessments and alternative assessments with special attention given to the plans being made for future assessments in mathematics and science.

Indicator: Present Mathematics and Science Assessments

The Florida Department of Education collected mathematics and reading scores only from district-administered standardized examinations during 1989-92. These examinations varied between districts but often included the California Achievement Tests and the Iowa Test of Basic Skills. These assessments included sections that spanned all areas of the curriculum but local administrators decided which sections were actually administered to students. Although some districts tested for science as part of a comprehensive battery, scores from science portions were not required to be reported to the state. By not collecting information on science scores, the state may be sending the message that science education is not a priority area for improvement. Scores in mathematics and reading may be more highly valued as they are used more frequently to make comparisons betweens schools, districts, and states. Caution must be exerted by the state, however. If science scores were to suddenly be requested, it might lead to the interpretation that science is being given a priority but more attention might be directed to improving student performance on the assessment than on improving the quality of learning science. The tests that are currently available on a national level are not the kinds of assessments envisioned by the Comprehensive Plan, so attention to testing without first reforming the tests may actually inhibit progress towards achieving the ideals set forth in the Comprehensive Plan.

Indicator: Plans for Assessment

One of the promising trends in assessment falls under the category of alternative or authentic assessments. These assessments require students to apply knowledge of content and process to determine a solution to a problem. Many of these assessments may also require students to manipulate materials in order to solve the problem provided to them.

Across the nation states such as Connecticut, New York, and California have implemented these types of assessment in mathematics and science (Baron, 1991; Kulm & Stuessy, 1991). In Florida, a statewide Task Force was assembled in early 1991 to explore alternative assessments in all subjects. The Task Force considered assessments in several areas and chose to implement one assessment. A statewide performance assessment in writing is scheduled to begin for grade four students in April 1992. As late as January of 1992, no other performance or alternative assessments were being considered at the state level. However, in early March 1992 the director of testing for the state, after receiving pressure to consider alternative mathematics and science assessments, announced to Department of Education employees that his office is considering a move towards using multiple modes of assessment to determine what students know and to assess programs. These multiple modes would include classroom, district, and statewide assessments which may include authentic, performance, or alternative assessments at any or all of those levels. The rationale behind this move stemmed from the need to have a better assessment system in mathematics and science without having the assessments drive the implemented curriculum in a manner inconsistent with the Comprehensive Plan (Shiver, personal communication, March 20, 1992). As of this writing, there are no specific plans nor timeline for the implementation of this innovative assessment plan.

Considering alternative assessments at the state level is timely. Assessment has been at the forefront of the reform movement and other large states, such as New York and California, have already developed and implemented alternative assessments in mathematics and science. Furthermore, assessments fit nicely into the other educational activities in the state such as the School Accountability and Improvement Program. Schools are being required to consider which assessments will be used at the local level. Accordingly, revised mathematics and science assessments could be incorporated into the Accountability program, into district assessments, into the High School Competency Test, or into the writing assessment.

District supervisors' responses seemed to indicate that some attention was being given to alternative modes of assessment for mathematics and science in at least several school districts. From one district, a supervisor stated that, "At the elementary level, we are strongly encouraging teachers to use observation of lab and team activities as a source of assessment." Another curriculum supervisor stated that, "Alternative assessment at the elementary level is being initiated this year." Yet, there is a level of skepticism and doubt as to the effectiveness of implementation of alternative assessments. A supervisor from a small, northern school district stated, "Although alternatives have been presented, I believe very few teachers have chosen to make use of them." It is curious to note that any moves towards alternative assessments were made at the elementary school level. This again reaffirms an earlier assertion that change was happening more so at that level than any other. Another intepretation for this change in some elementary schools is that staff development activities associated with Department of Education initiatives focused on improving elementary mathematics and science education and that alternative assessment strategies have been a part of some of those sessions.

As noted in Chapter 4, some supervisors saw value in promoting alternative assessments through staff development for teachers. Of the eleven supervisors who indicated on the questionnaires that their districts were thinking about alternative assessments districtwide, nine indicated specifically that staff development was a means to implement alternative assessment strategies. Written comments from supervisors also support this assertion. One supervisor commented, "Just starting to discuss alternative assessment and offer inservice in that area." Another indicated, "Portfolio information has been provided at secondary level via inservice." Lastly, two other supervisors also echoed the use of staff development and coupled that with local policy changes:

> Testing policy requiring minimal use of multiple choice (scantron) tests. Presentations on alternative forms of assessment have encouraged teachers to try journals, portfolios etc. as part of assessment. Elementary teachers are using more oral communication as an assessment tool.
>
> Just starting to effect change through inservice and proposed adoption of textbooks encouraging such changes in assessment.

It might be interpreted from these data that knowledge of assessment alternatives such as performance-based assessment techniques and portfolios by curriculum supervisors was limited. Such responses might also indicate that a variety of assessments are not employed in a systematic manner districtwide. District-wide testing, whether it is alternative or other, should place as high importance on science as on reading and mathematics. From an analysis of the data collected for this study regarding assessments at the district level, increased effort should be put into planning and implementing appropriate methods of measuring desired outcomes in science and mathematics. To that end, district-based plans should be developed which encourage teachers to use a variety of mathematics and science assessment techniques the purposes of such assessments being to monitor student progress and to inform instruction as well.

Although not much effort was noted at the state or district levels for promoting use of alternative assessments by teachers, some teachers reported that they were using some of these types of assessment strategies on a regular basis. Specifically, the elementary teachers in this study reported they used alternative assessment techniques more often than middle and high school teachers. Nearly 70% of elementary teachers implemented strategies such as student observations, portfolios, and interviews at least once a week. Likewise, although not to the same extent, science teachers appeared to have embraced notions of alternative assessments. Sixty percent of middle school science teachers and 41% of high school science teachers reported that they used strategies such as student observations and interviews at least once a week. Middle and high school mathematics teachers reported they used alternative assessments least. Nearly 46% of the middle school teachers and 25% of the high school teachers reported using alternative assessment at least once a week during the past year.

An interpretation of these data support the notion that science may lend itself more easily to alternative assessments that involve student performance due to the usual laboratory component associated with many science courses. Also, elementary teachers may be more focused on alternative modes of assessment as traditional paper and pencil instruments may be difficult to administer and may not be reliable with young children. The data also are supportive of other data in this study which have pegged mathematics teachers, especially those at the high school level, as being least likely to support the kinds of change and innovation recommended in the

Comprehensive Plan. Another reason for fewer alternative assessments being employed for mathematics may be due to the pervasiveness of standardized examinations for mathematics and limited scope of teacher knowledge of assessment strategies.

Indicator: District Emphasis on Preparation for Standardized Examinations

The majority of the curriculum supervisors responding to the questionnaire indicated that policies regarding instructional time used for preparing elementary and secondary school students to take standardized science tests have not changed in the past two years. Approximately 55% of both mathematics and science supervisors reported no change. Approximately 23% curriculum supervisors reported an increase and 21% reported a decrease in attention teachers in the district have given to preparing students for these types of science examinations. The data were similar for mathematics supervisors with approximately 60% of respondents reporting no change at the elementary and secondary levels. However, at the elementary level, 30% of the supervisors reported that the tendency to focus on preparing students for mathematics standardized tests had increased in the past two years. At the secondary school level, an increased focus on student preparation was noted by approximately 21% of secondary science supervisors.

On the basis of these responses it would appear that the focusing effect of standardized tests was greater in mathematics than in science. However, it is difficult to interpret what is meant by the no change responses as they could mean that the level of student preparation is either high or low. In general, these are curious responses as the state abolished the Statewide Student Assessment Test in 1990 for grades 4 and 7 and no other standardized statewide test is currently in use for those grades. Follow-up questions to supervisors to elaborate on these responses would have yielded a clarification of what was meant by these responses and the extent to which these supervisors had direct knowledge of what teachers were doing in their classrooms with respect to test preparation.

Data were also collected from schools to triangulate findings about standardized testing. More mathematics class time was used to prepare students for standardized tests than science class time. By a 3-to-1 margin, more elementary teachers than middle or high school teachers indicated they used less class time for mathematics and/or science test preparation than they did two years ago. Likewise, about one-half of middle and high school teachers reported no change in the amount of class time they used for preparing students for standardized tests compared to less than a third of the elementary teachers. These data may indicate that along with the elimination of the Statewide Student Assessment Tests in grades 4 and 7, the emphasis on preparing students to take these examinations is also being eliminated in many classrooms.

One elementary teacher's comments reflected a concern for students' scores on standardized tests and the instructional time allocated for test preparation. That teacher wrote:

> My students' math test scores are usually high. They were unusually low this year and I am not sure why. It may have been because I used cooperative learning or because I did not prep or review for the standardized test. I would like to isolate the factor(s) myself.

It might be said that this teacher was facing the dilemma of dealing with low student tests scores and feeling that instructional decisions that were made may be the source of low scores. It should be of great concern to state personnel and administrators that student test scores are a driving force in teachers' instructional decision making. This teachers' comments suggested that cooperative learning was a new instructional strategy being tried and that it was possible that students did not learn through those lessons the kinds of knowledge they were expected to know for the standardized examinations.

It might be concluded from these data that teachers and administrators may have an understanding of assessment that limits the types of assessment that are considered to be valid and reliable indicators of student progress. Assessment was viewed almost exclusively as an end product to determine what students have and have not learned. Staff development experiences about uses of alternative assessments might be used to assist teachers in developing a set of reasons for student assessment. Furthermore, school based plans should be developed which encourage teachers to use a variety of assessment strategies with the express purpose of complementing and informing instruction. These plans should include an ongoing professional development component which not only presents teachers with a variety of assessment techniques but also assists teachers and school-level administrators in using assessment to improve programs of instruction. Plans of this nature would also fit well with the School Improvement Program.

Developing Productive Partnerships

The goals and recommendations of the Comprehensive Plan were meant to be addressed not only by schools but by the entire community. As such it was recommended in the plan to expand the productive collaboration of educators with parents, community resources, business, and industry. The intention behind this goal was that businesses, parent and community groups, governmental agencies, science museums, and universities all have a role to play in the improvement of mathematics, science and computer education.

The majority of the activity in this area at the state has occurred outside the realm of the Department of Education. Although the Department has established an office to coordinate partnerships, the emphasis has not been on partnerships which directly influence mathematics and science education in schools as intended by the Comprehensive Plan.

Indicator: Involvement of Organizations Other than Business

The Florida School Board Association (FSBA) formed a partnership with the Department of Education during the 1990-91 school year to involve local school boards in the implementation of the Comprehensive Plan. The president of FSBA, Bill Gene Smith, served as an Ambassador to the districts and enlisted their help in improving mathematics, science, and computer education. Through his encouragement, school boards endorsed a resolution to adopt the Comprehensive Plan as a district policy. All sixty-seven districts adopted the resolution by the 1990-91 school year.

Involvement of the Florida School Board Association in the implementation of the Comprehensive Plan was crucial in moving the responsibility for improving mathematics and science education beyond the realm of state policymakers. However, a school board adopting a resolution and the district office and teachers taking action are two separate issues. Although official adoption might be considered to be a crucial first step, the actions which follow from the adoption seemed to be most critical. The degree to which districts were acting on their resolutions was not clear from this study although reports by curriculum supervisors can be interpreted to indicate that there is great disparity between districts with respect to implementation.

Indicator: Involvement by Business and Industry

There has been some noticeable involvement by the business community in improving mathematics, science, and computer education across the state. At a recent meeting of the Mathematics, Science, and Computer Education Advisory Council for Florida, a prominent member of the business community called on other business leaders and educators to band together to continue productive collaborations. He cited the needs of his corporation and other high technology corporations as reasons why mathematics and science education improvement efforts must continue. His argument focused on the growing difficulty in finding qualified workers, especially those from under-represented populations.

It was for precisely that reason that the Florida Chamber of Commerce implemented a partnership program called StarMaker to identify and mentor high potential minority middle school students. By fall 1991, over 150 mentors had been educated in the goals of StarMaker from nine local Chambers of Commerce representing 40 Florida companies. Fifteen school districts and over 30 schools were involved, and between 250 and 300 students were paired with business mentors.

Another indicator of success in the area of partnerships was the extent to which partnerships were expected as a part of the day-to-day operation of state supported programs and initiatives. At least four statewide mathematics, science or technology related initiatives required partnerships in the past two years. These programs generated approximately $22.7 million in matching support from business and industry from 1989 to 1991. Table 14 summarizes the programs and the amount of matching funds generated from these partnership programs.

Table 14

Programs/Initiatives Requiring Matching Funds

Program	Allocation in 1991-92 Budget	Total amount of matching funds generated over two years
Math/Science Challenge Grants	-0-	$1.9 million
TeacherQuest	$500,000	$840,000
Instructional Technology Grants	$6.04 million	$19 million
Regional Centers of Excellence	$473,189	$1 million

The data regarding productive partnerships were limited to the business community at the state level. From these data it can be concluded that continued expansion of people partnerships, such as mentors and ambassadors, may maximize the effective use of available human resources as well as financial resources. It is not clear from these data, however, the benefits that businesses are receiving from these arrangements. However, like the state, school districts reported that they enjoyed the benefits of a variety of partnerships.

Indicator: Partnerships in the Local Community

Community resources were reported as being used by most school districts to enhance the learning of mathematics and science. One item on the questionnaire provided an opportunity for respondents to indicate how community resources were utilized in science and mathematics. Specifically, the question asked for a list of museums, environmental education centers, or other community locations that had been utilized to enhance science and mathematics lessons in the district during the past two years. A long list of places was the result. Over 172 different locations ranging from university campuses to environmental centers to the Ringling Museum of Art to the Florida Lottery Offices were on the list. However, it is not clear how specifically those community resources were utilized specifically to enhance the science and mathematics curricula.

The intent of the Comprehensive Plan goes beyond having the community financially subsidize mathematics and science education. It was clear from the list that some school districts were making extensive use of community resources in a manner envisioned in the Comprehensive Plan. For example, in an interview with a science supervisor the following example of collaboration with the community was given:

> . . . we applied for, and received, a state science summer camp grant. This summer camp is for minority females, and it is in oceanography. We are working with the University of South Florida Department of Marine Science based in Baybar Harbor in Pinellas as well as the Florida Institute of Oceanography. Through the grant we have been able to rent from the Florida Institute of Oceanography research vessels. So the girls will go out on research vessels and they will be working for female oceanographers.

The same science supervisor also indicated that a variety of community resources were utilized to enhance the science curriculum. He enthusiastically described several different resources that were used and the influence those resources were having on science education in the district:

> We have three [science museums] available to us here. We are very fortunate. We have the County Science Center which is a non-profit separate entity. They do science activities and programs for students. It is used mainly at the elementary level. We have something called Great Explorations, which is a hands-on science museum. It is used also as a field trip site. Fairly well used although the district doesn't put any money into it. We have a variety of public aquariums here. Also, we have available to us the Museum of Science and Industry. A lot of our teachers take field trips over to there.

This supervisor, unlike many other supervisors interviewed, appeared to have an understanding of what teachers were doing in their classrooms and could react to how teachers were using the resources available to them in the community. He stated:

> Our teachers do utilize educational programs at Busch Gardens, Lowery Park in Tampa, Clearwater Marine Science Center, The Pier Aquarium, and Mote Marine Laboratory. We have got a lot of stuff that teachers can take kids to and they do use them. We do

> encourage it. However, the district doesn't have the funds for field trips. The teachers have to raise the money on their own to get to these sites.

The lack of funds for field trips was cited by a number of supervisors as a limiting factor. However, the community also may have a role in assisting teachers to find the resources for their students to engage in field trips. The supervisor quoted above also addressed the financial issue in more detail:

> [Schools and teachers] have all kinds of projects and often use their recycling funds to help with that. There is PTA support. The problems comes, at least in our school district, in that there is a big disparity between the different schools. Some schools will be able to raise a tremendous amount and go to several field trip sites. Other schools with low socio-economic groups cannot and they don't take as many trips and they are often the ones that need them the worst. In the past we have been able to get our Board to provide transportation to our environmental center for every fourth grader. That is the only thing that the Board really does sponsor.

In the case of this science supervisor, community resources were high on the list as a way to enhance science learning. This supervisor appeared to understand the potential of field trips as a way to help establish a context of relevance for student learning. The supervisor also recognized the constraints associated with funds required to make the field trips work to the students' advantage. The highest priority was given by the supervisor to allocating additional funds for field trips to enable students to visit the diverse resources that are available in the local community. In the cases of all supervisors who discussed field trips the issue of funding also entered the discussion. However, this particular school district may not be similar to other districts in its attempts to encourage field trips.It might be concluded that some districts are doing a better job than others at maximizing community resources to enhance student learning of mathematics and science and that the successful strategies being employed in one district should be shared with supervisors in another district.

School level data echoed the district level concerns about limited funding available to enjoy the benefits that might be derived from an increased involvement with community resources.

Indicator: Use of Community Resources/Taking Field Trips

Approximately 4 out of 10 teachers in this study made a comment on the questionnaire next to the item about their use of field trips regarding the lack of funds available or their desire to have more funds to take field trips. Based on the questionnaire data, elementary teachers were more likely to be involved in partnerships with museums or other community groups as they take students on more mathematics- and science-related field trips than teachers in higher grades. Figure 8 presents a graphic summary of teachers' reports on feild trips.

Indicator: Partnerships with Parents

As with other trends in the data set, parental support generally decreased with an increase in grade level. Approximately three-quarters of the elementary teachers and two-thirds of the middle and high school teachers reported that parental involvement and support had been available to them during the past two years. Furthermore, items on the questionnaire asked teachers to indicate the direction of change in parental support, if any, during the past two years. About one-quarter of elementary teachers and about 20% of the secondary teachers have experienced an increase in parental support in the past two years. Less than 10% of teachers indicated a decrease in parental support with the majority of teachers reporting that there had been no change in the extent to which parents are supporting schools.

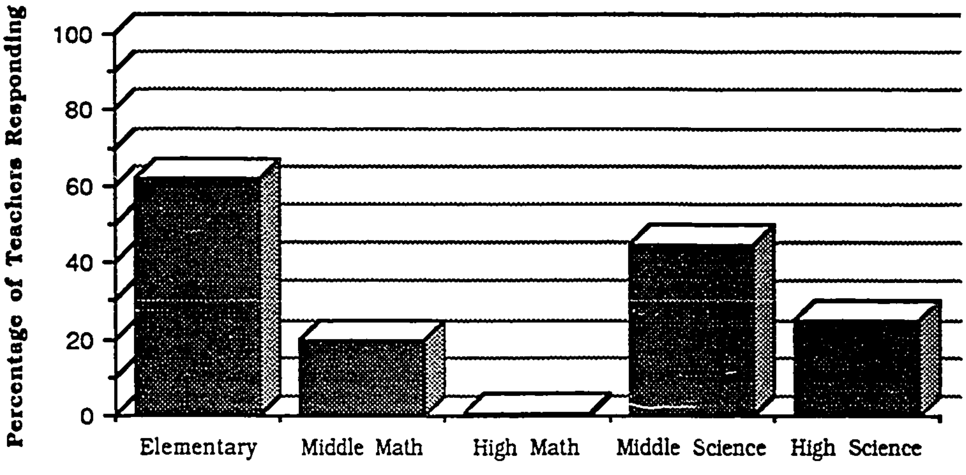


Figure 8. Teachers Who Use Field Trips at Least Once a Year

It is not clear from these data the forms of support received from parents. It is likely that the support varies greatly and only in few instances is the support generally used to enhance the mathematics and science education programs. Teachers in the study indicated they have limited direct involvement in developing partnerships with groups like parents and businesses. This, again, may be due to the perception of time constraints and the feeling of being over-burdened mentioned by several of the teachers.

CHAPTER 7

THE MATHEMATICS, SCIENCE, AND COMPUTER EDUCATION REPORT CARD: A SUMMARY OF FINDINGS AND RECOMMENDATIONS

The purpose of this chapter is to provide an overview of the findings and recommendations from the implementation evaluation. Previous chapters of this dissertation focused on specific findings associated with the eight goals of the Comprehensive Plan. This chapter presents a synthesis of all findings and provides policy recommendations to state policy-makes and stakeholders. The text of the findings and recommendations sections in this chapter are taken from the 'summary of findings' and recommendations prepared for the Florida Department of Education (Dana, 1992). The summary took the form of a "report card" on mathematics, science, and computer education.

The concept of preparing a "report card" to describe the summary of findings was suggested by Florida Department of Education personnel. The primary focus of such a document from a policy perspective was to outline whether the state was "on target" or "not on target" for achieving to goals of the Comprehensive Plan by 1999. To facilitate that purpose, an icon of an archery target and arrow was utilized in the report prepared for the Florida Department of Education. Arrows in the bulls-eye indicated the state was on target for achieving the goal by 1999 while arrows on the periphery of the canvas indicated more attention was needed. Those assessments were based on iterative analyses of quantitative and qualitative data and were negotiated with members of the Florida Department of Education during several months of on-going discussions concerning the nature of the findings and their implications for state and local policies.

Overall Findings

This section provides a summary of the findings of the study. The purpose of a section on overall findings, and another about overall recommendations, is to provide audiences such as legislators, their staffers, Department of Education personnel, and other interested parties, a brief summary of the issues which were of the most importance to the implementation of the goals of the Comprehensive Plan.

The implementation of the Comprehensive Plan at the state level has been hampered by the decentralized responsibility for administering mathematics, science, and computer education initiatives within the Department of Education and the lack of full support by the legislature. Within the DOE, responsibility for implementing the Comprehensive Plan was assigned to one office but this office did not have the authority to coordinate the initiatives of the many program offices involved. Most program offices cooperated by linking their program goals and priorities with the goals of the Comprehensive Plan. However, there was significant variation in the degree of implementation. Additionally, the legislature never enacted a coordinated funding package to implement the goals of the Comprehensive Plan. In fact, programs that contribute directly to the attainment of the goals have seen major cuts since the initial implementation year. Furthermore, present and future Comprehensive Plan implementation strategies used by the state will be profoundly impacted by the passage of the School Improvement and Accountability legislation.

With heavy focus on the implementation of specific programs, few school districts have developed a comprehensive approach to improving their mathematics, science, and computer education programs. School districts with curriculum supervisors whose responsibilities are focused on mathematics and/or science appear to have a greater understanding of the priorities presented in the Comprehensive Plan and are working towards implementation of the goals. Mathematics, science, and computer education enhancement activities were of a lower priority level for supervisors with more varied responsibilities (i.e., grades K-12, all curriculum areas).

Changes in instructional strategies of teachers were highly consistent with the intentions of the Comprehensive Plan. Although there remained a heavy reliance on passive learning activities such as textbook readings and lectures, hands-on/minds-on activities were being used on an increasing basis. Elementary teachers have demonstrated the most progress in reaching the goal of actively involving students in problem-solving and hands-on activities, and high school mathematics teachers appeared to be the most resistant to these kinds of changes.

Overall Recommendations

This study has shown that teachers, schools, districts, and the state are responding positively towards most of the goals of the Comprehensive Plan. However, a reformed curriculum which emphasizes higher order thinking requires substantial changes in classroom and supervisory practices which are likely to take many years to fully implement. To that end, three major recommendations emerged:

1. The Comprehensive Plan should be revisited to strategically address the most critical needs areas in light of progress to date. A plan should be developed and implemented to focus on how the Comprehensive Plan can come alive on a school by school basis. Authority for making decisions on coordinating program initiatives should be given to a centralized steering committee within the Department of Education. Future Comprehensive Plan implementation efforts should be closely linked to the school improvement initiative as a means for reaching all schools.

2. The Florida Legislature should enact a consolidated funding package designed to support the goals of the Comprehensive Plan.

This package should include a heavy emphasis on supporting formal and informal staff development for teachers and curriculum supervisors. Findings from this study suggest that a critical factor to successful implementation of the recommendations of the Comprehensive Plan is high quality staff development.

3. Student assessment will be the basis for the final judgment of success in the mathematics, science, and computer reform movements. To that end, a substantial and worthwhile student and program assessment system which avoids the emphasis on basic skills is required. The system must encourage student performance and application, be consistent with the highest caliber, world class standards for mathematics and science, and be capable of monitoring programmatic progress.

Findings and Recommendations Specific to the Eight Goals of the Comprehensive Plan

Goal 1

The purpose of Goal 1 was to improve the quality of the mathematics, science, and computer education curriculum. Specifically the goal recommended:

> Strengthen the K-12 curricula in mathematics, science, and computer education. The emphasis should be on student learning rather than merely content coverage so that students are prepared to succeed in a society requiring a high degree of technological and scientific literacy.

Progress in this area was considered to be the "good news story" in this study. Department of Education personnel were quite pleased to learn that there has been some progress in the area of strengthening the curriculum. In fact it was they who dubbed the "good news story" label to describe the findings associated with both Goals 1 and 2. The greatest progress was noted in the elementary grades. It can be summarized that the overall curriculum reform efforts fall short of the original kindergarten through grade 12 focus at this time. It also should be noted that progress varies between school districts around the state with more progress being made in districts which had the resources and leadership for improvement. However, all districts have made some degree of progress in this area.

Goal 1 findings. Four themes emerged from the data regarding the progress of the various school entities. Those themes were: the focus of reform efforts, the use of textbooks, subject integration, and time spent on instruction in the elementary grades.

1. Consistent with recent national reform efforts, the emphasis for mathematics and science curriculum improvement in the State of Florida was largely at the elementary school level. State, district office, and school personnel had a heightened awareness of the need to strengthen the elementary curriculum, this was evidenced by the focus of curriculum improvement in state and local efforts.

2. Teachers relied heavily on textbooks as the primary mode of instruction. Since textbook quality and innovativeness generally lags

several years behind any reform movement, most texts being used now in schools are not consistent with this goal. In addition to textbooks, current curricular guidelines and assessment procedures were perceived to place pressure on teachers to cover too many topics in little depth. These practices continue to be a major barrier to the goal of helping students achieve high order understanding of subjects required for application in the real world, especially at the middle and high school levels (see Figure 9).

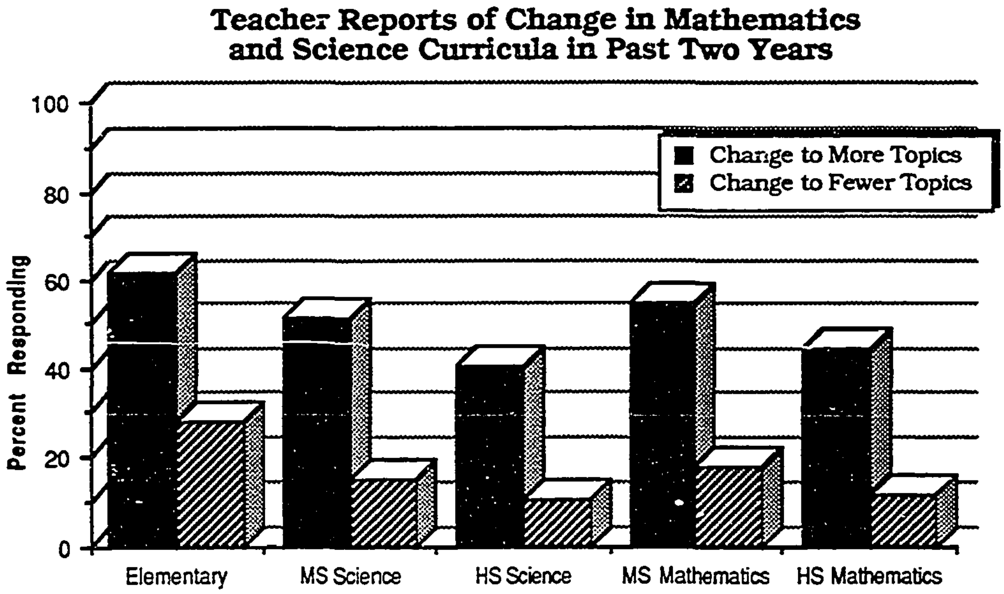


Figure 9. Teachers' Perceptions of Curriculum Change

3. The integration of mathematics and science, and the use of instructional technology, as advocated in the Comprehensive Plan, was

not being implemented in an extensive manner in elementary, middle, or high schools.

4. Elementary school students were engaged in mathematics activities more frequently and for a longer duration than science activities (see Figure 10).

Of the five days in a typical week, how many days is mathematics and science taught?

	PERCENT OF TEACHERS	
	Mathematics	Science
0 day	0.2	0.5
1 day	0.2	4.6
2 days	0.2	12.7
3 days	0.4	28.9
4 days	3.3	18.9
5 days	95.6	34.4

How much time is spent on a typical mathematics and science lesson?

	Mathematics	Science
0 to 15 minutes	0.4	3.5
16 to 30 minutes	8.6	24.8
31 to 45 minutes	26.3	50.2
46 to 60 minutes	48.5	18.9
60+ minutes	16.2	2.6

Figure 10. Florida Elementary Teachers' Use of Class Time for Mathematics and Science Lessons

Goal 1 recommendations. Based on analyses of the qualitative and quantitative data pertaining to Goal 1, the following set of recommendations were negotiated with a group of Department of Education personnel:

1. Efforts at strengthening the curriculum as well as efforts to implement the other goals of the Comprehensive Plan should continue at the elementary level, but must also move to middle and high schools.

2. The Department of Education should take a leadership role in reversing the trend of students having to cover a large number of topics in courses or grade levels. Leadership might involve establishing uniform approaches to curriculum guidance which is consistent with the latest research and supported by national groups such as the National Council of Teachers of Mathematics and the National Science Teachers Association.

3. The Department of Education should provide leadership through technical assistance and resource development to help curriculum supervisors and teachers better integrate mathematics, science, and the use of instructional technology.

Goal 2

The purpose of Goal 2 was to complement the recommendations in Goal 1 by encouraging a reformulation of the learning environment to one where teaching strategies focus on promoting student understanding. Next to Goal 1, the most progress has been seen in this area, especially at the elementary school level. Specifically, Goal 2 recommended:

> Make mathematics, science, and computer education more exciting. Provide incentives to restructure schools and school systems to maximize student understanding, and share successful efforts statewide.

Goal 2 findings. The following list represents the set of findings associated with Goal 2:

1. The primary strategy for improving instructional strategies was through professional development opportunities for teachers.

2. The State was aggressive in allocating resources toward building and renovating laboratory facilities and in expanding the availability of instructional hardware and software in the schools. However, the 1991 Legislature cut categorical programs that support this goal by 50%.

3. Over 75% of elementary school teachers sampled reported weekly use of hands-on activities in mathematics and science. While the figures for middle and high school science teachers are similarly high, weekly use of materials and strategies which support active learning fell to 50% in middle school mathematics and 30% in high school mathematics (see Figure 11).

4. Daily use of textbooks with mathematics students was reported by two-thirds of elementary teachers and 85% of middle and high school teachers.

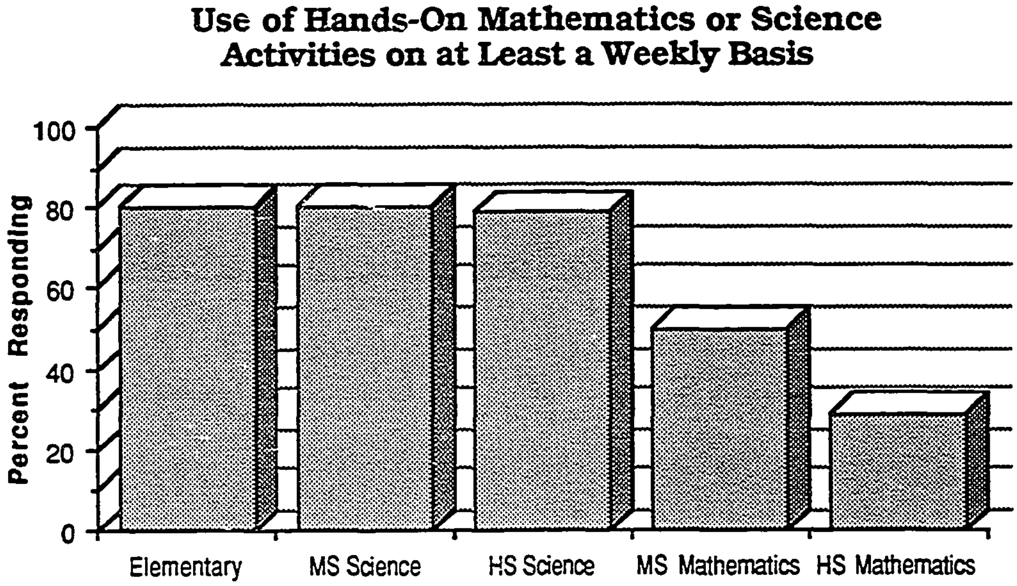


Figure 11. Use of Hands-On Mathematics or Science Activities on at Least a Weekly Basis

5. Eight out of ten curriculum supervisors with responsibilities for mathematics and/or science reported an increase in the use of active learning strategies in their districts in the past two years.

6. Use of field trips, cooperative learning, problem solving activities, and other hands-on instructional approaches were limited by funding for manipulative materials and teacher education,

perceptions by teachers that they take time away from covering the curriculum, and teacher insecurity in using unfamiliar techniques.

Goal 2 recommendations. Recommendations stemming from the study and supported by the Department of Education included:

1. The Legislature should make a renewed commitment to implementing the goals of the Comprehensive Plan and making Florida a leader in mathematics, science and computer education by reinstating cuts made in these programs.

2. The Department of Education, in all its mathematics, science, and computer education programs and initiatives, should continue its aggressive promotion of teaching strategies which support active student involvement and meaningful student learning.

3. State and district restrictions on the use of instructional materials funds should be relaxed to allow for greater flexibility, especially during this time of rapid restructuring of educational programs. Promoting high-order thinking on the scale recommended in the Comprehensive Plan may require teachers to have less reliance on traditionally fact-centered textbooks and more reliance on a variety of instructional materials.

4. The State and school districts should lift barriers to flexible scheduling as well as the use of discretionary funds to promote innovation and use of instructional approaches advocated in the Comprehensive Plan and supported by national mathematics and science reform movements.

Goal 3

Goal 3 complements Goals 1 and 2 by offering the recommendation that innovative instructional technologies can be of assistance in strengthening the curricula and making learning more exciting. The premise behind this goal is that mathematics and science learning can be enhanced by appropriate use of instructional technologies. Specifically, it suggested that schools:

> Increase the availability and use of state-of-the-art instructional technology to improve the productivity and effectiveness of mathematics, science and computer education.

Goal 3 findings. Progress towards meeting this goal must be measured by not only the numbers of computers and other instructional technologies in the schools but also by how these tools are being used by teachers and students. Findings associated with this goal are:

1. Florida public schools reported an increase of 22.5% in the number of instructional microcomputers available to teachers and students during 1990-91. This represents one computer for approximately every 14 public school students.

2. School self-report data collected by the DOE show that computer use for mathematics and science ranks two and five respectively in the top five subjects that use computers for instruction. Rankings one, three and four were computer literacy, language arts, and reading.

3. Legislative appropriations to educate teachers about integrating technology into the classroom was cut for the 1991-92 school year.

4. Teachers at all levels of school reported an increase in their use of computers for mathematics and science over the past two years. However, the greatest increase occurred among elementary teachers by a 2 to 1 margin over middle and secondary teachers.

5. Two-thirds of all teachers in this study reported they had access to a computer but computer use by students was much less positive. Nearly three-quarters of the teachers in this study involved students in using a computer as a way to enhance students' mathematics and/or science learning once a month or less during the school year (see Figure 12).

6. Other instructional technologies such as calculators and video players were generally available and commonly used in all levels of school.

Goal 3 recommendations. The following set of recommendations can assist Florida in achieving this goal of increasing the availability and use of instructional technology:

1. The Legislature should reinstate cuts made to programs to educate teachers about integrating technology into the classroom. Better teacher education efforts would complement the success that schools have had in acquiring computers and related technology. It

is one matter to have the equipment, it is another matter entirely to learn how to use it effectively.

2. Strengthened mathematics and science curricula guidance from the Department of Education should illustrate for districts and teachers ways in which technology can be used to enhance teaching and learning.

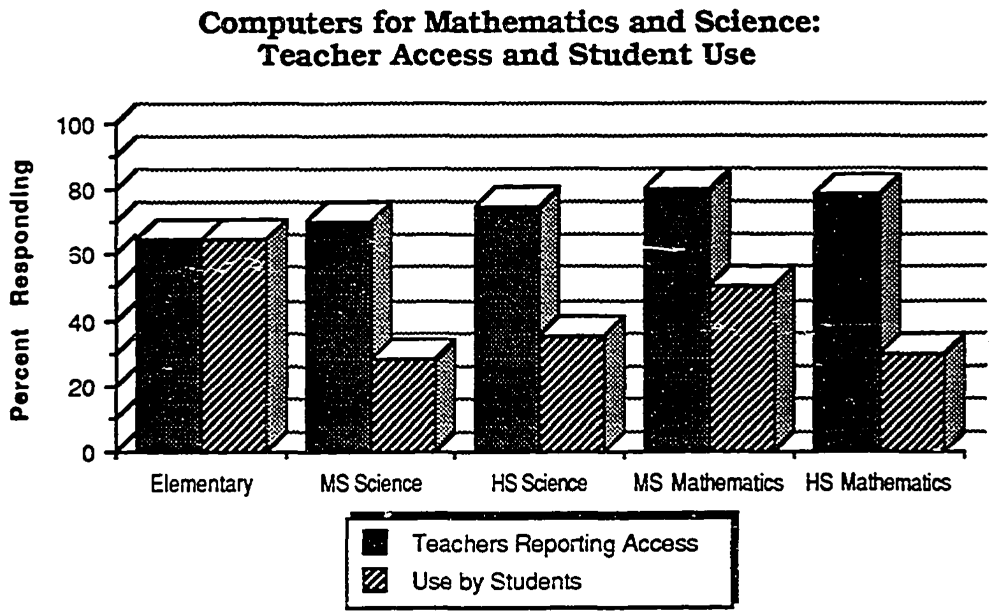


Figure 12. Computers for Mathematics and Science: Teacher Access and Student Use

Goal 4

This goal centered on developing resources and support systems which allowed mathematics, science, and computer education teachers to develop exciting opportunities for meaningful student learning. Enhanced teacher education efforts was one of the most important goals of the Comprehensive Plan as classrooms are the final "proving ground" for implementation of goals and recommendations. This goal stated:

> Increase the number of qualified teachers of mathematics, science, and computer education.

Goal 4 findings. Other findings of this study, such as the satisfactory progress towards Goals 1 and 2, were in areas where teacher education efforts were strongest in the past several years. In areas where teachers reported staff development was weakest, such as alternative assessment and meeting the needs of female and minority students (Goals 5 and 7), progress was substantially less than satisfactory indicating that teacher enhancement programs may be crucial to achieving comprehensive curriculum reform and improved student outcomes. Findings of relevance to Goal 4 are:

1. Appropriation levels for teacher enhancement programs in mathematics, science, and computer education decreased or remained the same for all programs except the Eisenhower (Title II) Mathematics and Science Program which has increased in the past two years. The Eisenhower and the Mathematics/Science Teacher Education Training programs resulted in a district level focus on improving mathematics and science through localized teacher

education efforts. These efforts have been primarily directed at improvement at the elementary school level.

2. Professional development funds were administered by five different Department of Education offices, only one of which included staff with expertise in mathematics, science, and computer education. Each of these programs operated independently and, as a consequence, there was little coordination in initiatives which should have resulted in improved curricula, student learning, and educational equity.

3. About 50% of teachers in this study have participated in some type of professional development activity geared towards enhancing mathematics, science, or computer education.

Goal 4 recommendations. The recommendations for Goal 4 center on promoting teacher education activities:

1. Enhanced teacher professional development in mathematics, science, and computer education must be made a priority to ensure the success of efforts of the Department of Education and school districts towards reaching the goals of the Comprehensive Plan.

2. A systematic approach to teacher professional development needs to be established which: (a) Centralizes mathematics, science, and computer education staff development funds so they can have a systemic impact on reform in these areas, and (b) Coordinates

efforts at improving mathematics, science, and computer education with School Improvement Plans.

3. The Department of Education should develop strategies geared toward the district and school levels to promote an understanding of the rationale for the goals of the Comprehensive Plan and assist supervisors and teachers to construct a commitment to personally improving mathematics, science, and computer education. These strategies should be incorporated into present and future staff development opportunities.

Goal 5

Improving mathematics, science, and computer education requires that special attention be given to those groups who are traditionally under-represented in these areas. The goal challenged the school system to:

> Provide greater motivation, incentives, and opportunities for minority, female, at-risk, disabled, and gifted students to pursue programs and careers in mathematics, science, and computer fields.

Goal 5 findings. Although the Department of Education implemented a number of initiatives directed at achieving this goal, there was little progress towards achieving this goal in most schools and districts across the state. Exceptions included mostly urban districts with large percentages of minority students who had this area as a stated priority. Findings associated with promoting under-represented students are:

1. For the past three years, the proportion of African American students enrolled in remedial mathematics courses (Level I) was greater than the proportion of these students in a school's population. Enrollment data for other courses by race, ethnicity, and gender were not available for the years studied but will be available for the 1991-92 school year.

2. Based on proposals for Mathematics/Science Teacher Enhancement Training (M/STET) funding, 17.5 % of the state's elementary schools addressed the goal for increasing the involvement and achievement of under-represented students. As a result, teacher education in this area reached 14% of the state's elementary teachers.

3. Assisting teachers to learn strategies for encouraging under-represented students in mathematics, science, and computer applications was a focus of staff development efforts in 15% of the Florida school districts sampled.

Goal 5 recommendations. The following recommendations can assist Florida to achieve the goal of promoting mathematics, science, and computer education among groups of students traditionally under-represented in these areas:

1. Districts should conduct needs analyses to determine what special efforts might be useful in encouraging under-represented students to pursue high level courses. Elimination of all Level I courses, traditionally highest in minority enrollment, is a step in this

direction. Additionally, districts should develop and implement plans, under the guidance of the Department of Education, for monitoring under-represented student participation in mathematics, science, and computer courses.

2. Staff development for effective approaches with under-represented students must become a priority for mathematics, science, and computer teachers. School counselors and administrators must be included in this area as well. Schools should be encouraged to incorporate this goal into their school improvement plans.

3. The Department of Education should establish incentives for the increased offering of applied mathematics and science courses, holding schools accountable for equitable participation and achievement.

4. Certain districts, such as Dade County School District, have formal documents illustrating their efforts in this goal area. Dissemination of the "wonderful ideas" from districts like Dade through organizations such as the state mathematics and science curriculum supervisors associations might be useful for districts who are just beginning to consider ways to tackle minority/gender issues.

Goal 6

The purpose of this goal was to make the Comprehensive Plan a viable planning document for state organizations and schools. As such it requires Department of Education mathematics, science, and computer education programs, as well as school districts, to adopt the goals of the plan as a framework for programs and initiatives. Goal 6 suggested:

> Implement and refine the Comprehensive Plan as necessary to make substantial, measurable improvements in mathematics, science and computer education by 1999.

Goal 6 findings. This goal was on its way to being met by the state and school districts but there was an apparent lack of coordination between state programs and school district programs. The lack of coordination may severely inhibit further progress towards full implementation of the goals. The findings pertinent to this goal are:

1. Although the Comprehensive Plan was intended to coordinate statewide efforts, the state had no operational plan for reaching the eight goals of the Comprehensive Plan in a systematic manner.

2. There was a lack of consistency in the evaluation component of categorical programs in mathematics, science, and computer education, making it relatively impossible to determine the effectiveness of schools and programs. Also, data collected about mathematics, science, and computer education programs were not centrally available as they were held by different Department of Education entities.

3. Although all 67 school districts have formally adopted the Comprehensive Plan, there was considerable variability between

districts with respect to efforts made to implement the goals of the Comprehensive Plan.

4. When asked to identify state and federal programs and initiatives that have been most helpful in local efforts to improve mathematics, science, and computer education, district curriculum supervisors overwhelmingly chose programs with the greatest flexibility and entitlement. The top seven programs, ranked in order of degree of helpfulness, are listed in Figure 13.

Most Helpful

- **Summer Inservice Institutes**
- **Eisenhower Program (Title II)**
- **Mathematics/Science Teacher Enhancement Training (M/STET)**
- **Teacher Stipends**
- **PECO funds for science laboratories**
- **High Cost Science Lab Materials**
- **State Science Fair**

Figure 13. State and Federal Programs Identified as Most Helpful by District Curriculum Supervisors

5. The extent to which school districts used their Regional Centers of Excellence in Mathematics, Science, and Computer Education and found their services useful depended largely on the specific Center, although Centers received a wide range of ratings from districts in their service area. Over 50% of the responding curriculum supervisors said they received newsletters, staff

development opportunities, and information about curriculum resources as services. However, 86 supervisors representing 41 districts responded to our survey and indicated that their level of overall satisfaction was not very high. Fourteen percent of supervisors found services to be highly satisfactory, 47% thought the services were adequate, and 39% were not satisfied with the services of their Center.

Goal 6 recommendations. Stronger efforts in making the Comprehensive Plan a useful set of state goals might be accomplished by some changes in current procedures. Recommendations connected to this goal are:

1. Progress is being made in some areas of the Comprehensive Plan while other areas need much improvement. It is time to revisit the goals and recommendations of the plan in light of progress that has been made to date. Priorities and procedures should be revised to ensure that Florida can reach all goals of the Comprehensive Plan by 1999.

2. The state should establish one entity to oversee implementation of the Comprehensive Plan and give them resources and authority to coordinate the work of all offices involved with mathematics, science, and computer education programs. One of the activities this entity might also do is collect successful strategies being used by programs and school districts in meeting the goals of the Comprehensive Plan and disseminate all programs and districts.

3. The Commissioner should direct a strong mechanism for coordinating the programs that can further the goals of the Comprehensive Plan. Such mechanisms may involve reassignment of programs, restructuring offices, or stronger accountability of managers for cooperation and coordination.

4. Program staff should also be required to establish evaluation models that result in outcome and impact measures that can be used to guide programs, and indicate how their program assists the State and schools in reaching the goals of the Comprehensive Plan. It might also be prudent to establish a team of persons to set evaluation criteria and guidelines which can be used by all offices involved in implementing the Comprehensive Plan.

5. Funding allocations for programs which have had a positive impact on improving mathematics, science, and computer education must continue at levels which will allow the programs to have maximum impact.

6. The Regional Centers of Excellence must actively collaborate with all districts in their service areas to assist districts to meet the goals of the Comprehensive Plan. All districts in a region deserve the same level of service from a Center. The Department of Education should make clear to the Centers that there are high expectations for consistent and useful performance. Furthermore, centers might be able to play a crucial role in regional

implementation of the Comprehensive Plan as they can serve as liaisons between the DOE and local school districts.

Goal 7

Curriculum changes of the magnitude recommended by the Comprehensive Plan demand assessment approaches that are powerful, yet sensitive, to the kinds of learning expected of students. Nationally, student assessment has come to the forefront of mathematics and science education reform efforts as the success or failure of reform rests squarely on assessment outcomes. Accordingly, the plan set forth as a goal:

> Re-examine and adjust the statewide testing program to support the goals of the Comprehensive Plan.

Goal 7 findings. In Florida there was minimal effort by both the state and districts in restructuring mathematics and science assessment so that it was appropriate for monitoring conceptual understandings, problem solving, and habits of thinking. Findings associated with this goal are:

1. Science scores on standardized examinations administered by districts are not collected by the DOE. Accordingly, many school districts do not rank improvement of science instruction or assessment as a priority.

2. In early 1991, a statewide task force was charged with exploring alternative assessments in all subject areas. A performance assessment for writing (grade four) is planned for April 1992, but no

other performance or alternative assessments are being considered at this time.

3. In addition to little state-level attention to alternative assessment procedures, less than 10% of the school districts in this study are formally exploring district-wide alternative assessment techniques such as portfolios and performance-based measures to monitor student progress in mathematics or science. Yet, approximately 70% of elementary teachers, 50% of science teachers, and 30% of mathematics teachers report they regularly use these kinds of assessments with their students.

Goal 7 recommendations. Much attention is required in this area by the Department of Education and districts. Recommendations which might support efforts in this area include:

1. Districts need to know that the state values how students are doing in mathematics, science, and computer literacy. The Department of Education in cooperation with districts should develop a protocol for collecting and reporting data from districts which will allow student progress in these areas to be monitored. Although it should not be considered the only tool or indicator, student achievement on standardized tests such as the ACT, which tests for both mathematics and science achievement, might be used to monitor programmatic progress.

2. A move known as alternative or performance-based assessment is being explored nationally for mathematics and science.

The state should make an immediate priority the establishment of performance assessments or alternative paper and pencil measures for mathematics and science. States such as California, New York, and Connecticut are making strong progress in this area. Florida can easily build on the successes of these states. Alternative assessments could be incorporated into the School Improvement and Accountability program, regularly administered district assessments, the High School Competency Test, or writing assessments.

3. Many teachers report using alternative assessment strategies on an informal basis with their students. District-based plans should be developed which encourage teachers to use a variety of mathematics and science assessment techniques on a more formal basis. These assessments should not only monitor student progress but inform instruction as well.

Goal 8

The task force that devised the Comprehensive Plan believed that businesses, parent and community groups, governmental agencies, science and environmental museums, and universities all have a role to play in the improvement of mathematics, science, and computer education. Accordingly, the final goal of the plan was:

> Expand the productive collaboration of educators with parents, community resources, business and industry.

Goal 8 findings. Some effort was made to implement this goal throughout the state. The greatest effort came from business and industry. However, it appears a great resource still remains untapped. Findings associated with this goal are:

1. At least four statewide mathematics, science, or technology related initiatives generated $22.7 million in matching support from business and industry in the past two years.

2. Nearly 40 state-funded partnerships were lost when the Math/Science Challenge Grants were not funded by the 1991 Legislature.

3. In 1991, the Florida Chamber of Commerce implemented a program called "StarMaker" bringing together 40 Florida companies, 15 school districts and over 30 schools to promote mentoring of high potential students from under-represented populations. The program continues in 1992.

4. Community resources such as museums and environmental centers were used by school on a funds-available basis.

5. Nearly 70% of all teachers in this study perceived some degree of parental involvement in school-related activities. Parental involvement increased more at the elementary and middle schools than high schools in the past two years (see Figure 14).

6. Florida School Board Association President Bill Gene Smith served as an Ambassador to school districts for the Department of Education. Between 1989 and 1991 he convinced all districts in the state to endorse a resolution to formally adopt the Comprehensive Plan as local policy.

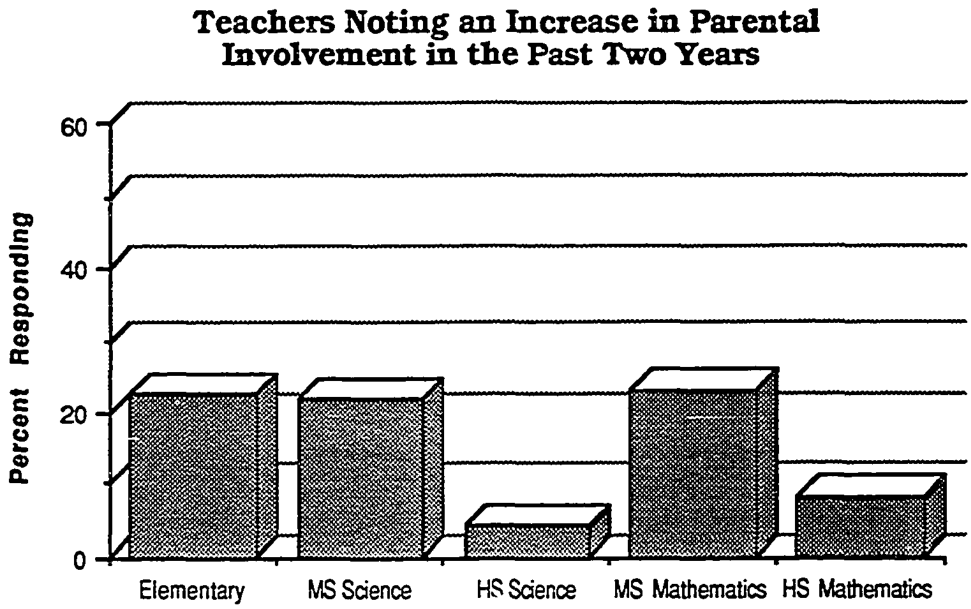


Figure 14. Teachers Noting an Increase in Parental Involvement in the Past Two Years

Goal 8 recommendations. The following recommendation related to the focus of Goal 8:

1. The state should continue to enlist the assistance of business, community members, parents, and universities in improving mathematics, science, and computer education. These kinds of activities pay for themselves as they maximize effective use of human as well as financial resources. Funds provided to these groups might be leveraged against their level of involvement.

Chapter Conclusions

The results from a study of the implementation of a state-initiated policy such as the Florida Comprehensive Plan for Improving Mathematics, Science, and Computer Education can be useful to policy-makers, district supervisors, and reform scholars. This chapter provided a synthesis of the findings of the implementation study. An important product of this chapter was the recommendations under each of the eight goals. Those recommendations were negotiated with Department of Education personnel so that their intent and scope would be fully understood by the primary implementors of the plan.

As education decision-makers ask for improved data and statistics to track progress towards the state's mathematics, science, and computer education goals, the indicator system developed and used in this study should be of assistance. The data reported here are likely to be used as baseline data in the coming years. This chapter, in the form originally submitted to the Department of Education, received considerable attention by state-level decision-makers. The attention illustrates the importance of communicating research findings to the policy community. Research can be of assistance to policy-makers only if it addresses the issues of most salience to the policy-making community. In both its style and content, the report on which this chapter is based appeared to have met the needs and interests of the policy-makers it was intended to inform.

CHAPTER 8

ISSUES SURROUNDING IMPLEMENTATION

Achieving radical curriculum reform in mathematics, science, and computer education is a high priority for the State of Florida. A set of statewide goals to improve the state of mathematics, science, and computer education in Florida schools was set in 1989. The task force of business and education leaders that devised the goals set high expectations for systemically improving the quality of science, mathematics, and computer education. The goals and recommendations of the task force were reported in a document called A Comprehensive Plan: Improving Mathematics, Science, and Computer Education in Florida. The report presented a synthesis of knowledge about effective mathematics and science teaching and learning and outlined a vision of what mathematics, science, and computer education should be. The vision included notions of restructuring curricula to limit superficiality and encourage depth, changing the learning environment to support learning with understanding, using technology to enhance mathematics and science learning, preparing more qualified teachers and enhancing teacher professional development, encouraging students from traditionally under-represented groups, reconceptualizing assessment to be consistent with "active" learning, and promoting productive partnerships between educators and members of the community. The report was disseminated to school districts, universities, businesses, and the legislature as a stimulus for change. However, its implementation was not legislatively mandated.

The Florida mathematics, science, and computer education plan came at a time when the nation was renewing its interest in reforming all aspects of education. As a result of the renewed interest, the effect of state education policy initiatives on reform at district, school, and classroom levels has received much attention. Two positions generally can be found in the literature on the effect of school reform efforts. One position substantiates that state reform policies have not had lasting effects on the curriculum that is taught or how teachers teach (Fuhrman, Clune, & Elmore, 1988). On the other hand, there is a group of scholars who support the position that state reform policies have had a lasting effect in the sense that changes requiring increased time on core subjects and increased graduation requirements appeared to have taken hold in most school districts (Clune, White, & Patterson, 1989). However, both groups agree that goals such as the ones set forth in Florida's Comprehensive Plan recommending changes to teaching and learning of higher-order thinking have not been systemically implemented. Although states such as Connecticut and California have made substantial strides in attempting to produce improvement in mathematics and science, little progress has been noted even in these states in the implementation of higher-order thinking curriculum reforms (Blank & Dalkilic, 1990).

The purpose of this chapter is to present an analysis of implementation issues pertaining to the Comprehensive Plan itself as well as mathematics, science, and computer education categorical programs. The chapter is organized around the central theme of implementation coordination. This theme became a strong factor in understanding implementation issues and provided a framework for the recommendations that were reported in previous chapters. The concept of coordination came from a set of implementation factors identified by Marsh and Odden (1991). In addition to coordination, two other factors were used to frame an analysis of the issues critical to Comprehensive Plan implementation. Those factors were vision and technical assistance. In the following chapter sections, the concepts of coordination, vision, and technical assistance are used to understand implementation efforts. The chapter concludes with relevant observations and implications about policy implementation.

Implementation Coordination

The issue of coordination became a driving force in understanding how the Comprehensive Plan was being implemented. One of the major reasons for using the concept of coordination as a framework for understanding implementation issues stemmed from the fact the Comprehensive Plan was never legislatively mandated and that its implementation was more of a local and philosophic decision than a legal one. As such, programs and initiatives put forth at the state level over the past two years may or may not have promoted the goals of the Comprehensive Plan.

As an example of the lack of coordination of programs that fall under the auspices to the Comprehensive Plan, out of 17 categorical programs in mathematics, science and technology funded for 1990-91, only two projects identified Comprehensive Plan goals as a justification for content or scope of the program. Furthermore, each of those projects purported to serve different needs in the state. Yet, there was no way to determine to what extent they were effective because six had no evaluation component, five had process evaluation but no follow-up evaluation to assess impact on student learning, and only two included site visits to determine classroom impact as part of the evaluation.

That example was typical of what was learned about mathematics, science, and computer education programs administered by the Florida Department of Education. By way of a different example, the issue of coordination, or more correctly lack of coordination, is again highlighted. In conducting this study, data regarding all aspects of mathematics, science, and computer education programs needed to be collected from the Department of Education. However, the needed information was not centrally available, further supporting the notion that there is a lack of coordination in the state for these types of programs. To support this point, five instances are offered:

1) to obtain information on expenditures for mathematics and science at least five different offices had to be contacted.

2) to obtain information on curriculum guidance at least four different offices had to be contacted.

3) to obtain information on instructional technology at least three different offices had to be contacted.

4) to obtain information on staff development at least five different offices had to be contacted.

5) to obtain information on the federally funded Eisenhower Mathematics and Science Program at least three different offices had to be contacted.

There is no single Department of Education entity where complete, up-to-date information and data are readily available that can be used to determine the effectiveness of schools and programs with regard to mathematics, science and computer education.

A major barrier to achieving the goals of the Comprehensive Plan may be the lack of a coordinating agency for mathematics, science, and computer education projects for the state. Using Firestone's (1989) concept of "dominant coalition," there had been no dominant coalition at the state level promoting the implementation of the goals and recommendations of the Comprehensive Plan. The Office of Policy Research and Improvement, for example, was designated as the office responsible for the implementation of the plan but had no direct influence over other offices that administer mathematics, science, and computer education programs. In turn, the variety of offices with programs had no responsibility to coordinate their efforts with the Comprehensive Plan or any other efforts being put forth by other programs. This lack of a dominant coalition with the power or authority to fully implement the ideals of the plan has been a limiting factor in the overall implementation plan.

During February and March of 1992, the issue of internal coordination of mathematics, science, and computer education programs at the Florida Department of Education came to the forefront after the "Report Card" version of this study was disseminated (Dana, 1992). Establishing coordination structures became a focus for the Bureau of School Improvement and Instruction. The director of this bureau also indicated that further implementation of the Comprehensive Plan now is under the direction of this office and that he is uncertain to what extent he will be successful. He cited problems associated with authority as his limiting factor as many of the recommendations in the Comprehensive Plan call for changes in programs or policies that are outside the realm of the Bureau for School Improvement and Instruction and outside the Division of Public Schools, in which this bureau is administratively housed. By way of an example, of which this director says there are many, it is impossible for staff in his office to influence what happens at the university level in science, mathematics, or education classrooms. The director also indicated that he felt constrained because it was highly likely that if he was to make a recommendation to Florida universities that would require changes called for in the Comprehensive Plan, the Chancellor for the university system would rebel. He cited some of the coordination problems, such as the university example, as issues of "turfdom" and added that he had never experienced the level of "turf protection" that he has found at the Department of Education.

On a more positive note, oversight of the mathematics, science, and computer education plan by this official is likely to achieve some of the benefits that a coordinating office can provide. The majority of categorical programs for mathematics, science, and computer education improvement are located in that bureau and he has the authority to require coordination among those programs. Additionally, the state received approximately $8 million from the National Science Foundation to improve science education in grades K-8 as well as in lower level undergraduate courses. The Project Director of this Statewide Systemic Initiative as well as the bureau chief cited above have stated that it would be prudent to coordinate all mathematics, science, and computer education efforts directed at K-8 and lower level university with the NSF project. Discussions in late March 1992 centered around the possibility of the Project Director also being the coordinating officer for the other programs and initiatives to ensure that the goals of the project were being addressed. The NSF project goals were firmly grounded in the goals of the Comprehensive Plan, so promoting the NSF project would in essence also promote the goals of the plan.

Another issue surrounding implementation has been referred to as "vertical and horizontal coordination" by McLaughlin and Marsh (1978). The efforts at the state level appeared to be more aligned horizontally now than they were over the first two years of implementation. Previously it could have been said that there was a lack of horizontal alignment as there were great differences in the purposes/goals of various mathematics, science, and computer education programs. As another example, Florida adopted six of the seven National Education Goals set forth in America 2000 (United States Department of Education, 1991) as the basis of the statewide Accountability/School Improvement Program. The single goal that the state did not adopt was the goal to have U.S. students become world leaders in mathematics and science achievement -- a goal that would directly complement the Comprehensive Plan.

The concept of vertical coordination can be useful in understanding implementation as well. This concept is generally associated with the terms "top-down" and "bottom-up." McLaughlin and Marsh (1978) support the notion that implementation plans that have both types of coordination are likely to be successful. At the state level, there was a lack of vertical coordination in the sense that the Legislature never mandated the implementation of the mathematics and science plan. It was neither "top-down" nor "bottom-up" implementation as the policy office that had initial responsibility for implementation had little influence on the day-to-day operations in the Department of Education, districts, or schools.

The concept of vertical coordination could be extended to coordination between state, districts, and schools as well. In this sense, teachers are the implementors at the "bottom" end and the Department of Education might be considered at the "top." The data from this study generally support the position that there was a lack of an articulated vertical coordination between schools, districts, and state. In most cases it was apparent that members from each of those groups were uncertain as to their roles in relation to those from the other groups. Only in a few instances did it appear that district supervisors transcended the boundary between district and state and between district and school. Those curriculum supervisors were most knowledgeable about the ideals set forth in the Comprehensive Plan and could relate those ideals to state initiatives and district policies that were assisting classroom teachers to achieve those goals. In the case of state administered programs, such as the Eisenhower Mathematics and Science Program (Title II) and the Mathematics/Science Teacher Enhancement Training, coordination with the Comprehensive Plan was apparent as fund administrators linked allocations to the improvement of mathematics and science at the elementary level, a priority area designated by the plan.

Vision: Having Will and Capacity

Another frame that is useful in understanding implementation issues is McLaughlin's (1987) concepts of will and capacity. There appeared to have been two temporal pockets of will for implementation: 1) in the late 1980s when the plan was first announced, and 2) in 1992 after the release of the "Report Card" (Dana, 1992) and during the promotion of the NSF/Florida Statewide Systemic Initiative project. These two events served to consolidate the will of several groups of "key players" to facilitate implementation. In the three or so years in between, the will to implement the plan was tempered by other critical issues such as the rising visibility of the School Accountability and Improvement Program and dramatic cuts and reductions in the budget. The School Accountability and Improvement Program is seen by Department of Education personnel as a feature that will greatly influence what happens in the Florida education system for years to come. As such, the passage of Florida's School Accountability and Improvement legislation is sure to have profound effects on how the state and districts set priorities.

What will be the fate of the Comprehensive Plan in light of the move towards school accountability? Several Department of Education personnel indicated in interviews that they wished to promote the Comprehensive Plan as a tool schools can use as they set local objectives for improvement. While this seems like a reasonable approach that would facilitate both horizontal coordination at the

Department of Education and vertical coordination between the Department and schools and show evidence of a will to integrate mathematics and science curriculum reform into the larger reform picture, little explicit work has been done to put this idea into action.

Aside from the state, school district curriculum supervisors and classroom teachers demonstrated little will towards implementation. The Comprehensive Plan was not known to most teachers and some supervisors and, in the cases where it was known, was not a major influence in setting local mathematics and science education priorities. The Curriculum and Evaluation Standards by the National Council of Teachers of Mathematics had more influence than the Comprehensive Plan. In addition to will, it might also be said that both curriculum supervisors and teachers lacked the capacity to implement the plan. The lack of capacity for understanding the nature and intent of the plan may be a critical factor in understanding why there is little evidence of the plan influencing local school district activities. The capacity for understanding the plan was apparent in only a limited number of cases, mostly supervisors who were directly involved in the original formulation of the plan's goals and recommendations. In those cases, the plan did not serve as a tool to initiate change at the local level, but as an opportunity to expand the efforts already under way. These supervisors had extensive knowledge of the intentions of the plan and the state programs that could be tapped into to enhance local mathematics and science education improvement efforts. These supervisors also were, generally, limited to curriculum supervision in mathematics and/or science only while other supervisors were responsible for all curriculum areas. In this sense, the capacity to implement the Comprehensive Plan at the local level was limited by the knowledge of the supervisor and the scope of the supervisor's responsibilities.

At the state level the capacity to implement, as already mentioned, was weakened by the bureaucratic structure which did not facilitate the coordination of mathematics, science, and computer education initiatives. Mathematics and science personnel at the state level reported having competing demands for their attention with the increased attention given to the school accountability movement. In short, state personnel did not have the authority or resources to implement the plan and any implementation that occurred did so despite the pressures for autonomy and decentralization within the Department of Education. It should also be mentioned that this evaluation of the implementation of the Comprehensive Plan came as a result of the efforts of a small number of Department of Education personnel and others who attempted to maintain the capacity and will to implement the plan as intended. It has been their efforts in conjunction with the reports of this evaluation that have rekindled implementation efforts.

Technical Assistance

Another way to understand capacity to implement is the extent to which technical assistance in implementing the recommendations of the plan was available. As noted before, the state was not coordinated in its efforts to implement the plan. Leadership by state personnel knowledgeable about mathematics, science, and computer education was confounded by the increasing demands on these people which broadened responsibilities beyond the scope of mathematics and science. Furthermore, as cited by many individuals whose voices have been included in this report, there were insufficient funds available for implementation. In fact, the Florida Legislature never enacted a funding package to implement the plan, and as a consequence, the state and districts focused their attention on implementing legislatively mandated and funded policies before giving attention to the Comprehensive Plan. It might be said that there was a lack of formal implementation capacity throughout the entire state with respect to the mathematics and science plan due to the lack of financial resources to assist in implementation.

Several products and projects that might be considered technical assistance were initiated by the state and have supported the Comprehensive Plan, however. For example, a model mathematics curriculum for grades K-5 was developed and released to schools as an alternative to current K-5 programs. The model curriculum was based on the NCTM standards and supports the recommendations of the

Comprehensive Plan. Another example is the formation of several model high schools where a variety of instructional technology, especially computers, was being used to enhance teaching and learning in all subject areas. Again, the intentions of this project were consistent with the general recommendations in the Comprehensive Plan. It remains unclear, however, whether these projects were a direct influence of the plan or are a result of other activities. Nonetheless, the projects can be viewed in a supporting role that will assist schools in implementing the Comprehensive Plan.

Technical support was not evidenced in other areas such as textbook adoption procedures or funding policies. It was recognized by Department of Education personnel as well as curriculum supervisors that changes of the scope called for in the Comprehensive Plan required changes in policies which influence what districts were expected to do. For example, flexibility in use of funds for texts and other instructional materials was cited as a way that might encourage schools to purchase a variety of instructional materials that could be used in "hands-on" lessons. At present, the state supports funding for acquiring new texts but not for acquiring additional instructional materials such as manipulatives that might be needed to support a "hands-on" mathematics or science program. The policy gave little flexibility to districts in the way they spend funds and can be perceived as a lack of technical assistance on the part of the state.

Technical assistance was indirectly available to districts in the area of teacher professional development. Funds for programs such as Title II and M/STET were available to districts on a competitive basis and generally required staff development efforts to focus on promoting innovation in mathematics and science teaching. As far as can be determined from an analysis of the 1990 M/STET proposals, activities to acquaint teachers with the Comprehensive Plan itself were not an official part of any of the funded programs. The staff development generally centered on instructional strategies such as cooperative learning and use of manipulatives. Furthermore, in only a few cases was on-going support an explicit part of the staff development program, making technical assistance in implementing innovative instructional strategies the exception, not the norm.

Relevant Observations

Several observations are relevant regarding the influence of a state policy initiative on local mathematics and science curriculum reform efforts. First, there were and still are competing forces within the Florida Department of Education that each have a say about the future of mathematics, science, and computer education in Florida. New policies will likely be required to be consistent with the intent of the Comprehensive Plan, as well as "fit" with the goals of the Statewide Systemic Initiative if those policies affect K-8 science education. There is great concern from members of the business community familiar with the state's efforts in mathematics, science, and computer education that there is failure in improving student performance in these subjects. The major reason for the limited acceptance and influence of the Comprehensive Plan, according to business leaders at a recent advisory council meeting, is the lack of will by those in authority to take charge and mandate the kinds of action suggested in the plan. This group of business leaders has a strong voice that is heard by many people in authority positions in the state. Any new policies that affect mathematics and science education will likely have to be strongly supported by business community.

Second, many of the recommendations and goals in the Comprehensive Plan were not considered to be new or innovative to some educators. That perception allows for curriculum supervisors and teachers to say that they have always done the things that are being recommended. Part of the reason may stem from a greater focus on implementing some parts of the Comprehensive Plan over others. Many examples have been presented where the plan has been used in a piecemeal fashion -- only those goals that promoted the present needs of state and district personnel were addressed. The concept of a comprehensive plan was supposed to indicate the need for pervasive and systemic change. Implementing curriculum reform of the scope and magnitude purported in the Comprehensive Plan cannot be achieved without also attending to issues such as assessment and educational equity. Accordingly, a major limiting factor in the full implementation of the plan is the belief by some that change is not needed at all and by others that it is needed only in certain areas.

Finally, this study provided some data regarding what teachers are doing in their classrooms when they teach mathematics and science. It can be inferred from the questionnaire data on change in the past two years that some teachers are changing their instructional practices in ways that are consistent with the ideals of the Comprehensive Plan. The purpose of this study was not to definitively describe what was happening in classrooms in terms of the impact of the Comprehensive Plan. However, the data collected allowed several trends to be documented such as an increased use of cooperative learning, problem-centered activities, and manipulatives in both mathematics and science.

Implications

Implications for various groups have been interspersed throughout this report. In sum, implementing a policy such as the Comprehensive Plan is complex and all people who have a relationship to mathematics and/or science education are affected by such as policy. This study provided several specific lessons regarding policy implementation and its influence on local level reform. First, capacity and will are important ingredients in the reform implementation process. It is likely that capacity and will cannot be "given" to persons expected to implement the Comprehensive Plan. Accordingly, ways must be found that allow the key players to develop both the capacity and the will to implement. Officially requiring coordination among mathematics, science, and computer education programs at the state may be a way to generate the feeling of capacity and will by the various entities since they will be required to collaborate, set common goals, and determine how to best achieve them. District officials and teachers also need to have capacity and will in order to implement the plan. This might be best accomplished by leaving the specifics of implementation to local leadership groups composed of both teachers and supervisors who understand the local conditions and what is needed to make implementation work at specific sites.

Second, the issue of "top-down" and "bottom-up" comes into play with the Comprehensive Plan. Although not legislatively mandated, the plan was still viewed as a "top-down" policy by district supervisors. In reform efforts in California (Marsh & Odden, 1991), the establishment of a linkage between the "top" and the "bottom" is credited with the overall success of the implementation of the California Mathematics and Science Frameworks. The Florida story might turn out successful over the next seven years if future efforts at implementation are geared more to teacher leadership than state leadership in order to forge stronger "bottom-up" links.

Third, the lack of coordination of policy initiatives and categorical programs was a severe inhibiting factor to the implementation of the Comprehensive Plan during the past two years.

The state initiated numerous programs to improve mathematics, science, and computer education without requiring efforts between these programs to be coordinated to achieve the same goals -- the goals of the Comprehensive Plan. The plan has the potential to provide a framework for a collective vision of mathematics and science in the state. Some state programs and school districts are using the plan explicitly in their planning and goal setting. Many others have yet to capitalize on the goals and recommendations. As a collective vision, the plan should assist all people with a hand in mathematics and science education such as teachers, curriculum supervisors, state personnel, and business leaders to compare their current efforts with those proposed and make and implement plans for revisions where needed.

The last lesson is perhaps the ultimate key to successful implementation -- continued professional development for all involved in implementation. The ideas reported in the Comprehensive Plan required paradigm shifts in understanding mathematics and science, as well as teaching and learning. It is unreasonable to expect that the kinds of changes discussed in the plan will occur overnight. Both Fullan (1990) and Tobin (1990) have argued that sustained curricular change can only occur when the culture of schools supports those kinds of change. The good news was reported before: changes are happening in some schools and they seem to be consistent with the changes called for in the plan. On-going professional development for not only teachers but for administrators and policymakers is called for as well. It seems important to provide opportunities for all members of the mathematics and science education community to develop a personal and institutional rationale for the changes called for as well as develop some concrete strategies for implementing those changes.

This study was conducted to determine where Florida stood with respect to the implementation of the Comprehensive Plan and to what extent state policies influence local reform. In Florida, it appeared that teachers, schools and districts were barely involved in the mathematics and science reform effort -- there is little evidence of "bottom-up." The state policy has had little influence over local efforts. This result might have been different if the implementation of the plan was mandated and teachers were earmarked as key players in implementation procedures. Changes in Department of Education coordination may facilitate the involvement of teachers and supervisors in planning for local implementation. Regardless, full implementation of the goals and recommendations of the Comprehensive Plan continues to be years away.

APPENDIX A

LIST OF INDICATORS FOR PROGRESS IN IMPROVING MATHEMATICS AND SCIENCE EDUCATION

The list of indicators provided on the following pages of Appendix A was developed to suit the specific needs of the evaluation team that assessed the implementation of the Comprehensive Plan. The indicators are based on indicators reported in the research literature on mathematics and science education improvement. The list was customized to take into account the nature of the Comprehensive Plan and other conditions specific to Florida. The list was used as a guide for data collection and analysis. However, data were not available for all indicators on the list. Some data were not collectable and other data were requested for analysis but never obtained.

Indicators reported in the various chapters of this dissertation are syntheses of several specific indicators found on the list of indicators in this appendix. Therefore, there may not always be direct correspondence between the indicator used in the chapter text and the indicator on the list in this appendix. Certain indicators were combined in order to provide a more holistic and coherent picture of what was happening with mathematics, science and computer education and possible explanations as to why it was happening.

Goal 1 -- Strengthen the Curriculum

Goal from the Comprehensive Plan:

To strengthen the K-12 curricula in mathematics, science and computer education. The emphasis should be on student learning rather than merely content coverage so that students are prepared to succeed in a society requiring a high degree of technological and scientific literacy.

State Key Indicators

- Course enrollment data for Level 1, 2 and 3 courses in mathematics and science
- Remedial mathematics course enrollment data
- Number of districts that have eliminated Level I (remedial) courses
- Number of districts and course enrollment for applied mathematics and science courses
- Survey of curriculum guiodance materials available to districts
- *Blueprint for Career Preparation* schools Levels 1,2,3 progress summaries and graphic analyses
- SSAT (Statewide Student Achievement Test) scores in mathematics
- College preparatory mathematics testing results (SAT, ACT, ASSET, MAPS)

District Key Indicators

- Evidence of influential documents/guides
- Subject-area integration reflected in policies and local curriculum guides
- Textbook series used (elementary, middle, high school; mathematics and science)
- Origination of district-adopted currriculum guides for mathematics and science
- Use of science themes such as "the environment" in district curriculum guides
- Changes made in elementary, middle, or high school mathematics and sceince curricula
- Assistance to districts from organizations such as Regional Centers of Excellence for curriculum reform
- Use of laboratory activities in curriculum guides
- District policies and efforts to support active learning strategies in all mathematics, science, and computer courses

- District policies and efforts at improving time spent on mathematics and science lessons
- District policies and efforts at integrating computer applications into the curriculum
- District policies and efforts at improving enrollments in Level II and Level III science and mathematics courses.

School Key Indicators

- Curriculum change to limit breadth and superficiality
- Teacher and student use of computers in mathematics and science
- Teacher integration of mathematics/science into subject areas
- Trends in the integration of computers in mathematics and science
- Time spent teaching mathematics and science at the elementary level
- Inclusion of environmental themes
- Inclusion of STS themes
- Inclusion of historical development of mathematical/scientific thought

Goal 2 -- Make Mathematics, Science and Computer Education More Exciting

Goal from the Comprehensive Plan:

To provide incentives to restructure schools and school systems to maximize student understanding, and share successful efforts statewide.

State Key Indicators

- Number of school districts using *Blueprint for Career Preparation* for school improvement
- Number of students served by science museums and zoos through school programs
- Expenditure of state funds on hands-on mathematics and science material and equipment, and texts
- Expenditure of district, local and private funds on hands-on mathematics, science and computer education materials and equipment
- Number of districts offering and students served by summer science, mathematics and computer programs

- Expenditure of state funds for science laboratory construction and renovation
- Number of winners and participants in science fairs and national competitions

District Key Indicators

- Policy and trend in promoting active learning strategies
- Policy on text availability and use
- Encouragement/incentives/staff development for promoting active learning strategies
- Allocations and policies for funding "active learning"

School Key Indicators

- Use of cooperative learning
- Staff development opportunities on cooperative learning
- Trends in use of problem-centered learning
- Use of problem-centered learning
- Use of museums and other out-of-school learning opportunities
- Trends in use of museums and other out-of-school learning opportunities
- Trends in use of hands-on experiences for active learning
- Staff development on the use of hands-on experiences for active learning
- Use of textbooks
- Availability of manipulatives
- Use of manipulatives
- Funds for purchasing materials
- Science lab facilities (secondary sci only)
- Trends in participation in science/math competitions
- Staff development in science/math competitions
- Availability of facilities to store manipulatives

Goal 3 -- Use State of the Art Technology

Goal from the Comprehensive Plan:

To increase the availability and use of state-of-the-art instructional technology to improve the productivity and effectiveness of mathematics, science and computer education.

State Key Indicators

- Number of instructional microcomputers
- Number and type of instructional microcomputers by district
- Number and type of microcomputers specifically allocated for mathematics, science and computer courses
- Number and type of microcomputers in elementary and middle schools
- Number and type of microcomputers specifically allocated to teachers for instructional management
- Expenditure of state funds for microcomputer software.
- Number and type of district projects awarded under the - Instructional Technology Challenge Grant program
- Number of teachers served by the Instructional Technology Teacher Training program

District Key Indicators

- Policies about providing teachers and students with greater access to computers and other technology
- Policies and plans for use of computers, calculators, etc. in mathematics and science
- Policies and plans to ensure access and use of appropriate mathematics and science software
- Allocations for instructional technology; trends and plans

School Key Indicators

- Use of computers in mathematics and science classes
- Trends in use of computers in mathematics and science classes
- Availability/use of appropriate software
- Availability/use of peripheral accessories
- Use of other forms of instructional technology
- Use of audio-video equipment
- Availability/use of calculators
- Trends in calculator usage
- Availability/use of telecommunications equipment
- Using technology for instructional purposes
- Staff development on computer applications
- Staff development on calculator applications
- Perceived value of Model Technology Schools

Goal 4 -- Prepare More Qualified Teachers

Goal from the Comprehensive Plan:

To expand the number of qualified teachers of mathematics, science and computer education.

State Key Indicators

- Annual average teacher salary percentage increases
- Teacher supply and demand report; fall vacancies summary
- Number of graduates of teacher education programs
- Number of first-time teaching certificates awarded in mathematics, science and computer education
- Current number of mathematics, science and computer education teaching certificates by discipline
- Number of out-of-field teachers
- Number and type of Teacher Stipends awarded
- Number and type of TeacherQuest awards
- Number of teachers served by and content of Summer Inservice Institute Program (SIIP)
- Staff development participant counts, hours, program types by district and state

District Key Indicators

- Perceptions about hiring qualified and certified science and mathematics teachers
- Trends and plans in professional development in mathematics and science for K-12 teachers
- Trends and plans in encouraging teacher collaboration to improve mathematics and science

School Key Indicators

- Teacher opportunities to exchange ideas and share successful practices; observing fellow teachers
- Teacher choice of instructional materials
- Participation in summer inservice institutes
- Staff development workshops attended
- Staff development in isolated school districts
- Teachers designing their own staff development
- Mentor teacher program participation
- Teacher/Quest program participation
- Planning for learning activities

- Support for improving science and mathematics teaching
- Teacher attendance at professional meetings
- Availability and use of professional journals

Goal 5 -- Reach Out to Students with Special Needs

Goal from Comprehensive Plan:

To increase motivation, incentives, and opportunities for minority, female, at-risk, disabled, and gifted students to pursue programs and careers in mathematics, science, and computer education.

State Key Indicators

- Number of students enrolled in mathematics, science and computer education courses crosstabulated by race, gender and disability
- Enrollments in remedial courses
- Identification of programs and reports on effectiveness of programs that sought to address this goal
- Number of post-secondary degrees awarded in mathematics, science and computer related courses
- Trends in the supply of minority teachers
- Post-secondary career plans of Florida public high school graduates
- Racial/ethnic membership in programs for exceptional students
- Number of students reached through summer pre-college programs in mathematics, science and related areas

District Key Indicators

- Policies and plans for ability-grouping and alternatives to tracking
- Special programs which address the needs of females, minorities, at-risk, disabled, and gifted students
- Availability of programs for teachers to educate about special needs of females, minorities, at-risk, disabled, and gifted students

School Key Indicators

- Use of ability grouping
- What has been done to encourage of females, minorities and "alternatively-abled"
- Programs/lessons about career opportunites in mathematics, science or technology
- Participation in higher level courses

Goal 6 -- Evaluate Results and Build on Success

Goal from the Comprehensive Plan:

To implement and refine the Comprehensive Plan as necessary to make substantial, measurable improvements in mathematics, science and computer education in Florida by the year 1999.

State Key Indicators

- Identification of state level Department of Education divisions and bureaus addressing recommendations from the Comprehensive Plan; how are they being addressed
- Number and content of state level programs using and disseminating the Comprehensive Plan as part of program planning and implementation
- Number of district school boards endorsing the Comprehensive Plan
- Number of districts implementing recommendations of the Comprehensive Plan
- Number and type of recommendations being addressed at the district level
- Status of programs and initiatives that should be directly affected by recommendations

District Key Indicators

- Local level awareness of Comprehensive Plan
- Plans for using and refining recommendations
- Identifying and disseminating local successful mathematics, science, and computer education programs
- Perceptions about Regional Centers of Excellence

School Key Indicators

- Use of state and federal programs/initiatives
- Perceptions about Regional Centers of Excellence
- Awareness of Comprehensive Plan
- Classroom influence of Comprehensive Plan
- How are schools/teachers using the Comprehensive Plan?

Goal 7 -- Reexamine and adjust assessment programs

Goal from the Comprehensive Plan:

Re-examine and adjust the statewide testing program to suppport the goals of the Comprehensive Plan.

State Key Indicators

- Status of current mathematics and science assessments
- Plans regarding changes in assessments
- Policies and plans for alternative assessment techniques
- Policies and plans for using technology in assessment
- Evidence of coordination of assessments with Comprehensive Plan

District Key Indicators

- Status of current mathematics and science assessments
- Plans regarding changes in assessments
- Policies and plans for alternative assessment techniques
- Plans for improving evaluation program to be consistent with the Comprehensive Plan
- Policies and plans to educate teachers about a variety of assessment techniques

School Key Indicators

- Teacher use of alternative assessments
- Instructional time used for standardized testing

Goal 8 -- Expanding partnerships with families, business and the community.

Goal from the Comprehensive Plan:

Expand the productive collaboration of educators with parents, community resources, business, and industry.

State Key Indicators

- Number and type of Math/Science Challenge Grants awarded
- Number of TeacherQuest placements
- Number of grant programs that require or offer incentives for partnerships
- Number and type of partnerships included as part of Instructional Technology Challenge Grants
- Number and type of partnerships engaged in at Centers of Excellence

District Key Indicators

- Use of community centers/Environmental Centers/Museums
- Policies and plans for partnerships
- Use of business, community and parent awareness programs

School Key Indicators

- Teacher involvement in partnership programs
- Teacher perceptions about parental involvement
- List of specific community centers/ museums/ environmental centers used

APPENDIX B

QUESTIONNNAIRES

Copies of the questionnaires used in this study are provided on the following pages of Appendix B. There were questionnaires designed to collect data from elementary school teachers, middle school science teachers, high school science teachers, middle school mathematics teachers, high school mathematics teachers, district curriculum coordinators with mathematics supervision, and district curriculum coordinators with science supervision.

ELEMENTARY SCHOOL TEACHER QUESTIONNAIRE

SCIENCE, MATHEMATICS AND COMPUTER EDUCATION IN FLORIDA'S PUBLIC SCHOOLS

This survey is being sent to randomly selected elementary school teachers throughout Florida. Your cooperation in answering the questions on this survey will assist the Florida Department of Education and the Science and Mathematics Education Program at Florida State University in understanding what is happening with respect to science, mathematics, and computers in Florida's elementary schools.

The following questions ask for your opinions about science and mathematics education and computer use at your elementary school. Please base your answers to these questions on the practices in your classroom and at your school during the present year. Other questions ask your opinion about trends in science and mathematics education. Please base those answers on practices during the past two years. This survey should take 10 to 15 minutes to complete.

BACKGROUND INFORMATION

A. District: ______________________ B. School: ______________________

C. Please circle the grade level you primarily teach:

K	1	2	3	4	5	6

D. Please check the box that best represents YOUR background:

	African-American
	Asian
	Caucasian
	Hispanic
	Other

E. Please check the box that represents YOUR age:

	Less than 30 years old
	30 to 40 years old
	41 to 50 years old
	51 or older

F. Please check the box that represents YOUR years of teaching elementary students in this county:

	1 to 2 years
	3 to 5 years
	6 to 15 years
	16 to 25 years
	26 or more years

I. INFORMATION ABOUT YOUR CLASSROOM

DIRECTIONS: For the following questions, please answer with reference to the PRESENT SCHOOL YEAR (1990-1991). Please mark an X in the appropriate box. Use the following definitions:

ALMOST ALWAYS = 3 to 5 times per week (nearly every day)
ON FREQUENT OCCASIONS = 3 to 5 times per month (about once a week)
ON A FEW OCCASIONS = 6 to 10 times per year (about once a month)
ALMOST NEVER = 0 to 3 times per year

During this year, how often have...	ALMOST ALWAYS	ON FREQUENT OCCASIONS	ON A FEW OCCASIONS	ALMOST NEVER
1. **Science** lessons incorporated the use of manipulatives or hands-on experiences?				
2. **Mathematics** lessons incorporated the use of manipulatives or hands-on experiences?				
3. **Science** lessons been integrated into other areas of the curriculum?				
4. **Mathematics** lessons been integrated into other areas of the curriculum?				
5. Electronic technologies other than computers (e.g., calculators) been used in **science** lessons?				
6. Electronic technologies other than computers (e.g., calculators) been used in **mathematics** lessons?				
7. Children in your class used computers for **science**?				
8. Children in your class used computers for **mathematics**?				
9. Your students used a text while learning **science**?				
10. Your students used a text while learning **mathematics**?				
11. Children worked in teams or cooperative groups while learning **science**?				
12. Children worked in teams or cooperative groups while learning **mathematics**?				
13. Children learned about science or mathematics career opportunities?				

Comments:

I. INFORMATION ABOUT YOUR CLASSROOM (continued)

DIRECTIONS: For the following questions, please answer with reference to the PRESENT SCHOOL YEAR (1990-1991). Please mark an X in the appropriate box. Use the following definitions:

ALMOST ALWAYS = 3 to 5 times per week (nearly every day)
ON FREQUENT OCCASIONS = 3 to 5 times per month (about once a week)
ON A FEW OCCASIONS = 6 to 10 times per year (about once a month)
ALMOST NEVER = 0 to 3 times per year

During this year, how often have...	ALMOST ALWAYS	ON FREQUENT OCCASIONS	ON A FEW OCCASIONS	ALMOST NEVER
14. You used alternative forms of assessment such as oral interviews, student observations, or concept maps to assess **science** learning?				
15. You used alternative forms of assessment such as oral interviews, student observations, or concept maps to assess **math** learning?				
16. You used audio-visuals such as films & videos to enhance **science** learning?				
17. You used audio-visuals such as films & videos to enhance **mathematics** learning?				
18. Museums or other out-of-classroom activities been used to enhance **science** learning?				
19. Museums or other out-of-classroom activities been used to enhance **mathematics** learning?				

COMMENTS:

II. ACTUAL TEACHING OF SCIENCE AND MATHEMATICS

DIRECTIONS: Please circle the appropriate box.

20. Of the five days in an average school week, how many days is **science** taught in your classroom?

0 DAYS	1 DAY	2 DAYS	3 DAYS	4 DAYS	5 DAYS

21. On a typical school day in which you teach **science**, about how much time is spent on a **science** lesson?

0-15 minutes	15-30 minutes	30-45 minutes	45-60 minutes	60 minutes or longer

22. Of the five days in an average school week, how many days is **mathematics** taught in your classroom?

0 DAYS	1 DAY	2 DAYS	3 DAYS	4 DAYS	5 DAYS

23. On a typical school day in which you teach **mathematics**, about how much time is spent on a **math** lesson?

0-15 minutes	15-30 minutes	30-45 minutes	45-60 minutes	60 minutes or longer

COMMENTS:

III. TRENDS AND CHANGES IN MATHEMATICS, SCIENCE AND COMPUTER EDUCATION

DIRECTIONS: Place an X in the appropriate box to indicate **DEGREE OF CHANGE IN YOUR SCIENCE AND MATHEMATICS TEACHING OVER THE PAST TWO (2) YEARS.**
N/A = DON'T HAVE; DON'T USE; NOT APPLICABLE TO MY SITUATION

In the past 2 years, the degree of change in:	**HAS INCREASED**	**HAS NOT CHANGED**	**HAS DECREASED**	**N/A**
24. The amount of time **science** is taught per week				
25. The amount of time **mathematics** is taught per week				
26. Student use of computers for **science**				
27. Student use of computers for **mathematics**				
28. The amount of time available for teacher planning and preparation for **mathematics** and **science**				
29. Classroom use of VCR or video equipment				
30. Student use of calculators				
31. Student use of manipulatives				
32. Making observations of science, mathematics or computer lessons by other teachers				
33. Parental involvement in mathematics, science, or computer education				
34. Your collaboration with other teachers to develop science, mathematics, or computer activities				
35. The amount of hands-on materials available for **science**				
36. The amount of hands-on materials available for **mathematics**				
37. Use of problem-centered learning activities				
38. Administrative support for improving **science** teaching				
39. Administrative support for improving **math** teaching				
40. Instructional time used for preparing students to take standardized tests				
41. Participation in Science Fair, Invent America, Science Olympiad, etc.				
42. Museum visits/mathematics & science field trips				
43. Attending professional meetings				
44. Your participation in a teacher mentoring program				

COMMENTS:

III. TRENDS AND CHANGES IN MATHEMATICS, SCIENCE AND COMPUTER EDUCATION (continued)

DIRECTIONS: Place an X in the appropriate box to indicate DEGREE OF CHANGE IN YOUR SCIENCE AND MATHEMATICS TEACHING OVER THE PAST TWO (2) YEARS.
N/A = DON'T HAVE; DON'T USE; NOT APPLICABLE TO MY SITUATION

In the past 2 years, the degree of change in:	HAS INCREASED	HAS NOT CHANGED	HAS DECREASED	N/A
45. Your choice in textbooks and other materials for science and mathematics				
46. Using "The Environment" as a topic of study				
47. Teaching about science-technology-society issues				
48. Your attendance at professional meetings				
49. Facilities for storing science/math equipment				

COMMENTS:

IV. GENERAL INFORMATION ABOUT MATHEMATICS AND SCIENCE AT YOUR SCHOOL

DIRECTIONS: Please circle either YES or NO

50. Are any special efforts made at your school to encourage female and minority students to take advanced mathematics or science courses?	YES	NO
51. Are students in your class ability-grouped in mathematics or science?	YES	NO
52. Are efforts made to have female and minority role models as a part of mathematics or science education at your school?	YES	NO
53. Are efforts made at your school to help students develop confidence in their mathematical or scientific abilities?	YES	NO
54. Do you feel there is equal access for ALL students to participate in higher or advanced level courses?	YES	NO
55. Are efforts made at your school to encourage persons with handicapping conditions to pursue science and mathematics?	YES	NO
56. Have you heard of a Florida Department of Education document called A Comprehensive Plan: Improving Mathematics, Science and Computer Education in Florida?	YES	NO
57. Has this document influenced the way you teach mathematics or science in your classroom?	YES	NO
58. Are you aware of the location of Regional Center for Excellence in Mathematics, Science, Computers, and Technology for your district?	YES	NO
59. Have you received any services such as newsletters, workshops, resource materials from the Regional Center for Excellence this year?	YES	NO
60. Has the curriculum changed to cover a broader range of topics?	YES	NO
61. Has the curriculum changed to explore fewer topics in more depth?	YES	NO

COMMENTS:

V. ACCESS AND USE OF INSTRUCTIONAL TECHNOLOGIES FOR SCIENCE AND MATHEMATICS

DIRECTIONS: Please put an X in the box that best represents **YOUR PERSONAL DEGREE OF ACCESS AND USE** of the following instructional technologies during the present school year.

AVAILABLE WITH EASY ACCESS = **the equipment is available to you when you need it.**
AVAILABLE WITH LIMITED ACCESS = **the equipment is available but you may not be able to use it.**
AVAILABLE BUT NOT USED = **the equipment or software is available but you do not use it.**
NOT AVAILABLE = **the equipment is not available to you at your school.**

ACCESS AND USE OF:	AVAILABLE WITH EASY ACCESS	AVAILABLE WITH LIMITED ACCESS	AVAILABLE BUT NOT USED	NOT AVAILABLE
62. Microcomputers				
63. Computer printer				
64. Large group computer display				
65. Modem/Telecommunications				
66. Video equipment				
67. Networked computers				
68. Mathematics Manipulatives such as pattern blocks, geoboards, Cuisennaire rods, Dienes blocks, tangrams				
69. Science Equipment such as magnifying glasses, magnets, batteries/bulbs				
70. Measuring equipment such as balance pans, meter sticks, thermometers				
71. Calculators				
72. Tutorial software				
73. Drill and practice software				
74. Games software				
75. Simulation software				
76. Problem-solving software				
77. Programming software (LOGO, etc)				
78. Graphics software				
79. Other mathematics software				
80. Other science software				
81. Professional journals and other teacher curricular materials				

COMMENTS:

VI. STAFF DEVELOPMENT OPPORTUNITIES

DIRECTIONS: Please circle either YES or NO.

82. Have you **IN THE PAST TWO SUMMERS OR WILL YOU THIS SUMMER** participate in a staff development institute regarding science, mathematics, or computer education?

YES	NO

DIRECTIONS: Mark the appropriate box.

FORMAL = district provided workshop, university course, TEC, etc.
INFORMAL = Interactions you have arranged with colleagues, teacher collaboration.
N/A = not available or did not participate.

In the past two school years I have participated in staff development about:	**FORMAL**	**INFORMAL**	**N/A**
83. Problem-centered learning			
84. Computer applications			
85. Using calculators with students			
86. Math manipulatives			
87. Hands-on science			
88. Science teaching strategies			
89. Mathematics teaching strategies			
90. Cooperative learning			
91. Science curriculum development			
92. Mathematics curriculum development			
93. Science Fair, Invent America, Science Olympiad, etc.			
94. Identifying resource people in community to enhance science and mathematics lessons			
95. Mathematics content			
96. Science content			

COMMENTS:

Thank you for completing and returning this questionnaire in a timely fashion.

MIDDLE SCHOOL SCIENCE TEACHER QUESTIONNAIRE

SCIENCE, MATHEMATICS AND COMPUTER EDUCATION IN FLORIDA'S PUBLIC SCHOOLS

This survey is being sent to randomly selected middle school science teachers throughout Florida. Your cooperation in answering the questions on this survey will assist the Florida Department of Education and the Science and Mathematics Education Program at Florida State University in understanding what is happening with respect to science and computers in Florida's schools.

The following questions ask for your opinions about science education and computer use at your middle school. Please use the present school year as your frame-of-reference when answering these questions. Other questions ask about trends in science education at your school during the past 2 years. This survey should take 10 to 15 minutes to complete.

BACKGROUND INFORMATION

A. District:______________________ B. School:______________________

C. Please check the course(s) you primarily teach:

	Life science
	Physical science
	Earth/space science
	Other

D. Please check the box that best represents YOUR background:

	African-American
	Asian
	Caucasian
	Hispanic
	Other

E. Please check the box that represents YOUR age:

	Less that 30 years old
	30 to 40 years old
	41 to 50 years old
	51 or older

F. Please check the box that represents YOUR years of teaching middle school in this county:

	1 to 2 years
	3 to 5 years
	6 to 15 years
	16 to 25 years
	26 or more years

I. INFORMATION ABOUT YOUR CLASS

DIRECTIONS: Mark an X in the appropriate box for each question. Please think about the type of class you checked on the cover sheet and answer with reference to the PRESENT SCHOOL YEAR (1990-1991).

ALMOST ALWAYS = 3 to 5 times per week (nearly every day)
ON FREQUENT OCCASIONS = 3 to 5 times per month (about once a week)
ON A FEW OCCASIONS = 6 to 10 times per year (about once a month)
ALMOST NEVER = 0 to 3 times per year

During this year, how often have...	ALMOST ALWAYS	ON FREQUENT OCCASIONS	ON A FEW OCCASIONS	ALMOST NEVER
1. Science lessons incorporated the use of manipulatives or hands-on experiences?				
2. Science lessons been integrated with other areas of the curriculum?				
3. Your students used a text while learning science?				
4. Electronic technologies (e.g., calculators) other than computers been used in science lessons?				
5. Students in your class used computers for science?				
6. Museums or other out-of-classroom activities been used to enhance science lessons?				
7. Historical developments in science been incorporated into lessons?				
8. Students worked in teams or cooperative groups while learning science?				
9. Students learned about science-related career opportunities?				
10. You used alternative forms of assessment such as oral interviews, student observations, concept maps etc. to assess science learning?				
11. The units taught incorporated "The Environment" as a theme?				

COMMENTS:

II. TRENDS AND CHANGES IN SCIENCE AND COMPUTER EDUCATION

DIRECTIONS: Please answer these questions by thinking about **all the courses** you have taught during the past two years. Place an X in the appropriate box to indicate **THE DEGREE OF CHANGE OVER THE PAST TWO (2) YEARS.**

N/A = DON'T HAVE; DON'T USE; NOT APPLICABLE TO MY SITUATION

In the past 2 years, the degree of change in:	HAS INCREASED	HAS NOT CHANGED	HAS DECREASED	N/A
12. Student use of computers				
13. The amount of time available for teacher planning and preparation				
14. Classroom use of VCR or video equipment				
15. Student use of calculators				
16. Student use of manipulatives for science				
17. Making observations of science or computer lessons by other teachers				
18. Parental involvement in science				
19. Your collaboration with other teachers to develop science or computer education activities				
20. The amount of hands-on materials available for science lessons				
21. Use of problem-centered learning activities				
22. Administrative support to improve science teaching				
23. Instructional time given to preparing students for science portions of standardized tests				
24. Choice in selecting texts and other materials				
25. Science-related field trips				
26. Participation in science competitions				
27. Attending professional meetings to upgrade skills				
28. Your participation in a teacher mentor program				
29. Using "The Environment" as a theme for lessons				
30. Teaching science-technology-society issues				
31. Facilities for storing science equipment				

COMMENTS:

III. ACCESS AND USE OF INSTRUCTIONAL TECHNOLOGIES FOR MATHEMATICS

DIRECTIONS: Please mark an X in the appropriate box to rate **YOUR PERSONAL DEGREE OF ACCESS AND USE** of the following instructional technologies during the present school year.

AVAILABLE WITH EASY ACCESS = **the equipment is available to you when you need it.**
AVAILABLE WITH LIMITED ACCESS = **the equipment is available but you may not be able to use it.**
AVAILABLE BUT NOT USED = **the equipment or software is available but you do not use it.**
NOT AVAILABLE = **the equipment is not available to you at your school.**

ACCESS AND USE OF:	AVAILABLE WITH EASY ACCESS	AVAILABLE WITH LIMITED ACCESS	AVAILABLE BUT NOT USED	NOT AVAILABLE
32. Microcomputers				
33. Computer printers				
34. Large group computer display				
35. Modem/telecommunications				
36. Video equipment				
37. Networked computers				
38. Film/slide projectors				
39. General science equipment such as incline plane, power supply, etc.				
40. Expendable supplies such as chemicals, glassware, batteries, etc.				
41. Major pieces of science equipment such as lasers, projecting microscopes, etc				
42. Measurement equipment such as balances, rulers, graduated cylinders				
43. Models, visual aids, rock samples, etc				
44. Professional journals and other teacher curricular materials				
45. Calculators				
46. Tutorial software				
47. Drill and practice software				
48. Games software				
49. Simulation software				
50. Problem-solving software				
51. Graphics software				
52. Interactive video discs				
53. Other science software				

COMMENTS:

IV. GENERAL INFORMATION ABOUT SCIENCE AT YOUR SCHOOL

DIRECTIONS: Please circle either YES or NO

54. Are any special efforts made at your school to encourage female and minority students to take advanced science courses?	YES	NO
55. Are students at your school ability-grouped in science?	YES	NO
56. Are efforts made to have female and minority role models as a part of science instruction?	YES	NO
57. Are efforts made at your school to help students develop confidence in their mathematical abilities?	YES	NO
58. Do you feel there is equal access for all students to participate in higher or advanced level science?	YES	NO
59. Are efforts made at your school to encourage persons with handicapping conditions to pursue science and mathematics?	YES	NO
60. Have you heard of a Florida Department of Education document called <u>A Comprehensive Plan: Improving Mathematics, Science and Computer Education in Florida</u>?	YES	NO
61. Has this document influenced the way you teach science in your classroom?	YES	NO
62. Are you aware of the location of Regional Center for Excellence in Mathematics, Science, Computers and Technology for your district?	YES	NO
63. Have you received any services such as newsletters, workshops, resource materials from the Regional Center for Excellence this year?	YES	NO
64. Has the curriculum changed to cover a broader range of topics?	YES	NO
65. Has the curriculum changed to explore fewer topics in greater depth?	YES	NO

COMMENTS:

VI. STAFF DEVELOPMENT OPPORTUNITIES

DIRECTIONS: Please circle either YES or NO.

66. Have you **IN THE PAST TWO SUMMERS OR WILL YOU THIS SUMMER** participate in a staff development institute regarding science or computer education?

YES	NO

DIRECTIONS: Mark the appropriate box.

FORMAL = district provided workshop, university course, TEC, etc.
INFORMAL = interactions you have arranged with colleagues, teacher collaboration.
N/A = not available or did not participate.

In the past two school years I have participated in staff development about:	FORMAL	INFORMAL	N/A
67. Problem-centered learning			
68. Computer applications			
69. Calculators			
70. Science manipulatives/hands-on science			
71. Science teaching strategies			
72. Cooperative learning			
73. Science curriculum development			
74. Identifying resource people in community to enhance science lessons			
75. Special-needs students			
76. Science content			
77. Science fair			
78. "Real-world" applications for science			

COMMENTS:

Thank you for completing and returning this questionnaire in a timely fashion.

HIGH SCHOOL SCIENCE TEACHER QUESTIONNAIRE

SCIENCE, MATHEMATICS AND COMPUTER EDUCATION IN FLORIDA'S PUBLIC SCHOOLS

This survey is being sent to randomly selected high school science teachers throughout Florida. Your cooperation in answering the questions on this survey will assist the Florida Department of Education and the Science and Mathematics Education Program at Florida State University in understanding what is happening with respect to science and computers in Florida's schools.

The following questions ask for your opinions about science education and computer use at your high school. PLEASE CHOOSE ONE COURSE YOU TEACH THIS SCHOOL YEAR AS YOUR FRAME-OF-REFERENCE WHEN ANSWERING THESE QUESTIONS. Other questions ask about trends in science education at your school during the past 2 years. This survey should take 10 to 15 minutes to complete.

BACKGROUND INFORMATION

A. District:____________________ B. School:____________________

C. Please check the type of course you are using as your frame-of-reference for answering this questionnaire:

	College prep
	Non-college prep

D. The name of this course is:____________________________

E. Please check the box that best represents YOUR background:

	African-American
	Asian
	Caucasian
	Hispanic
	Other

F. Please check the box that represents YOUR age:

	Less than 30 years old
	30 to 40 years old
	41 to 50 years old
	51 or older

G. Please check the box that represents YOUR years teaching high school science in this county:

	1 to 2 years
	3 to 5 years
	6 to 15 years
	16 to 25 years
	26 or more years

I. INFORMATION ABOUT YOUR CLASS

DIRECTIONS: Mark an X in the appropriate box for each question. Please think about the type of class you checked on the cover sheet and answer with reference to the PRESENT SCHOOL YEAR (1990-1991).

ALMOST ALWAYS = 3 to 5 times per week (nearly every day)
ON FREQUENT OCCASIONS = 3 to 5 times per month (about once a week)
ON A FEW OCCASIONS = 6 to 10 times per year (about once a month)
ALMOST NEVER = 0 to 3 times per year

During this year, how often have...	**ALMOST ALWAYS**	**ON FREQUENT OCCASIONS**	**ON A FEW OCCASIONS**	**ALMOST NEVER**
1. Science lessons incorporated the use of manipulatives or hands-on experiences?				
2. Science lessons been integrated with other areas of the curriculum?				
3. Your students used a text while learning science?				
4. Electronic technologies (e.g., calculators) other than computers been used in science lessons?				
5. Students in your class used computers for science?				
6. Museums or other out-of-classroom activities been used to enhance science lessons?				
7. Historical developments in science been incorporated into lessons?				
8. Students worked in teams or cooperative groups while learning science?				
9. Students learned about science-related career opportunities?				
10. You used alternative forms of assessment such as oral interviews, student observations, concept maps etc. to assess science learning?				
11. The units taught incorporated "The Environment" as a theme?				

COMMENTS:

II. TRENDS AND CHANGES IN SCIENCE AND COMPUTER EDUCATION

DIRECTIONS: Please answer these questions by thinking about all the courses you have taught during the past two years. Place an X in the appropriate box to indicate THE DEGREE OF CHANGE OVER THE PAST TWO (2) YEARS.

N/A = DON'T HAVE; DON'T USE; NOT APPLICABLE TO MY SITUATION

In the past 2 years, the degree of change in:	HAS INCREASED	HAS NOT CHANGED	HAS DECREASED	N/A
12. Student use of computers				
13. The amount of time available for teacher planning and preparation				
14. Classroom use of VCR or video equipment				
15. Student use of calculators				
16. Student use of manipulatives for science				
17. Making observations of science or computer lessons by other teachers				
18. Parental involvement in science				
19. Your collaboration with other teachers to develop science or computer education activities				
20. The amount of hands-on materials available for science lessons				
21. Use of problem-centered learning activities				
22. Administrative support to improve science teaching				
23. Instructional time given to preparing students for science portions of standardized tests				
24. Choice in selecting texts and other materials				
25. Science-related field trips				
26. Participation in science competitions				
27. Attending professional meetings to upgrade skills				
28. Your participation in a teacher mentor program				
29. Using "The Environment" as a theme for lessons				
30. Teaching science-technology-society issues				
31. Facilities for storing science equipment				

COMMENTS:

III. ACCESS AND USE OF INSTRUCTIONAL TECHNOLOGIES FOR MATHEMATICS

DIRECTIONS: Please mark an X in the appropriate box to rate YOUR PERSONAL DEGREE OF ACCESS AND USE of the following instructional technologies during the present school year.

AVAILABLE WITH EASY ACCESS = the equipment is available to you when you need it.
AVAILABLE WITH LIMITED ACCESS = the equipment is available but you may not be able to use it.
AVAILABLE BUT NOT USED = the equipment or software is available but you do not use it.
NOT AVAILABLE = the equipment is not available to you at your school.

ACCESS AND USE OF:	AVAILABLE WITH EASY ACCESS	AVAILABLE WITH LIMITED ACCESS	AVAILABLE BUT NOT USED	NOT AVAILABLE
32. Microcomputers				
33. Computer printers				
34. Large group computer display				
35. Modem/telecommunications				
36. Video equipment				
37. Networked computers				
38. Film/slide projectors				
39. General science equipment such as incline plane, power supply, etc.				
40. Expendable supplies such as chemicals, glassware, batteries, etc.				
41. Major pieces of science equipment such as lasers, projecting microscopes, etc				
42. Measurement equipment such as balances, rulers, graduated cylinders				
43. Models, visual aids, rock samples, etc				
44. Professional journals and other teacher curricular materials				
45. Calculators				
46. Tutorial software				
47. Drill and practice software				
48. Games software				
49. Simulation software				
50. Problem-solving software				
51. Graphics software				
52. Interactive video discs				
53. Other science software				

COMMENTS:

IV. GENERAL INFORMATION ABOUT SCIENCE AT YOUR SCHOOL

DIRECTIONS: Please circle either YES or NO

54. Are any special efforts made at your school to encourage female and minority students to take advanced science courses?	YES	NO
55. Are students at your school ability-grouped in science?	YES	NO
56. Are efforts made to have female and minority role models as a part of science instruction?	YES	NO
57. Are efforts made at your school to help students develop confidence in their mathematical abilities?	YES	NO
58. Do you feel there is equal access for all students to participate in higher or advanced level science?	YES	NO
59. Are efforts made at your school to encourage persons with handicapping conditions to pursue science and mathematics?	YES	NO
60. Have you heard of a Florida Department of Education document called A Comprehensive Plan: Improving Mathematics, Science and Computer Education in Florida?	YES	NO
61. Has this document influenced the way you teach science in your classroom?	YES	NO
62. Are you aware of the location of Regional Center for Excellence in Mathematics, Science, Computers and Technology for your district?	YES	NO
63. Have you received any services such as newsletters, workshops, resource materials from the Regional Center for Excellence this year?	YES	NO
64. Has the curriculum changed to cover a broader range of topics?	YES	NO
65. Has the curriculum changed to explore fewer topics in greater depth?	YES	NO

COMMENTS:

VI. STAFF DEVELOPMENT OPPORTUNITIES

DIRECTIONS: Please circle either YES or NO.

66. Have you **IN THE PAST TWO SUMMERS OR WILL YOU THIS SUMMER** participate in a staff development institute regarding science or computer education?

YES	NO

DIRECTIONS: Mark the appropriate box.

FORMAL = district provided workshop, university course, TEC, etc.
INFORMAL = interactions you have arranged with colleagues, teacher collaboration.
N/A = not available or did not participate.

In the past two school years I have participated in staff development about:	FORMAL	INFORMAL	N/A
67. Problem-centered learning			
68. Computer applications			
69. Calculators			
70. Science manipulatives/hands-on science			
71. Science teaching strategies			
72. Cooperative learning			
73. Science curriculum development			
74. Identifying resource people in community to enhance science lessons			
75. Special-needs students			
76. Science content			
77. Science fair			
78. "Real-world" applications for science			

COMMENTS:

MIDDLE SCHOOL MATHEMATICS TEACHERS QUESTIONNAIRE

SCIENCE, MATHEMATICS AND COMPUTER EDUCATION IN FLORIDA'S PUBLIC SCHOOLS

This survey is being sent to randomly selected middle school mathematics teachers throughout Florida. Your cooperation in answering the questions on this survey will assist the Florida Department of Education and the Mathematics and Science Education Program at Florida State University in understanding what is happening with respect to mathematics, science and computers in Florida's schools.

The following questions ask for your opinions about mathematics education and computer use at your middle school. Please use the present school year as your frame-of-reference when answering these questions. Other questions ask about trends in mathematics education at your school during the past 2 years. This survey should take 10 to 15 minutes to complete.

BACKGROUND INFORMATION

A. District:________________ B. School:________________

C. Title of course you PRIMARILY teach: ________________

D. Please check the box that best represents YOUR background:

	African-American
	Asian
	Caucasian
	Hispanic
	Other

E. Please check the box that represents YOUR age:

	Less than 30 years old
	30 to 40 years old
	41 to 50 years old
	51 or older

F. Please check the box that represents YOUR years of teaching middle school mathematics in this county:

	1 to 2 years
	3 to 5 years
	6 to 15 years
	16 to 25 years
	26 or more years

I. INFORMATION ABOUT YOUR CLASS

DIRECTIONS: Mark an X in the appropriate box for each question. Please think about the PRESENT SCHOOL YEAR (1990-1991) when answering these questions.

ALMOST ALWAYS = **3 to 5 times per week (nearly every day)**
ON FREQUENT OCCASIONS = **3 to 5 times per month (about once a week)**
ON A FEW OCCASIONS = **6 to 10 times per year (about once a month)**
ALMOST NEVER = **0 to 3 times per year**

During this year, how often have...	**ALMOST ALWAYS**	**ON FREQUENT OCCASIONS**	**ON A FEW OCCASIONS**	**ALMOST NEVER**
1. Mathematics lessons incorporated the use of manipulatives or hands-on experiences?				
2. Mathematics lessons been integrated with other areas of the curriculum?				
3. Your students used a text while learning mathematics?				
4. Electronic technologies (e.g., calculators) other than computers been used in mathematics lessons?				
5. Students in your class used computers for mathematics?				
6. Museums or other out-of-classroom activities been used to enhance mathematics lessons?				
7. Historical developments in mathematics been incorporated into lessons?				
8. Students worked in teams or cooperative groups while learning mathematics?				
9. Students learned about mathematics-related career opportunities?				
10. You used alternative forms of assessment such as oral interviews, student observations, concept maps etc. to assess mathematics learning?				

COMMENTS:

II. TRENDS AND CHANGES IN MATHEMATICS AND COMPUTER EDUCATION

DIRECTIONS: Please answer these questions by thinking about **all the courses** you have taught during the past two years. Place an X in the appropriate box to indicate THE DEGREE OF CHANGE OVER THE PAST TWO (2) YEARS.

N/A = DON'T HAVE; DON'T USE; NOT APPLICABLE TO MY SITUATION

In the past 2 years, the degree of change in:	HAS INCREASED	HAS NOT CHANGED	HAS DECREASED	N/A
11. Student use of computers				
12. The amount of time available for teacher planning and preparation				
13. Classroom use of VCR or video equipment				
14. Student use of calculators				
15. Student use of manipulatives for mathematics				
16. Making observations of mathematics or computer lessons by other teachers				
17. Parental involvement in mathematics				
18. Your collaboration with other teachers to develop mathematics or computer education activities				
19. The amount of hands-on materials available for mathematics lessons				
20. Use of problem-centered learning activities				
21. Administrative support to improve math teaching				
22. Instructional time given to preparing students for mathematics portions of standardized tests				
23. Choice in selecting texts and other materials				
24. Mathematics-related field trips				
25. Participation in mathematics competitions				
26. Attending professional meetings to upgrade skills				
27. Your participation in a teacher mentor program				

COMMENTS:

III. ACCESS AND USE OF INSTRUCTIONAL TECHNOLOGIES FOR MATHEMATICS

DIRECTIONS: Please mark an X in the appropriate box to rate YOUR PERSONAL DEGREE OF ACCESS AND USE of the following instructional technologies during the present school year.

AVAILABLE WITH EASY ACCESS = the equipment is available to you when you need it.
AVAILABLE WITH LIMITED ACCESS = the equipment is available but you may not be able to use it.
AVAILABLE BUT NOT USED = the equipment or software is available but you do not use it.
NOT AVAILABLE = the equipment is not available to you at your school.

ACCESS AND USE OF:	AVAILABLE WITH EASY ACCESS	AVAILABLE WITH LIMITED ACCESS	AVAILABLE BUT NOT USED	NOT AVAILABLE
28. Microcomputers				
29. Computer printers				
30. Large group computer display				
31. Modem/telecommunications				
32. Video equipment				
33. Networked computers				
34. Film/slide projectors				
35. Mathematics manipulatives such as metric measurement instruments, geometric models, etc.				
36. Professional journals and other teacher curricular materials				
37. Calculators				
38. Tutorial software				
39. Drill and practice software				
40. Games software				
41. Simulation software				
42. Problem-solving software				
43. Programming software (BASIC, etc.)				
44. Graphics software				
45. Other mathematics software				

COMMENTS:

IV. GENERAL INFORMATION ABOUT MATHEMATICS AT YOUR SCHOOL

DIRECTIONS: Please circle either YES or NO

46. Are any special efforts made at your school to encourage female and minority students to take advanced mathematics courses?	YES	NO
47. Are students at your school ability-grouped in mathematics?	YES	NO
48. Are efforts made to have female and minority role models as a part of mathematics instruction?	YES	NO
49. Are efforts made at your school to help students develop confidence in their mathematical abilities?	YES	NO
50. Do you feel there is equal access for all students to participate in higher or advanced level mathematics?	YES	NO
51. Are efforts made at your school to encourage persons with handicapping conditions to pursue science and mathematics?	YES	NO
52. Have you heard of a Florida Department of Education document called <u>A Comprehensive Plan: Improving Mathematics, Science and Computer Education in Florida</u>?	YES	NO
53. Has this document influenced the way you teach mathematics or science in your classroom?	YES	NO
54. Are you aware of the location of Regional Center for Excellence in Mathematics, Science, Computers and Technology for your district?	YES	NO
55. Have you received any services such as newsletters, workshops, resource materials from the Regional Center for Excellence this year?	YES	NO
56. Has the curriculum changed to cover a broader range of topics?	YES	NO
57. Has the curriculum changed to explore fewer topics in greater depth?	YES	NO

COMMENTS:

V. STAFF DEVELOPMENT OPPORTUNITIES

DIRECTIONS: Please circle either YES or NO.

58. Have you **IN THE PAST TWO SUMMERS OR WILL YOU THIS SUMMER** participate in a staff development institute regarding mathematics or computer education?

YES	NO

DIRECTIONS: Mark the appropriate box.

FORMAL = district provided workshop, university course, TEC, etc.
INFORMAL = interactions you have arranged with colleagues, teacher collaboration.
N/A = not available or did not participate.

In the past two school years I have participated in a staff development workshops about:	FORMAL	INFORMAL	N/A
59. Problem-centered learning			
60. Computer applications			
61. Calculators			
62. Math manipulatives			
63. Mathematics teaching strategies			
64. Cooperative learning			
65. Mathematics curriculum development			
66. Identifying resource people in community to enhance mathematics lessons			
67. Special-needs students			
68. Mathematics content			
69. Mathematics competitions			
70. "Real-world" applications for mathematics			

COMMENTS:

Thank you for completing and returning this questionnaire in a timely fashion.

HIGH SCHOOL MATHEMATICS TEACHERS QUESTIONNAIRE

MATHEMATICS, SCIENCE AND COMPUTER EDUCATION IN FLORIDA'S PUBLIC SCHOOLS

This survey is being sent to randomly selected high school mathematics teachers throughout Florida. Your cooperation in answering the questions on this survey will assist the Florida Department of Education and the Mathematics and Science Education Program at Florida State University in understanding what is happening with respect to mathematics and computers in Florida's schools.

The following questions ask for your opinions about mathematics education and computer use at your high school. PLEASE CHOOSE ONE COURSE YOU TEACH THIS SCHOOL YEAR AS YOUR FRAME-OF-REFERENCE WHEN ANSWERING THESE QUESTIONS. Other questions ask about trends in mathematics education at your school during the past 2 years. This survey should take 10 to 15 minutes to complete.

BACKGROUND INFORMATION

A. District:______________________ B. School:______________________

C. Please check the type of course you are using as your frame-of-reference for answering this questionnaire:

	College prep
	Non-college prep

D. The name of this course is: ______________________________

E. Please check the box that best represents YOUR background:

	African-American
	Asian
	Caucasian
	Hispanic
	Other

F. Please check the box that represents YOUR age:

	Less than 30 years old
	30 to 40 years old
	41 to 50 years old
	51 or older

G. Please check the box that represents YOUR years of teaching high school mathematics in this county:

	1 to 2 years
	3 to 5 years
	6 to 15 years
	16 to 25 years
	26 or more years

I. INFORMATION ABOUT YOUR CLASS

DIRECTIONS: Mark an X in the appropriate box for each question. Please think about the PRESENT SCHOOL YEAR (1990-1991) when answering these questions.

ALMOST ALWAYS = 3 to 5 times per week (nearly every day)
ON FREQUENT OCCASIONS = 3 to 5 times per month (about once a week)
ON A FEW OCCASIONS = 6 to 10 times per year (about once a month)
ALMOST NEVER = 0 to 3 times per year

During this year, how often have...	ALMOST ALWAYS	ON FREQUENT OCCASIONS	ON A FEW OCCASIONS	ALMOST NEVER
1. Mathematics lessons incorporated the use of manipulatives or hands-on experiences?				
2. Mathematics lessons been integrated with other areas of the curriculum?				
3. Your students used a text while learning mathematics?				
4. Electronic technologies (e.g., calculators) other than computers been used in mathematics lessons?				
5. Students in your class used computers for mathematics?				
6. Museums or other out-of-classroom activities been used to enhance mathematics lessons?				
7. Historical developments in mathematics been incorporated into lessons?				
8. Students worked in teams or cooperative groups while learning mathematics?				
9. Students learned about mathematics-related career opportunities?				
10. You used alternative forms of assessment such as oral interviews, student observations, concept maps etc. to assess mathematics learning?				

COMMENTS:

II. TRENDS AND CHANGES IN MATHEMATICS AND COMPUTER EDUCATION

DIRECTIONS: Please answer these questions by thinking about all the courses you have taught during the past two years. Place an X in the appropriate box to indicate THE DEGREE OF CHANGE OVER THE PAST TWO (2) YEARS.

N/A = DON'T HAVE; DON'T USE; NOT APPLICABLE TO MY SITUATION

In the past 2 years, the degree of change in:	HAS INCREASED	HAS NOT CHANGED	HAS DECREASED	N/A
11. Student use of computers				
12. The amount of time available for teacher planning and preparation				
13. Classroom use of VCR or video equipment				
14. Student use of calculators				
15. Student use of manipulatives for mathematics				
16. Making observations of mathematics or computer lessons by other teachers				
17. Parental involvement in mathematics				
18. Your collaboration with other teachers to develop mathematics or computer education activities				
19. The amount of hands-on materials available for mathematics lessons				
20. Use of problem-centered learning activities				
21. Administrative support to improve math teaching				
22. Instructional time given to preparing students for mathematics portions of standardized tests				
23. Choice in selecting texts and other materials				
24. Mathematics-related field trips				
25. Participation in mathematics competitions				
26. Attending professional meetings to upgrade skills				
27. Your participation in a teacher mentor program				

COMMENTS:

III. ACCESS AND USE OF INSTRUCTIONAL TECHNOLOGIES FOR MATHEMATICS

DIRECTIONS: Please mark an X in the appropriate box to rate YOUR PERSONAL DEGREE OF ACCESS AND USE of the following instructional technologies during the present school year.

AVAILABLE WITH EASY ACCESS = the equipment is available to you when you need it.
AVAILABLE WITH LIMITED ACCESS = the equipment is available but you may not be able to use it.
AVAILABLE BUT NOT USED = the equipment or software is available but you do not use it.
NOT AVAILABLE = the equipment is not available to you at your school.

ACCESS AND USE OF:	AVAILABLE WITH EASY ACCESS	AVAILABLE WITH LIMITED ACCESS	AVAILABLE BUT NOT USED	NOT AVAILABLE
28. Microcomputers				
29. Computer printers				
30. Large group computer display				
31. Modem/telecommunications				
32. Video equipment				
33. Networked computers				
34. Film/slide projectors				
35. Mathematics manipulatives such as metric measurement instruments, geometric models, etc.				
36. Professional journals and other teacher curricular materials				
37. Calculators				
38. Tutorial software				
39. Drill and practice software				
40. Games software				
41. Simulation software				
42. Problem-solving software				
43. Programming software (BASIC, etc.)				
44. Graphics software				
45. Other mathematics software				

COMMENTS:

IV. GENERAL INFORMATION ABOUT MATHEMATICS AT YOUR SCHOOL

DIRECTIONS: Please circle either YES or NO

46. Are any special efforts made at your school to encourage female and minority students to take advanced mathematics courses?	YES	NO
47. Are students at your school ability-grouped in mathematics?	YES	NO
48. Are efforts made to have female and minority role models as a part of mathematics instruction?	YES	NO
49. Are efforts made at your school to help students develop confidence in their mathematical abilities?	YES	NO
50. Do you feel there is equal access for all students to participate in higher or advanced level mathematics?	YES	NO
51. Are efforts made at your school to encourage persons with handicapping conditions to pursue science and mathematics?	YES	NO
52. Have you heard of a Florida Department of Education document called A Comprehensive Plan: Improving Mathematics, Science and Computer Education in Florida?	YES	NO
53. Has this document influenced the way you teach mathematics or science in your classroom?	YES	NO
54. Are you aware of the location of Regional Center for Excellence in Mathematics, Science, Computers and Technology for your district?	YES	NO
55. Have you received any services such as newsletters, workshops, resource materials from the Regional Center for Excellence this year?	YES	NO
56. Has the curriculum changed to cover a broader range of topics?	YES	NO
57. Has the curriculum changed to explore fewer topics in greater depth?	YES	NO

COMMENTS:

V. STAFF DEVELOPMENT OPPORTUNITIES

DIRECTIONS: Please circle either YES or NO.

58. Have you IN THE PAST TWO SUMMERS OR WILL YOU THIS SUMMER participate in a staff development institute regarding mathematics or computer education?

YES	NO

DIRECTIONS: Mark the appropriate box.

FORMAL = district provided workshop, university course, TEC, etc.
INFORMAL = interactions you have arranged with colleagues, teacher collaboration.
N/A = not available or did not participate.

In the past two school years I have participated in a staff development workshops about:	**FORMAL**	**INFORMAL**	**N/A**
59. Problem-centered learning			
60. Computer applications			
61. Calculators			
62. Math manipulatives			
63. Mathematics teaching strategies			
64. Cooperative learning			
65. Mathematics curriculum development			
66. Identifying resource people in community to enhance mathematics lessons			
67. Special-needs students			
68. Mathematics content			
69. Mathematics competitions			
70. "Real-world" applications for mathematics			

COMMENTS:

Thank you for completing and returning this questionnaire in a timely fashion.

Mathematics Supervisor Questionnaire

District: ______________________ Grade Levels Supervised: ____________

Position/Title: ____

I. Trends and Changes in Mathematics Education

Please respond to the following statements with respect to the state of mathematics education in your district **during the past 2 years.** If a question is not applicable, please indicate N/A.

(Please Circle One Number on Each Line)

	Has Increased		Has Not Changed		Has Decreased	N/A
1. The amount of hands-on/manipulative mathematics equipment available for the elementary student use in your district	1	2	3	4	5	6
2. The amount of hands-on/manipulative mathematics equipment available for the secondary student use in your district	1	2	3	4	5	6
3. Instructional time used for preparing elementary school students to take standardized mathematics tests	1	2	3	4	5	6
4. Instructional time used for preparing secondary school students to take standardized mathematics tests	1	2	3	4	5	6
5. The funds available for purchasing mathematics materials	1	2	3	4	5	6
6. Computer and other technology use by students in the elementary schools	1	2	3	4	5	6
7. The availability of computers for student use in the secondary schools	1	2	3	4	5	6
8. Collaborative efforts among elementary school teachers to develop mathematics or computer activities	1	2	3	4	5	6
9. Collaborative efforts among secondary school teachers to develop mathematics or computer activities	1	2	3	4	5	6

	(Please Circle One Number on Each Line)					
	Has Increased		**Has Not Changed**		**Has Decreased**	**N/A**
10. Teacher participation in a lead teacher or mentor teacher program	1	2	3	4	5	6
11. Elementary school teacher use of alternative instructional strategies (e.g. cooperative learning) as a part of mathematics instruction	1	2	3	4	5	6
12. Secondary school teacher use of alternative instructional strategies (e.g. cooperative learning) as a part of mathematics instruction	1	2	3	4	5	6

Please describe briefly any district activities which encouraged teachers to use a variety of teaching strategies:

13. Elementary school teacher use of alternative forms of assessment such as oral interviews, portfolios, students observations, or concept maps to assess mathematics learning	1	2	3	4	5	6
14. Secondary school teacher use of alternative forms of assessment such as oral interviews, portfolios, student observations, or concept maps to assess mathematics learning	1	2	3	4	5	6

Please describe briefly any changes to assessment practices in your district during the past two years:

15. Special efforts or incentives to encourage female and minority elementary school students to participate in mathematics.	1	2	3	4	5	6
16. Special efforts or incentives to encourage female and minority secondary school students to participate in mathematics.	1	2	3	4	5	6

Please describe specific actions taken in your district with respect to encouraging female and minority students in mathematics:

II. Information about Mathematics Education Resources

Textbooks

Elementary Level

17. Name of mathematics series:______________________________

18. Publisher & Copyright Date:______________________________

Middle Level

19. Name of mathematics series:______________________________

20. Publisher & Copyright Date:______________________________

High School Level

21. Name of mathematics series:______________________________

22. Publisher & Copyright Date:______________________________

23. If your district has a policy on how elementary and secondary teachers are expected to use mathematics textbooks, please describe the policy briefly.

Curriculum

Other than the textbooks series, has your district adopted a curriculum for mathematics?

24. The district's elementary mathematics curriculum is:

Please circle answer: Purchased or Locally Developed

25. Name & Publisher if purchased:______________________________

26. The district's middle level mathematics curriculum is:

Please circle answer: Purchased or Locally Developed

27. Name & Publisher if purchased:______________________________

28. The district's high school level mathematics curriculum is:

Please circle answer: Purchased or Locally Developed

29. Name & Publisher if purchased:________________________________

30. Have elementary and/or secondary teachers been encouraged to integrate mathematics into other areas of the curriculum (e.g., mathematics, social mathematicss, etc.)?

YES NO

If yes, please describe specific actions taken in the district to encourage such integration.

31. Do any of the mathematics curriculum guides for your district currently use "the environment" as a theme? If so, please tell which levels and provide examples of how "the environment" is used.

32. What is your district policy, if any, regarding time spent on mathematics instruction at the elementary and/or secondary levels? How, if at all, has this policy changed over the past two years?

33. Please describe briefly in what ways, if any, the elementary and /or secondary mathematics curricula have changed in the past two years.

Comprehensive Plan

34. Have you heard of a Florida Department of Education document called A Comprehensive Plan: Improving Mathematics, Mathematics and Computer Education in Florida?

YES NO

35. If yes, please describe some specific ways this plan has influenced, if it has at all, the way mathematics is taught in your district.

Regional Centers of Excellence

Please indicate whether you or your teachers have received any of the following services from your Regional Center of Excellence during the past school year?

36. Newsletter(s)	YES	NO
37. Technical Advice	YES	NO
38. Staff Development Opportunities	YES	NO
39. Information about Curriculum Resources	YES	NO
40. Assistance in Implementing Florida's Comprehensive Plan	YES	NO
41. Information about Science// Mathematics Education Research	YES	NO
42. Assistance in Establishing Partnerships with Local Businesses	YES	NO

43. To what extent are you satisfied, in general, with the services of your Regional Center?

NOT SATISFIED	SERVICES ADEQUATE	HIGHLY SATISFIED

44. Please describe which services, if any, you have found to be especially useful to the teachers in your district. Please be specific as to why these services were useful.

Community Resources

45. Please list the museums, environmental education centers, or other community locations, if any, that have been utilized to enhance mathematics lessons in your district during the past two years?

III. State and Federal Initiatives

If a question is not applicable, please leave it blank.

Please indicate to what extent the following initiatives have impacted the mathematics program in your district.

46. Summer Inservice Institutes	very helpful	somewhat helpful	not helpful
47. Elementary Mathematics and Science Teacher Enhancement (MSTET)	very helpful	somewhat helpful	not helpful
48. Teacher Quest	very helpful	somewhat helpful	not helpful
49. Teacher Stipends	very helpful	somewhat helpful	not helpful
50. Eisenhower Program (Title II)	very helpful	somewhat helpful	not helpful
51. Regional Centers of Excellence	very helpful	somewhat helpful	not helpful
52. Summer Camps	very helpful	somewhat helpful	not helpful
53. Mathematics and Science Partnership Challenge Grants	very helpful	somewhat helpful	not helpful
54. *4 Rs Recycling Awareness* Curriculum	very helpful	somewhat helpful	not helpful
55. Blueprint for Career Preparation Schools	very helpful	somewhat helpful	not helpful
56. Model Technology Schools	very helpful	somewhat helpful	not helpful
57. Florida Instructional Technology Challenge Grant Program	very helpful	somewhat helpful	not helpful

58. Mentor Teacher Projects	very helpful	somewhat helpful	not helpful
59. Incentives for Increased Student Enrollment in Upper Level Mathematics Courses	very helpful	somewhat helpful	not helpful
60. FAMU's Center for Minorities in Science and Technology	very helpful	somewhat helpful	not helpful
61. Florida Chamber of Commerce's *Star Maker* Program	very helpful	somewhat helpful	not helpful
62. DOE's *Sharing Success in Florida: Mathematics, Science and Computer Education*	very helpful	somewhat helpful	not helpful

IV. *Qualified Teachers*

Does your school district find it difficult to hire fully qualified (certified) **secondary** teachers for vacancies in each of the following areas:

63. Mathematics	YES	NO
64. Computer Science	YES	NO
65. Honors/Advanced Placement Mathematics Courses	YES	NO

Thank You for Helping Improve Mathematics Teaching and Learning in Florida

Science Supervisor Questionnaire

District: ______________________________ Grade Levels Supervised: ____________

Position/Title: ____

I. Trends and Changes in Science Education

Please respond to the following statements with respect to the state of science education in your district **during the past 2 years**. If a question is not applicable, please indicate N/A.

(Please Circle One Number on Each Line)

	Has Increased		Has Not Changed		Has Decreased	N/A
1. The amount of hands-on/manipulative science equipment available for the elementary student use in your district	1	2	3	4	5	6
2. The amount of hands-on/manipulative science equipment available for the secondary student use in your district	1	2	3	4	5	6
3. Instructional time used for preparing elementary school students to take standardized science tests	1	2	3	4	5	6
4. Instructional time used for preparing secondary school students to take standardized science tests	1	2	3	4	5	6
5. The funds available for purchasing science materials	1	2	3	4	5	6
6. Computer and other technology use by students in the elementary schools	1	2	3	4	5	6
7. The availability of computers for student use in the secondary schools	1	2	3	4	5	6
8. Collaborative efforts among elementary school teachers to develop science or computer activities	1	2	3	4	5	6
9. Collaborative efforts among secondary school teachers to develop science or computer activities	1	2	3	4	5	6

	(Please Circle One Number on Each Line)					
	Has Increased		Has Not Changed		Has Decreased	N/A
10. Teacher participation in a lead teacher or mentor teacher program	1	2	3	4	5	6
11. <u>Elementary</u> school teacher use of alternative instructional strategies (e.g. cooperative learning) as a part of science instruction	1	2	3	4	5	6
12. <u>Secondary</u> school teacher use of alternative instructional strategies (e.g. cooperative learning) as a part of science instruction	1	2	3	4	5	6

Please describe briefly any district activities which encouraged teachers to use a variety of teaching strategies:

13. <u>Elementary</u> school teacher use of alternative forms of assessment such as oral interviews, portfolios, students observations, or concept maps to assess science learning	1	2	3	4	5	6
14. <u>Secondary</u> school teacher use of alternative forms of assessment such as oral interviews, portfolios, student observations, or concept maps to assess science learning	1	2	3	4	5	6

Please describe briefly any changes to assessment practices in your district during the past two years:

15. Special efforts or incentives to encourage female and minority <u>elementary</u> school students to participate in science	1	2	3	4	5	6
16. Special efforts or incentives to encourage female and minority <u>secondary</u> school students to participate in science.	1	2	3	4	5	6

Please describe specific actions taken in your district with respect to encouraging female and minority students in science:

II. Information about Science Education Resources

Textbooks

Elementary Level

17. Name of the science series:________________________________

18. Publisher & Copyright Date:________________________________

Middle Level

19. Name of science series:________________________________

20. Publisher & Copyright Date:________________________________

High School Level

21. Name of science series:________________________________

22. Publisher & Copyright Date:________________________________

23. If your district has a policy on how elementary and secondary teachers are expected to use science textbooks, please describe the policy briefly.

Curriculum

Other than the textbooks series, has your district adopted a curriculum for science?

24. The district's elementary science curriculum is:

Please circle answer: Purchased or Locally Developed

25. Name & Publisher if purchased:________________________________

26. The district's middle level science curriculum is:

Please circle answer: Purchased or Locally Developed

27. Name & Publisher if purchased:________________________________

28. The district's high school level science curriculum is:

Please circle answer: Purchased or Locally Developed

29. Name & Publisher if purchased:______________________________

30. Have elementary and/or secondary teachers been encouraged to integrate science into other areas of the curriculum (e.g., mathematics, social sciences, etc.)?

YES NO

If yes, please describe specific actions taken in the district to encourage such integration.

31. Do any of the science curriculum guides for your district currently use "the environment" as a theme? If so, please tell which levels and provide examples of how "the environment" is used.

32. What is your district policy, if any, regarding time spent on science instruction at the elementary and/or secondary levels? How, if at all, has this policy changed over the past two years?

33. Please describe briefly in what ways, if any, the elementary and /or secondary science curricula have changed in the past two years.

Comprehensive Plan

34. Have you heard of a Florida Department of Education document called A Comprehensive Plan: Improving Mathematics, Science and Computer Education in Florida?

YES NO

35. If yes, please describe some specific ways this plan has influenced, if it has at all, the way science is taught in your district.

Regional Centers of Excellence

Please indicate whether you or your teachers have received any of the following services from your Regional Center of Excellence during the past school year?

36. Newsletter(s)	YES	NO
37. Technical Advice	YES	NO
38. Staff Development Opportunities	YES	NO
39. Information about Curriculum Resources	YES	NO
40. Assistance in Implementing Florida's Comprehensive Plan	YES	NO
41. Information about Science/ Mathematics Education Research	YES	NO
42. Assistance in Establishing Partnerships with Local Businesses	YES	NO

43. To what extent are you satisfied, in general, with the services of your Regional Center?

NOT SATISFIED	SERVICES ADEQUATE	HIGHLY SATISFIED

44. Please describe which services, if any, you have found to be especially useful to the teachers in your district. Please be specific as to why these services were useful.

Community Resources

45. Please list the museums, environmental education centers, or other community locations, if any, that have been utilized to enhance science lessons in your district during the past two years?

III. State and Federal Initiatives

If a question is not applicable, please leave it blank.

Please indicate to what extent the following initiatives have impacted the science program in your district.

46. *Summer Inservice Institutes*	very helpful	somewhat helpful	not helpful
47. Elementary Mathematics and Science Teacher Enhancement (MSTET)	very helpful	somewhat helpful	not helpful
48. Teacher Quest	very helpful	somewhat helpful	not helpful
49. Teacher Stipends	very helpful	somewhat helpful	not helpful
50. Eisenhower Program (Title II)	very helpful	somewhat helpful	not helpful
51. Regional Centers of Excellence	very helpful	somewhat helpful	not helpful
52. PECO funds for science laboratories	very helpful	somewhat helpful	not helpful
53. High Cost Science Lab Materials	very helpful	somewhat helpful	not helpful
54. Summer Camps	very helpful	somewhat helpful	not helpful
55. Mathematics and Science Partnership Challenge Grants	very helpful	somewhat helpful	not helpful
56. State Science Fair	very helpful	somewhat helpful	not helpful
57. *4 Rs Recycling Awareness* Curriculum	very helpful	somewhat helpful	not helpful
58. *Blueprint for Career Preparation* Curriculum	very helpful	somewhat helpful	not helpful
59. Model Technology Schools	very helpful	somewhat helpful	not helpful
60. Florida Instructional Technology Challenge Grant Program	very helpful	somewhat helpful	not helpful
61. Mentor Teacher Projects	very helpful	somewhat helpful	not helpful

62. Summer Honors Science Symposium	very helpful	somewhat helpful	not helpful
63. Incentives for Increased Student Enrollment in Upper Level Science Courses	very helpful	somewhat helpful	not helpful
64. FAMU's Center for Minorities in Science and Technology	very helpful	somewhat helpful	not helpful
65. Florida Chamber of Commerce's *Star Maker* Program	very helpful	somewhat helpful	not helpful
66. DOE's *Sharing Success in Florida: Mathematics, Science and Computer Education*	very helpful	somewhat helpful	not helpful

IV. *Qualified Teachers*

Does your school district find it difficult to hire fully qualified (certified) **secondary** teachers for vacancies in each of the following areas:

67. Biology	YES	NO
68. Chemistry	YES	NO
69. Physics	YES	NO
70. Physical Science	YES	NO
71. Life Science	YES	NO
72. Earth/Space Science	YES	NO
73. Honors/Advanced Placement Science Courses	YES	NO

Thank You for Helping Improve Science Teaching and Learning in Florida

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BIOGRAPHICAL SKETCH

EDUCATION AND CERTIFICATION

Degree	Date	Institution	Major
Doctor of Philosophy	1992	Florida State University Dr. Kenneth G. Tobin, Major Professor	Science Education Minors: Chemical Oceanography, Qualitative Research, Teacher Education
Master of Science	1987	State University of New York, College at Oswego Dr. J. Nathan Swift, Major Professor	Science Education and Affective Education
Bachelor of Science	1985	State University of New York, College at Oswego	Earth Sciences Education

Certification Teacher — Permanent Teaching Certificate, New York State Public School Earth Science, Physics, General Science

TEACHING EXPERIENCE

Dates	Level	Institution	Position
1989-1992	University	Florida State University Department of Curriculum & Instruction	Instructor / Graduate Assistant
1989-1990	Middle & High School	Florida State University Developmental Research School	University School Science Instructor

1985- 1989	High School	Mexico Academy and Central Schools	Science Teacher High School
1987- 1989	Elementary & Middle School	State University of New York at Oswego Sheldon Institute for Gifted Children	Science and Computer Instructor
1984- 1989	University	State University of New York at Oswego Elementary & Secondary Education Teaching Assistant	

RESEARCH EXPERIENCE

Grant Writing

- Wrote proposal and received $26,250 with Kenneth Tobin and Kenneth Shaw from Florida Department of Education for the continued evaluation of The Comprehensive Plan for Improving Mathematics, Science, and Computer Education in Florida.
- Authored funded proposal to acquire two Macintosh computers to be used in science teacher education.
- Part of collaborative team from University of Georgia and Florida State that wrote a proposal to NSF regarding history and philosophy of science.
- Assisted Kenneth Tobin with a proposal to NSF to study middle-level science teacher learning and curricular change.
- Assisted team from Classroom Interaction Research Laboratory at SUNY-Oswego in seeking funding from local and national agencies.

Research Projects -- Education

- Evaluated the implementation of a state mathematics and science policy.
- Part of team that established and maintained Professional Development Schools.
- Examined the role of early field experiences in science teacher education.
- Investigated practical and theoretical concerns about alternative modes of assessment for science students and prospective teachers.
- Explored science teachers' understandings of cooperative learning and project-oriented learning as alternatives to traditional instruction.
- Evaluated and redeveloped undergraduate science education courses to be consistent with modern learning theories.
- Investigated teachers' understandings about the use of technology to enhance learning, as part of Enhancing Mathematics and Science

Teaching project.
- Part of team that redeveloped introductory, non-majors geology/earth sciences courses at FSU.
- Part of team that organized First History and Philosophy of Science and Science Teaching Conference.
- Investigated teachers' understandings of and values about wait time in grade 9 science classes 5 years after participating in a wait time training program.
- Part of team exploring role of wait time and enhanced discussion skills on achievement and attitude in high school biology and chemistry classes.

Research Projects -- Science
- Developed procedure to determine ^{210}Po activity in low-level environmental water samples utilizing liquid scintillation (PERALS) alpha-spectroscopy.
- Part of team assessing the effects of phosphate mining on local groundwater systems in central and southwestern Florida via uranium-series radio-chemistry.

Researcher Roles
- Project Manager for first evaluation of the implementation of Florida's Comprehensive Plan. Designer of data collection and analysis procedures.
- Author of technical reports, final reports, and research papers.
- Data manager and computer programmer for data reduction routines using statistical packages such as SPSS.
- Presenter of research findings at national and local meetings.
- Research equipment coordinator

Research Interests
- Teacher learning and how that relates to curriculum change and school/cultural change
- The role of early field experience in teacher education
- The impact of educational policy on teaching and learning
- Constructivism and its relation to teaching and learning.

PUBLICATIONS

Dana, T. M., Perkins, R., Ledford, K., & St.Pierre, M. (submitted, Jan. 1992). Newton's laws of motion: May the force be with your students! Science and Children.

Dana, T. M. & Davis, N.T. (in press). Considering constructivism for improving mathematics and science teaching and learning. In K.G.Tobin (ed.), Constructivist Perspectives on the Learning of Mathematics and Science, American Association for the Advancement of Science, Washington, DC.

Dana, T. M. (1992 - in progress). Achieving Comprehensive Curriculum Reform: An Analysis of the Implementation of The Comprehensive Plan for Improving

Mathematics, Science, and Computer Education in Florida. (Doctoral dissertation, Florida State University, Dr. Kenneth Tobin, Major Professor).

Dana, T. M., Tobin, K., Engler, P., & Shaw, K. (1991). Evaluating the implementation of Florida's Comprehensive Plan for Improving Mathematics, Science, and Computer Education: Final Report. Tallahassee, FL: Florida State University, Mathematics and Science Education Program.

Dana, T.M., Lorsbach, A.W., Hook, K.S., & Briscoe, C. (1991). Showing what they know: Student assessment in a new age of science education. In S. Malcolm & G. Kulm (eds.), Science Assessment in the Service of Instruction (pp. 331-337), American Association for the Advancement of Science, Washington, DC.

Dana, T. M. (1991). A grade three teacher's journey in learning to use computers in her classroom. In A. Lorsbach (ed.), Hot Topic: Using Technology to Enhance Mathematics and Science Learning. Tallahassee, FL: State of Florida Department of Education.

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TECHNICAL AND RESEARCH REPORTS

Dana, T. M. (1991). How we are doing: A report card on mathematics, science, and computer education in Florida (Technical Report #12). Tallahassee, FL: Florida State University, Mathematics and Science Education Program.

Dana, T.M. & Nichols, S.E. (1991). Mathematics, science, and computer education in Florida elementary schools (Technical Report #1). Tallahassee, FL: Florida State University, Mathematics and Science Education Program.

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Dana, T.M. & Nichols, S.E. (1991). Science and computer education in Florida middle schools (Technical Report #4). Tallahassee, FL: Florida State University, Mathematics and Science Education Program.

Dana, T.M. & Nichols, S.E. (1991). Science and computer education in Florida high schools (Technical Report #5). Tallahassee, FL: Florida State University, Mathematics and Science Education Program.

Nichols, S.E. & Dana, T.M. (1991). What teachers say about mathematics, science, and computer education: Quotes and vignettes to support the evaluation of policy implementation Technical Report #12). Tallahassee, FL: Florida State University, Mathematics and Science Education Program.

Dana, T.M. (1990). A procedure for the determination of 210Po in groundwater samples using PERALS. Unpublished manuscript, Florida State University, Department of Oceanography, Tallahassee, FL..

PRESENTATIONS

Dana, T.M., Tippins, D.J., Tobin, K.G., Dana, N.F., Briscoe, C., Nichols, S., & Davis, N. (1992, February). Teacher learning and teacher change: Epistemological dimensions for reconceptualizing teacher education. Professional Clinic and paper presented at the 72nd annual meeting of the Association for Teacher Educators, Orlando, FL.

Shaw, K.L., Dana, T.M. & Alkove, L. (1992, February). Implementing Florida's Comprehensive Plan to Improve Mathematics, Science, and Computer Education. Paper presented at the 72nd Annual Meeting of the Association of Teacher Educators, Orlando, FL.

Dana, T.M., Nichols, S.E., & Tippins, D.J. (1992, February). Developmentally appropriate science activities to complement childrens' books. Paper and workshop presented at the Sixth Annual Capital City Developmental Education Symposium, Tallahassee, FL

Dana, N.F., Thomas, D., Tippins, D., Dana, T.M. & Kelsay, K. (1992, January). Qualitative interviewing and the art of questioning: Promises, possibilities, problems, and pitfalls. Paper and workshop presented at the 1992 Qualitative Research in Education Conference, Athens, GA.

Tobin, K.G., Tippins, D.J., Hook, K.S. & Dana, T.M. (1991, December). Ethical dimensions of science teaching. Paper presented at the regional meeting of the National Science Teachers Association, New Orleans, LA.

Dana, T.M. (1991, November). Whole language-->Whole Science? Presented at Leon County Schools, Professional Development Day Seminars, Tallahassee, FL.

Dana, T.M. (1991, November). The role of technology in education: Florida's science and mathematics story. Presented at the College of Education Teaching Associate Seminar Series, Florida State University, Tallahassee, FL.

Dana, T.M., Briscoe C. & Dana, N.F. (1991, October). Establishing a context for science activities: Using children's literature. Presented at the annual meeting of the Florida Association of Science Teachers, West Palm Beach, Florida.

Dana, T.M., Briscoe C. & Hook, K.S. (1991, October). Assessment in problem-centered learning environments. Presented at the annual meeting of the Florida Association of Science Teachers, West Palm Beach, Florida.

Dana, T.M., Nichols, S.E., Briscoe, C. & McGlamery, S. (1991, October). Science classes and Florida's Comprehensive Plan. Presented at the annual meeting of the Florida Association of Science Teachers, West Palm Beach, Florida.

Dana, N.F. & Dana, T.M. (1991, October). Exploring science through children's literature. Presented at the annual meeting of the Florida Reading Association, Jacksonville, FL.

Dana, T.M. (1991, April). Making sense of science and science teaching among prospective elementary teachers. Paper presented at the annual meeting of the National Association for Research in Science Teaching, Fontana, WI.

Dana, T.M. (1991, February). Enhancing learning through use of computers in an elementary classroom. Paper presented at the annual meeting of the Southeastern Association for the Education of Teachers of Science, Stone Mountain, GA.

Dana, T.M. (1991, February). Linking children's books and science lessons. Presented at the Fifth Annual Capital City Developmental Education Symposium, Tallahassee, FL.

Dana, T.M., Lorsbach, A.W., Hook, K.S., & Briscoe, C. (1990, October). Letting students show what they know: Alternative classroom assessments. Presented at the AAAS Forum on School Science, Washington, DC.

Dana, T. M. & Swift, J. N. (1987, February). A qualitative research perspective: Understanding classrooms through observations and interpretations. In C.T. Gooding (Chair), Qualitative and quantitative methods as complementary strategies for the analysis of teaching behavior. Symposium conducted at the annual meeting of the Eastern Educational Research Association, Boston.

Swift, J. N., Swift, P. R., & Dana, T. M. (1987, April). Analyzing your own classroom teaching: A way to become more effective. Presented at the annual meeting of the National Science Teachers Association, Washington, DC.

Dana, T. M. (1986, April). Observation and interpretation as methods of classroom research. Paper presented at Quest, State University of New York College, Oswego, NY.

PRESENTATIONS ACCEPTED

Nichols, S.E., Dana, T.M., & Briscoe, C. (1992, March). Learning to teach elementary science: Changing images, beliefs, and metaphors. Paper to be presented at the annual meeting of the National Association for Research in Science Teaching, Boston.

Dana, T.M., & Nichols, S.E. (1992, March). Assessing the state of science education in Florida schools. Paper to be presented at the annual meeting of the National Association for Research in Science Teaching, Boston.

Dana, T.M., Briscoe, C., Hook, K.S. & Lorsbach, A.W. (1992, March). Students showing what they know: Alternatives to traditional classroom assessments. Paper to be presented at the annual meeting of the National Science Teachers Association, Boston.

Dana, T.M. & Nichols, S.E. (1992, April). Policy and practice: Evaluating the implementation of a mathematics, science, and computer education policy in Florida. Paper to be presented at the annual meeting of the American Educational Research Association, San Francisco.

SERVICE AND CONSULTANCIES

Community and Local

- Florida Department of Education, consultant to mathematics and science oversight commissions for state policies and Florida/NSF Statewide Systemic Initiative.
- Regional Science Fair Judge, Panhandle Region (1992)
- Science Fair Judge, Elementary and Secondary Levels, Leon County School District (1989-)
- Program and Exhibit Committees Member, Odyssey--Tallahassee Science Center (1990-)
- Brain Brawl Judge, Tallahassee Community College (1991)
- Year-long teacher professional development project in mathemaics and science education, Chattahoochee Elementary School, FL (1990-91)
- Teacher Professional Development Workshop in laboratory skills for physical and earth sciences classes, Panhandle Area Educational Cooperative, Chipley, FL (1989) and Port St Joe, FL (1990)
- Teacher Professional Development Workshop in wait time and discussion skills, SUNY-Oswego (1988)

University

- Student Grade Appeals Committee, Florida State University (1990-91)
- Graduate Advisory Council, Student Representative, Florida State University (1990-91)
- Science Education Program Advisor (undergraduate and masters), FSU (Summer 1990)

- Science Education Graduate Program Review, Student Representative to Graduate Policy Sub-Committee (1990)

National and International
- Conference Session Presider, Association of Teacher Educators, Florida Reading Association, National Association for Research in Science Teaching (1989-)
- Manuscript Reviewer, International Journal of Science Education (1991-)
- Program Co-Chair, American Education Research Association SIG: Constructivist Theory and Practice (1991-92)
- SciencePlus Teachers' Network (1991-)
- Textbook Consultant, astronomy chapter, SciencePlus2, Technology and Society (1993), Holt, Rhinehart & Winston

AWARDS AND HONORS

- Graduate Assistantship, Department of Curriculum and Instruction, Florida State University (1989-1992)
- College of Education Teaching Fellowship, Florida State University (1989-90)
- Canberra Instruments, short course participant on alpha spectroscopy (1990)
- Graduate Assistantship, Classroom Interaction Research Laboratory, SUNY-Oswego
  (1985-87)
- Institute in Energy Education, Participant, SUNY-Oswego (1988-89)

MEMBERSHIPS

- National Association for Research in Science Teaching
- National Science Teachers Association
- American Educational Research Association
- Florida Association of Science Teachers
- Association of Teacher Educators
- Association for Supervision and Curriculum Development
- Association for the Education of Teachers of Science
- Southeastern Association for the Education of Teachers of Science
- Phi Delta Kappa