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Improving Middle School Mathematics Achievement in Florida: Voices from the Field

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Abstract

This article reports findings of a research project funded by the Florida Department of Education to determine the key elements of a successful middle school mathematics program, the barriers to the implementation of such a program in Florida's schools, and possible ways to overcome the barriers. Input from Florida stakeholders was elicited during seven regional focus group meetings. Additionally, stakeholder perceptions were augmented with published literature about the issues they identified. Despite the varied educational environments in which focus group participants engage, there was remarkable consensus in their views about the issues and concerns facing middle school mathematics achievement in Florida.

Every American has a stake in mathematics and science teaching for the 21st century. Parents, teachers, administrators, school board members, higher education institutions, state political leaders, and business leaders have particularly critical roles to play in insuring success. To improve students' achievement in mathematics and science, every one involved must first ask themselves several hard questions and then must take action. (Glenn Commission, 2000, p. 38)

Mathematics achievement has been a major concern to educators for at least the last two decades. The publication of A Nation at Risk (National Commission on Excellence in Education, 1983) alerted the public to the need for higher standards for teachers and students. Later in that decade, results from the Second International Mathematics Study (SIMS) found U.S. mathematics achievement at the eighth and twelfth grades to be below the international average (McKnight et al., 1987).

The release of the Curriculum and Evaluation Standards for School Mathematics (Standards) (National Council of Teachers of Mathematics (NCTM), 1989) renewed interest in and focused attention on the need for high mathematics expectations for all students and not just the mathematically talented. Many states used these Standards to develop or modify their own mathematics curriculum frameworks. Indeed, the mathematics portion of the Florida Sunshine State Standards (Florida

Department of Education, 1996) is aligned with the national standards.

Although educators have concerns about mathematics achievement at all levels, particular concern has been placed on mathematics achievement in the middle grades. *Leading the Way*, a report published by the Southern Regional Education Board (SREB), asserts that many middle-grades students "enter high school unprepared for the tougher graduation requirements that many states have enacted. As a result, these students have little chance of meeting high academic standards or being fully prepared for post-secondary education or promising employment" (Cooney, 1999c, p. 2). In many cases, these tougher graduation requirements include passing algebra and/or geometry, in addition to earning a passing score on high-stakes assessments.

Results from the Third International Mathematics and Science Study (TIMSS) conducted in 1995-96 indicate that the performance of U.S. fourth-grade students was above the international average in mathematics, while the performance of eighth-grade students was below the international average (U.S. Department of Education, 1997). Additional findings from that same study indicate that only 5% of U.S. eighth-grade students were in the top 10% of the world, compared to 45% and 32% of eighth-grade students in Singapore and Japan, respectively. Four years later, results from the repeat of the TIMSS assessment (TIMSS-R) showed that eighth-grade achievement levels had climbed to an average ranking among the participating nations; however, the average score was higher, but not significantly higher, than the eighth-grade average score four years previously. In fact, the relative performance of the 1999 eighth-grade students was below that of the 1995 fourth-grade students (U.S. Department of Education, 2000). Although direct comparisons are complicated due to test differences, the results from these tests suggest that U.S. students may have lost ground as they transitioned through the middle school years.

Closer to home, results from the 1996 National Assessment of Educational Progress (NAEP) indicate that the performance of Florida's eighth-grade students is somewhat below that of the nation as a whole. NAEP defines three levels of achievement: basic, proficient, and advanced. Eighth-grade students at the basic level understand arithmetic operations. Those at the proficient level can apply concepts and procedures to complex problems in the five NAEP strands of number sense/properties/operations, measurement, geometry and spatial sense, data analysis and statistics/probability, and algebra and functions. Eighth-grade students at the advanced level are "able to reach beyond the recognition, identification, and application of mathematical rules in order to generalize and synthesize concepts and principles in the five NAEP content strands" (Reese, Miller, Mazzeo, & Dossey, 1997, p. 44).

On the 1996 NAEP, only 2% of Florida's public school eighth-grade students scored at the advanced level and 17% scored at or above the proficient level, compared to 4% and 23% of the eighth-grade students in the nation, respectively. Fifty-four percent of Florida's eighth-grade students were at or above the basic level, compared to 61% in the nation (Reese, Jerry, & Ballator, 1997).

Performance levels on the Florida Comprehensive Assessment Test (FCAT) mirror the achievement levels on NAEP. On the 2000 administration of FCAT, 51% of Florida's eighth-grade students scored at Level 3 or above, an increase from 44% at Level 3 or above in 1999. Level 3 indicates partial success with the content of the Sunshine State Standards. Overall, achievement on these measures (TIMSS, NAEP, and FCAT) suggests that many middle-grades students are not achieving at the levels necessary to ensure success in high school academic courses essential for keeping future options open.

In addition to earning a passing score on the FCAT, which is regarded as more challenging than the previously required High School Competency Test, students must earn a credit in algebra to graduate from high school. Both of these requirements further enhance the view of mathematics as a "gatekeeper" that either expands or limits students' future options in academics and careers. Thus, enhancing student achievement in middle-grades mathematics is a key factor in ensuring that students enter high school ready for the academic challenges at that level.

Given the achievement levels and the broad concerns about mathematics achievement at the middle grades, the Florida Department of Education funded a research project to address the following questions:

1. What are the key elements of a successful middle school mathematics program as identified by Florida stakeholders?
2. What are the barriers to the implementation of such a program in Florida's middle schools?
3. What are possible solutions to overcome these barriers? What actions can be taken to address the solutions?
4. What does literature relating to research and best practice say about the key elements of a successful middle school program and the barriers to the implementation of such programs that were identified by Florida stakeholders?

The purpose of this article is to present the findings from this study, to discuss possible implications of this research on educational policy related to mathematics, and to raise questions for further research.

Method

To answer questions 1, 2, and 3, data were collected from curriculum specialists during a meeting of the Florida Association of Mathematics Supervisors (FAMS) and from stakeholders participating in seven focus group meetings held throughout the state. The investigators summarized the data from the FAMS meeting and the seven focus groups looking for themes and commonalities that reflected statewide consensus on the issues. These themes provided the starting point for the determining which literature to examine in order to address the fourth question. The purpose of this review was to identify best practices and policy recommendations related to themes raised in the focus groups and to identify any important issues not raised in those groups. Some refinement of themes occurred at a follow-up meeting of the FAMS and with input from a steering committee. Each method of data collection is discussed in greater detail below.

Data Collection

<u>Florida Association of Mathematics Supervisors (FAMS).</u> As an initial step, the investigators conducted a two-hour meeting with district mathematics supervisors from across the state during the 1999 meeting of the FAMS, held in conjunction with the annual meeting of the Florida Council of Teachers of Mathematics (FCTM). During this session, mathematics leaders generated their list of key elements of a successful middle school mathematics program, the barriers to its implementation, and possible ways to overcome those barriers.

<u>Steering Committee.</u> After the FAMS meeting, a steering committee was formed to advise the investigators about the project as a whole and about data collection. This steering committee consisted of a middle-grades principal, the presidents of FAMS and FCTM, a district mathematics supervisor and a middle school mathematics teacher. The steering committee used the information collected at FAMS to outline an agenda for the investigators to follow at focus group meetings.

<u>Focus Group Meeting.</u> Seven 1-day focus group meetings were conducted in Fall 1999. The meetings were facilitated by the Area Centers for Educational Enhancement, with one meeting held in each of regions 1, 2, 3, 5, and 6. Two meetings were held in region 4 because it encompasses a large geographic area and is the most populous region. Holding separate meetings in the north and south ends of the region 4 was designed to ensure that the smaller school districts comprising this region had an opportunity to have their voices heard.

At each focus group meeting, individuals began by individually listing their perceptions about the key elements of a successful middle school mathematics program. These perceptions were shared in a group setting with major elements compiled on chart paper. After this time of sharing and clarification, participants reviewed the list of elements identified by supervisors at the FAMS meeting to address items of agreement, concern, or confusion.

Then, individuals worked in small groups with others of similar positions (teachers with teachers, principals with principals, etc.) to identify barriers to successful middle school mathematics programs and to suggest ways to overcome those barriers. Informal consensus within the small groups was generally achieved as the groups recorded their information onto chart paper for sharing with the entire group. Throughout the sharing process, further clarification was obtained and the focus group participants added other information.

Following the group discussion of barriers, the investigators grouped barriers and issues into broad clusters. Groups of focus group participants selected a particular issue to develop a set of recommended actions. The recommendations were classified according to the level of responsibility for implementation, specifically the classroom level, the school level, the school district level, the state policy level (State Department of Education, Legislature, or Governor), and the university level. Each group shared their list of actions with the whole group to elicit further comments or clarifications.

During each phase of the focus group meeting, one of the investigators facilitated the meeting while the other took extensive notes. On a number of small issues, consensus was not achieved as opinions were diametrically opposed.

Data Analysis

Upon completion of the focus groups, data from all seven meetings were collated and synthesized by the two investigators. Initially, the investigators expected that results would vary depending on the size of the district or region. However, that was not the case. Using the notes taken and the charts collected from each of the focus group meetings, themes were identified that were common to all regions. The initial findings were enhanced and clarified at a second FAMS meeting in early 2000. Here, the findings were shared and additional comments were solicited from the district mathematics supervisors.

Participants

The focus group participants were mathematics teachers (42%), school level leaders (9%), district-level mathematics specialists (17%), curriculum specialists (16%), university mathematics teacher educators (7%), and others, including parents (9%). Table 1 lists the 154 participants by Florida regions. These individuals represented 40 school districts across rural, suburban, and inner-city environments and a range of socio-economic levels. One school district conducted its own focus group meeting and sent the results to the investigators. Thus, the data reported here are based on input from 41 school districts.

Table 1.

Composition Of Participants At The Focus Groups

Participant Category	**Region**							
	1	**2**	**3**	**4N**	**4S**	**5**	**6**	**Total**
Teacher	15	13	7	14	6	6	4	**65**
School Level Leader		1	5	2		3	3	**14**
Mathematics Specialists	1	7	5	6	1		6	**26**
Curriculum Specialists	5	5	1	3	1	9		**24**
University Mathematics Educators	3	3	2	1			2	**11**
Other*	3	4	3	1			3	**14**
Total								**154**

**Other includes a parent, preservice teachers, a mathematician, and other district-level administrators. At each meeting, at least one representative from the local Area Center for Educational Enhancement was present, although the individual may not have signed-in.*

Results

Results from Focus Groups

The *key elements of a successful middle school mathematics program* (Question1) identified by focus group participants fell into 7 broad categories. Appendix A contains the elements together with details to clarify the nature of the elements.

Based on the key elements, focus group participants identified *barriers to the implementation of such mathematics programs in Florida's middle schools and recommended solutions to address these barriers* (Question 2 & 3). Appendix B contains the ten most commonly identified barriers and suggested solutions for addressing them.

The identification of barriers and possible solutions enjoyed considerable consensus among focus group participants of different levels of responsibility. This is significant because it means that classroom teachers, principals, mathematics curriculum specialists, district-level administrators, university mathematics educators, and parents share a common perspective on the challenges facing Florida's schools in terms of mathematics, and thus, can work from common understandings to address the challenges.

Appendix C contains a list of *recommended actions to address the barriers* (Question 4) by level of responsibility. Each of the numbered items corresponds to the appropriate barrier from Table 3. Although there is not a one-to-one correspondence between the suggested solutions of Table 3 and the recommended actions of Appendix C, the vast majority of solutions are addressed by some recommendation. By looking down a column, readers can identify actions that can be taken at various levels to address a barrier. By looking across a row, individuals at a particular level can identify all the actions they may take to address the ten most important barriers to middle school mathematics achievement in Florida, at least as identified by those most responsible for delivering mathematics instruction to Florida's middle school children. It should be noted that some levels, such as the district level, could be further subdivided. Some actions at the district level can be handled by a mathematics curriculum specialist; others require policy decisions by local school boards.

The organization of the recommended solutions in Appendix C is based on suggestions that focus group participants provided for actions that need to be taken to improve middle school mathematics achievement. However, the table is not "all inclusive" or "comprehensive."

Linking Focus Group Results to Research

The fourth research question involved linking published literature to the data collected in the focus group meetings. To address this question, the investigators researched the published literature related to the key elements, barriers, and recommended solutions to determine research findings and national recommendations that would provide additional insights into the issues raised by Florida educators. Although not exhaustive, the review of the literature supports and clarifies issues emerging from the focus groups. The results of that search are summarized in four broad categories: issues related to teacher quality and supply; issues related to curriculum and instruction; issues related to professional development; and public relations issues that include community support, media, and the status of teaching as a profession.

Issues Related to Teacher Quality and Supply (Barriers 1, 5, & 6).

The need for an adequate supply of qualified mathematics teachers for the middle grades was the top issue in all of the focus group meetings. Currently, Florida has a shortage of mathematics teachers, as revealed by the fact that mathematics continues to be one of the areas on the critical teacher shortage list. This shortage raises concerns about the qualifications of individuals permitted to teach mathematics. Despite the shortage, the need for qualified teachers cannot be minimized.

Research shows that qualified teachers know the structure and the content of mathematics as well as the pedagogical content knowledge to plan and conduct lessons that facilitate learning (Grouws & Shultz, 1996). Further, the ability of teachers to structure materials, ask higher-order questions, use students' ideas and probe students' comments are considered by many important scholars to be important predictors in determining what students are able to learn (Darling-Hammond, Wise, & Pease, 1983). (NOTE: Although I cannot recall reading this specific article, my reading of other, similar Darling-Hammond work revealed no research-based support for a statement this strong. Author should either check Darling-Hammond's references or reword statement as above.

Research also shows that the mathematics background of middle grades mathematics teachers varies widely. In a national survey of mathematics and science teachers conducted in 1993-1994, Weiss, Matti, and Smith found that among grades 5-8 mathematics teachers, 20% had their last mathematics or mathematics education course in 1983-1988 and 36% had their last such course prior to 1983. Moreover, in the TIMSS-R, 41% of U.S. eighth-grade mathematics teachers reported their main area of study as mathematics and 37% reported their main area of study as mathematics education; the comparable international percentages were 71% and 31%, respectively (U.S. Department of Education, 2000). Among the states comprising the SREB, at least a third of the middle grades teachers hold elementary certification, rather than a major or minor in mathematics (Cooney, 1999b). Cooney's work illustrates that as states move toward higher standards and expectations of all students it is imperative that teachers have the knowledge to teach the advanced content that these standards require (Cooney, 1999c).

The areas of teacher quality and supply are broad ones that encompass a number of specific issues, such as the impact of teacher quality on student achievement, teacher certification, recruitment and retention, support for early career teachers, and teacher preparation programs. Each of these specific issues was researched further.

<u>The Impact of Teacher Quality on Student Achievement.</u> The results of many studies suggest that the qualifications of the teacher play a major role in students' achievement. In mathematics, a well-qualified teacher should be considered one with regular certification, the equivalent of a major or minor in the content discipline that they teach, and appropriate content-specific pedagogical preparation. Darling-Hammond (2000) reports that "the strongest, consistently negative predictors of student achievement … are the proportions of new teachers who are uncertified and the proportions of teachers who hold less than a minor in the field they teach" (p. 27). Other researchers found that

unqualified teachers tend to have greater difficulties planning curriculum, teaching, managing the classroom, and diagnosing students' learning needs (Feiman-Nemser & Parker, 1990; Grossman, 1989). In contrast, effective teachers are better able to adjust their teaching to fit the demands of different instructional goals, topics, and methods. They are able to modify their approaches to meet the needs of students, including those who do not fit the "typical" mold (Ohanian, 1999).

Teacher Certification. Teacher licensing is typically used to indicate the quality of teachers. Certifying teachers is one way to ensure that individuals teaching in the public schools meet a minimal level of competency. However, the current shortage of mathematics teachers in many parts of the country creates a tension between meeting the needs of the mathematics classroom and maintaining high standards for certification. Some states have created procedures that enable individuals to obtain certification without meeting higher standards. Others have developed incentives that raise standards and enhance teaching quality. States with higher certification requirements, such as Wisconsin and Minnesota, also have high student achievement on national assessments (Darling-Hammond, 1999).

The issue of teacher certification is a complex one, especially when teacher shortages exist. Alternative paths to certification enable individuals making career shifts to enter the classroom quickly, acknowledging skills they bring to the classroom from other environments. However, difficulties arise when alternative paths are less rigorous than traditional certification routes, encouraging individuals to circumvent the pedagogical training that may help provide strategies to ensure students' academic success. Hiring individuals who are unprepared or who are working outside their area of expertise may have decidedly negative effects on student achievement, especially as the content expectations for students continue to rise (Darling-Hammond, 1999).

Researchers found that teachers who were certified in the content area and in education were rated more highly and were more successful with students than teachers without such credentials (Evertson, Hawley, & Zlotnik, 1985). Others report that students who were taught by teachers with "in-field" certification showed greater gains than those who were taught by teachers who were not certified "in-field" (Hawk, Coble, & Swanson, 1985). Yet others report that teachers allowed to teach with less than full preparation tend to leave the profession at higher than average rates (Lutz & Hutton, 1989; Stoddart, 1992).

Supply, Recruitment, and Retention. Recruiting, preparing, and retaining quality teachers, in addition to improving the quality of the current teaching force, is necessary in order to staff schools with enough qualified mathematics teachers. Before this can be accomplished, factors that deter individuals from choosing to enter or remain in the teaching profession must be addressed. A study of more than 1,000 school districts "concluded that every additional dollar spent on more highly qualified teachers netted greater improvements in students' achievement than did any other use of school resources" (Ronald Ferguson (1991) as cited in National Commission on Teaching and America's Future, 1996, pp. 6, 8). Issues such as professional support, administrative support, classroom management, and motivation problems among students are the main reasons listed by teachers who leave the profession early in their career (Cooney, 1999b).

Support for Early Career Teachers. Retaining teachers currently in the field is an effective and necessary approach for combating future teacher shortages (American Council on Education, 1999). This involves nurturing new teachers into the profession, as well as providing opportunities for veteran teachers to grow professionally without leaving the classroom. Darling-Hammond and Ball (1998) report that difficulties experienced by first-year teachers are often exacerbated by difficult teaching assignments or assignments in the most challenging schools, and there is often little mentoring or support. To retain teachers, it is important that they are provided "opportunities to meet with colleagues to plan curriculum or teaching approaches [because such opportunities] enable teachers to expand their views of mathematics, their resources for teaching, and their repertoire of teaching and learning skills" (Beaton et al., 1996, p. 145). It is well documented that teachers are more effective when they are part of a learning community whose goal is to improve teaching and learning of significant subject matter (Ben-Perez, 1990; Sparks & Hirsh, 2000; Zemelman, Daniels, & Hyde, 1998).

Teacher Preparation Programs. Teacher preparation programs play an important role in the development of qualified teachers and have been found to have a positive effect on student learning (Evertson, Hawley, & Zlotnik, 1985). In terms of teacher preparation programs in mathematics, there is a need for both mathematics content and mathematics pedagogy. Teachers need some opportunities to revisit the school mathematics they will be expected to teach, but from an advanced standpoint. The Conference Board of the Mathematical Sciences (CBMS) (2000) recommends that prospective middle school teachers complete 21 semester hours of mathematics with some courses designed to strengthen teachers' own knowledge of mathematics and some courses designed to develop a deep understanding of the school mathematics they will be required to teach. This report identifies the need for mathematics courses that provide teachers a deep conceptual understanding of mathematics by engaging them in learning mathematics through the pedagogical practices that they will need to use in their own classroom. Currently, prospective teachers are not given an opportunity to consider pedagogy as they study mathematics (Darling-Hammond & Ball, 1998).

The authors of Educating Teachers of Science, Mathematics, and Technology, a report prepared by a committee under the auspices of the National Research Council, acknowledge that increased standards and expectations for students have resulted in increased expectations for teachers (National Research Council (NRC), 2000). They assert that the preparation of teachers of mathematics is a joint endeavor between mathematicians and mathematics educators. However, many mathematics faculty do not "have the kinds of professional development experiences in teaching that would enable them to model effectively the kinds of pedagogy that are needed for success in grade K-12 classrooms" (NRC, 2000, p. 2). Further, the report describes the need for policies to attract and educate professionals, as well as the need to consider novices and veterans from different perspectives. The report also provides a vision for collaborative agreements between schools and teacher preparation programs to provide preparation for teachers that closely resembles the environments in which they will be expected to teach.

Issues Related to Curriculum and Instruction (Barriers 2, 3, 7, 8)

Individuals at all levels were concerned that the middle school curriculum is not focused, coherent, or challenging and that students are often not taught using instructional practices appropriate for that level. Wiggins (1995) indicates that one cannot judge the coherence of a curriculum without considering the meaning that learners derive from their experience with it. He claims that

> *"an effective curriculum must be fluid while being focused, built on feedback loops in relation to fixed operational goals – where we are versus where we need to eventually be. Learners' idiosyncratic and unpredictable responses to our teaching toward goals must cause the curriculum to adjust … but the curriculum must enable students to meet our preestablished performance goals."* (pp. 108-109)

<u>Challenging Curriculum</u>. The importance of a strong curriculum is reiterated in many reports. "The mathematics curriculum should provide opportunities and materials for mastery of the knowledge and skills needed to apply arithmetic, algebra, and geometry concepts and to demonstrate mathematical reasoning through solving problems with multiple steps" (Cooney, 1999c, p. 1). The National Middle School Association (1995) asserts that middle school students require curricula that is challenging, integrative, and exploratory. Challenging curricula keep students actively engaged in their studies; integrative curricula help students make sense of their lives by connecting the real world of their

experience to their school experiences; and exploratory curricula enable students to discover their interests and talents.

To illustrate the difference in the mathematics curriculum between high and low achieving schools, Cooney (1999a) notes that high performing schools provide a challenging curriculum for their students. They emphasize "higher level academics and the intellectual development of students in the middle grades as opposed to schools that concentrate most of their energy on social development and are satisfied with achievement on low-level skills" (Cooney, 1999a, p. 13). International studies reveal that the mathematics in the U.S. eighth-grade curriculum is often taught at the seventh grade in other countries (U. S. Department of Education, 1997).

<u>Curriculum and Assessment Interactions.</u> Because issues of assessment are intertwined with issues of curriculum coherence, it is essential that the curriculum is aligned. "Curriculum alignment is a process of aligning the written curriculum, the tested curriculum, and the supported curriculum to make the taught curriculum more effective" (Glatthorn, 1994, p. 49). Wiggins (1995) advocates working backwards from assessments in an attempt to make curricula coherent. His assumption is that "with clarity about the intended performances and results, teachers will have a set of criteria for ordering content, reducing aimless 'coverage,' and adjusting instruction en route; and students will be able to grasp *their* priorities from day one" (p. 101) (italics in the original).

<u>Instructional Approaches.</u> The nature of the curriculum outlined above requires different instructional strategies than the typical lecture or presentation of new material followed by a period of time to begin homework. If learners are going to construct knowledge and tie new experiences to existing knowledge, they must be actively engaged with the mathematics. That is, they must be "doing" mathematics and not just "receiving" knowledge from their teachers.

The major goal of mathematics instruction should be to help students become mathematically powerful.

> *"Teachers who help children become mathematically powerful devote less attention to telling students about mathematics, assigning worksheets for computational practice, and requiring rote memorization. Instead, they employ activities that promote the active involvement of their students in doing mathematics in authentic situations"*
> (Zemelman, Daniels, & Hyde, 1998, p. 89).

The National Middle School Association (1995) suggests,

> "*teaching techniques should enhance and accommodate the diverse skills, abilities, and knowledge of young adolescents. … While direct instruction is still important, varied*

> *approaches are needed, including experiments, demonstrations, opinion polls, simulations, and independent study"* (pp. 24-25).

Class Size. Focus group participants were in favor of smaller class sizes at the middle school level, recommending a maximum of 25 students in a class with appropriate adjustments made for special needs students. Their desire for smaller class sizes was related to the ability to offer more individualized instruction and more hands-on learning opportunities. Some research studies on class-size at the middle-grades level seem to support their views. Smaller class sizes were related to higher student achievement, provided that students were in such classes for at least 100 hours. Smaller class sizes enhanced teacher morale and the quality of instruction (Smith & Glass, as cited in *Reducing Class Size, What Do We Know?*, March 1999). Additionally, smaller eighth-grade mathematics classes led to an improved social environment, which in turn led to better achievement (Weglinsky, as cited in *Reducing Class Size, What Do We Know?*, March 1999).

Issues of Professional Development (Barrier 4)

Helping teachers become more effective in their teaching practice through professional development is often touted as the primary means for producing gains in teacher quality and consequently in student achievement. The majority of time students are in school is spent under the tutelage of teachers. Therefore, teachers' teaching abilities directly impact the quality of learning that students encounter in any classroom. Improving the quality of teaching means a lifetime of study and a workplace that supports continuous learning as an integral part of the daily, weekly, and yearlong job. To be effective, the organization, focus, and implementation of the professional development activities must actively engage and support teachers' efforts to enhance students' achievement (Joyce & Showers, 1995; Killion, 1999).

Sparks and Hirsh's (2000) work affirms the focus group participants' notion that effective professional development needs to relate directly to the lives of teachers and to their classrooms and should help them make connections between subject matter and pedagogy.

> "*Teachers are key to the transformation of schools … for teachers to lead the reform effort, they need to be offered expanded and enriched professional development experiences that should be tied directly to the emerging student performance standards and be continuous, site-based, job-embedded, teacher designed, and organizationally focused"* (Dilworth & Imig, 1995, p. 5).

Professional development should involve groups of teachers, use teachers as participants in classroom activities, allow time and opportunity for planning and reflection, and recognize that change is gradual.

It should address issues raised by the teachers and provide them some choices (Clarke, 1994). Researchers found that teachers "who participated in a professional development activity that lasted eight hours or more were three to five times more likely to say that the activity improved their teaching a lot as were teachers with a shorter activity" (Sparks & Hirsh, 2000, p. 11). Others suggest that the school year should be extended by 25% (without additional student time) to accommodate the time necessary for teachers to work collaboratively to improve teaching and learning (Killion, 1999).

<u>Professional Development and Its Relation to the Profession.</u> The effectiveness of professional development activities should be measured by improvement in changes in practice and improved student learning. Renyi (1996) contends that the ability of practitioners to engage in ongoing high-quality professional development is a hallmark of enterprises that are known for high performance and that enjoy sustained public confidence. To this end, professional developers and policy makers, at all levels, must work together "to develop and institute policies that recognize that professional development … is an essential component of an effective school system rather than an add-on activity that can be eliminated in difficult times" (Loucks-Horsley, Hewson, Love, & Stiles, 1998, p. 208).

Public Relations Issues (Barriers 9 & 10)

Two other major issues surfaced at the focus groups. One issue dealt with the perception that the public views schools in a negative fashion; this is related to the realization that parents and a strong supportive community are necessary ingredients of successful schools. The second issue dealt with the perception that teaching is not viewed as a profession.

<u>Strong Community Support.</u> The SREB report, *Leading the Way*, notes that parents must understand and support the higher expectations of students in order for those expectations to be effective (Cooney, 1999c). Because parents play such a vital role in the educational experience of students, they should be included in the development, implementation, and evaluation of the curriculum (Delagardelle & Ludwig, 1998).

Parents are important to the academic well-being of middle school students; students' attitudes towards academics are affected by their parents' involvement in the educational process (Eilers, Fox, Welvaert, & Wood, 1998). Indeed, teachers, parents, and students must all work together for a school to be successful:

> *"Successful schools address all three components of student learning: teachers, parents, and students. Addressing only one of these components greatly diminishes the chances of increasing student commitment to schoolwork. Success also depends on recognizing that a change in one component affects the other two."* (p. 8)

Cai, Moyer, and Wang (1997) studied the impact of parental roles on student achievement in mathematics. Parental roles fell into two categories: those that involved directly assisting students with work such as content advisor and learning counselor; and those that focused on providing emotional and resource support. “Students with the most supportive parents demonstrated higher mathematics achievement and more positive attitudes towards mathematics than students with the least supportive parents” (p. 2). In fact, parental roles that provided emotional or resource support were more predictive of achievement than were roles in which parents directly assisted with learning.

A number of educators report efforts at schools that have helped to build stronger support for education. Fowler and Corley (1996) report results from one school in which parents receive a copy of curriculum plans for the year as well as a weekly newsletter. A Parent Center, with a paid staff person, is open to provide support to parents on a wide range of social and educational issues. Because of the strong community support, business and community volunteers engage students in activities on Friday mornings to give teachers an opportunity to develop lesson plans collaboratively with other colleagues.

Indeed, the current climate, with higher expectations in terms of content and changed instructional practices, raises questions from all groups – students, parents, teachers, and the media – that need to be respected and discussed. All parties must understand that many learning steps are necessary in this process and that time and support are crucial for reform’s success (Zemelman, Daniels, & Hyde, 1998).

<u>Media Issues.</u> Berliner and Biddle (1999) cite a number of problems with the education reporting in the press, among which are the following: a bias that reports negative news much more than positive news; a lack of understanding about the complex environments of schools; and a lack of understanding about basic statistics and social science research. They argue that a possible result of such negative reporting is an abandonment of public schools and an increase in private school enrollment, with greater privilege for some and fewer opportunities for success for others.

In early 2000, The American Youth Policy Forum and the Center on Education Policy released a report dealing with the good news about public education in an attempt to provide a more balanced media perspective on education. In comments to the media, they focus on the fact that constant negative reporting discourages both teachers and students (Sager, 2000).

In another perspective on media and public relations, the 1999 National Education Summit

(Achieve, Inc.) highlights the importance of educating the public about reform, standards, and high-stakes tests. Such education is particularly important when new state tests focus on higher-level thinking rather than lower-level computational skills. Examining sample items and engaging in discussions about expectations from initial testing help prepare parents, policy makers, and the media for test results. The continued dialogue helps all interested parties understand the improvements that can be expected over time. Such dialogue is crucial to ensure the levels of long-term change essential in raising achievement to world-class standards.

<u>Status of Teaching as a Profession.</u> In the focus group meetings, concern was expressed about the perceived lack of professionalism in the teaching profession. The two areas often mentioned were the negative attention that public school education receives in the media and the lack of control teachers feel about their own profession. According to the Carnegie Forum on Education and the Economy (1986),

> *"Professional work is characterized by the assumption that the job of the profession is to bring special expertise and judgment to bear on the work at hand. Because of their expertise, … professionals enjoy a high degree of autonomy in carrying out their work. They define the standards used to evaluate the quality of work done, they decide what standards are used to judge the qualifications of professionals in their field, and they have a major voice in deciding what program of preparation is appropriate for professionals in their field."* (p. 36)

Although teachers constantly make decisions about the instruction in their classrooms, they often feel that external forces beyond their control set standards and policies that impact accountability. Consequently, teachers often feel powerless in the face of these external pressures.

The ability to set standards for judging the quality of the profession is a feature of many professional fields. Accordingly, the effort to enhance the professionalization of teaching should be aimed at developing the same kind of quality assurance that is afforded other professions (Wise, 1995). The National Board for Professional Teaching Standards, with membership that includes teachers, is one such standards-setting board that enacts and enforces high licensing standards, including a peer review and improvement process.

Focus group participants asserted that actions taken by the state can thwart efforts towards professionalizing the teaching profession. As discussed earlier in the report, the issuance of "emergency" licenses to unqualified individuals for staffing classrooms or allowing teachers to teach out-of-field sends a clear message regarding the specialized skills teachers are purported to have

(Wise, 1995). Additionally, other professions recognize advanced levels of skills through additional certification such as board certification for doctors in areas such as surgery or oncology. Individuals who have met these standards are allowed to perform functions that others cannot. Currently, teachers with certification continue to do the same job as those without.

The conditions under which teachers work must change in ways that enhance, rather than inhibit, professionalism. If teaching is the core of the profession, then the majority of the teacher's time should be devoted to the teaching process, including the act of teaching as well as the time to reflect and work on improving lessons. Unfortunately, focus-group teachers reported that they spend a great deal of time responding to what could be considered secretarial work, such as bus duty and lunch duty. "There is no professional reason for teachers to spend time as hall monitors, detention guards, and lunchroom patrollers when they can be using that time for learning," planning, or preparing to teach (Sparks & Hirsh, 2000, p. 12).

Discussion

The significance of the middle school years in impacting the academic and career options of students makes the focus on middle-grades mathematics achievement imperative. The essence of the successful elements identified by Florida stakeholders can be summarized in a policy statement from the SREB in its report, *Leading the Way*: "All students in the middle grades will learn a rigorous academic core with highly qualified teachers who engage their interests through relevant, hands-on materials and activities, and all students will leave eighth grade ready for success in high school" (Cooney, 1999c, p. 2). Embedded in this statement is the recognition that a successful middle-grades program has a strong curriculum taught by content-knowledgeable teachers who use instructional approaches appropriate for middle school students.

The barriers directly connect to the key elements because they focus primarily on the shortage of qualified mathematics teachers and the perceived lack of a coherent middle school mathematics curriculum. The Sunshine State Standards (Florida Department of Education, 1996) envisions a challenging and coherent curriculum, but difficulties arise in its implementation. The amount of content to be covered in the middle grades requires highly knowledgeable and pedagogically skilled teachers. Such teachers are able to make connections within and between strands to help students master the content and processes of the Sunshine State Standards, including the levels of achievement expected on FCAT.

The interlinking of the shortage of qualified mathematics teachers and the demands of meeting the Sunshine State Standards poses interesting policy dilemmas for district and state policy makers and educators. In times when a shortage of teachers exists, how do we ensure that not only are classrooms staffed, but that they are staffed by individuals who possess the necessary content knowledge to teach the subject matter, the general pedagogical knowledge needed to organize classrooms, plan lessons, and engage students, and the pedagogical content knowledge necessary to teach the subject matter in ways that are accessible to students?

Individuals teaching mathematics in the middle grades need deep conceptual understanding of mathematics at many levels. Because of the unique role middle grades mathematics plays as a potential gate-keeper, mathematics teachers at this level need a thorough grounding in elementary school mathematics so that they are able to aid students who enter middle grades with mathematical deficiencies. They also need an understanding of high school mathematics to develop mathematics concepts in ways that are appropriate for learning more advanced mathematics.

There has been much discussion about the special qualifications needed to teach mathematics. In her seminal research, Ma (1999) asserts that the teaching of mathematics requires a "profound understanding of fundamental mathematics." Presently, mathematicians are acknowledging that the mathematics understanding needed for teaching is different from the mathematics understanding needed in other fields (CBMS, 2000). The need for special qualification for teaching raises several issues.

- As a state, what information do we have about the content preparation of those already teaching mathematics in the middle grades? Are the current guidelines for teaching mathematics at the middle grades sufficient to provide this multi-dimensional perspective? Currently, individuals may teach in middle grades with various certifications: (1) elementary certification, if they are teaching grade 6 only; (2) middle grades generalists certification, which requires as few as twelve hours of mathematics; (3) middle grades mathematics certification, requiring a minimum of 18 hours of mathematics; or (4) 6-12 certification, which typically involves a major in mathematics or mathematics education containing a minimum of 30 hours of mathematics. In all but the latter case, there are very few requirements for what the hours of mathematics entail. Given the varied pathways to certification, are highly qualified individuals staffing mathematics classrooms? Or, are classrooms being staffed by people who may know some mathematics but lack the mathematical pedagogical knowledge needed to make that content accessible to students? Or, are classrooms are being staffed by teachers who have pedagogical strategies but lack the content knowledge needed to help students achieve to high levels?

- For individuals who are already in the classroom but who lack sufficient content preparation, can or should deficiencies be remedied through professional development that focuses solely on content? Rather does professional development need to link content knowledge with how it plays out in the middle school? Indeed, Sparks and Hirsh (2000) note that effective professional development is directly linked to what teachers do in the classroom, that is, it connects subject matter and pedagogy.
- Given that universities in the state do not produce enough mathematics teachers to staff Florida's schools, how do universities and school districts work together to improve the qualities of teachers? As mentioned earlier in this article, neither content knowledge nor pedagogical knowledge alone is sufficient for teachers to engage in high quality instruction. Given the changes in mathematics standards and expectations for students, how can district and university teacher preparation programs work together to identify the content and pedagogical skills teachers need if they are to prepare students to be successful on high stakes assessments?

Many of the issues identified in this article are not specific to mathematics; they may be relevant to other content areas as well. In addition to a shortage of mathematics teachers, there is also a shortage of science teachers. As science moves to high stakes assessment, with the science FCAT in 2003, those concerned about the state of science knowledge may want to consider what lessons may be learned from the mathematics focus groups that are applicable to science.

The findings from the research reported here also suggest that there is a need to consider factors that impede the implementation of national and state standards. The existence of standards (NCTM 1989, 2000; Florida Department of Education, 1996) have provided the vision for mathematics achievement and expectations, but the barriers suggest the existence of practical difficulties that hinder the implementation of such standards, even when teachers want to change their practices. Failure to recognize, acknowledge, and address these barriers will further delay efforts to improve students' achievements. As noted in Table 4, the suggested solutions fall into various levels of responsibility for action.

Achieving improvement will involve coordinated efforts from individuals at many levels. Florida consists of a wide range of schooling environments, from small rural districts to extremely large urban districts. Many districts contain a range of schools from rural settings with migrant populations to suburban school with affluent student populations to inner-city schools with poor populations. Despite the expectation of differences in the elements and barriers, there was remarkable consistency across the state. Because of this, the findings from this study can serve as a springboard for improving the state of middle-grades mathematics in Florida. The common views, concerns, barriers, and recommended solutions from educators of multiple levels of responsibility provide a basis for developing and implementing actions that can be used to improve middle-grades students' mathematics achievement.

One aspect of the research reported here is worth special note. The focus group brought together educators with different levels of responsibility and provided a forum for articulation across these different levels. Too often such articulation does not exist, and yet attempting to solve the problems of mathematics achievement in Florida requires that all individuals at all levels work in concert to improve the current situation. The fact that teachers, principals, district curriculum supervisors, mathematics educators and parents generated common understandings and beliefs about issues related to middle school mathematics enabled them to work together to build a foundation for discussing solutions. During the focus groups, members of one group, say teachers, were often surprised by the understanding that others of different groups had regarding the challenges they face. Now that the various stakeholder groups have common understandings of the issues, it is time to develop an action plan to make progress in addressing these issues.

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Endnotes

[1]Copies of a condensed report, entitled Improving Middle School Mathematics Achievement in Florida, is available from the Curriculum Support section of the Florida Department of Education and online at http://www.firn.edu/doe

Appendix A
Elements of a Successful Middle School Mathematics Program

1. An adequate supply of highly qualified mathematics teachers, in terms of content knowledge and pedagogical knowledge, must exist. • Teachers have strong mathematics and pedagogical content knowledge. • Teachers know and use a variety of instructional strategies. • Teachers are certified in middle-grades mathematics. • Teachers are able to determine appropriate methods and materials to use in their lessons with students. • Teachers use class time wisely. • Teachers have high expectations of students. • Teachers understand the ways adolescents learn and how adolescents differ from elementary and high school students.	2. The middle school mathematics curriculum must be challenging, coherent, and focused. • The curriculum encourages the study of topics in-depth, rather than a brief survey of a wide range of topics. • The curriculum balances understanding of mathematics with skill development. • The curriculum is vertically aligned, with appropriate expectations and objectives for each grade level. That is, the curriculum should progress from one grade level to another without being overly repetitive. • The curriculum is relevant. That is, it connects mathematics to the lives of middle school students and careers. • The curriculum addresses mathematics presented in context. • The curriculum focuses on problem solving. • The curriculum is aligned with national and state standards. • The curriculum prepares students with the mathematics necessary to be successful in high school. • Technology is integrated in the curriculum. • Curriculum, instruction, and assessment are aligned.	3. Instructional approaches must consider the nature and needs of the middle school child. • Teachers use diverse strategies and materials during instruction. • Teachers meet the needs of students by accommodating different learning styles and intelligences. • Teachers permit students to work cooperatively. • Students are engaged in doing mathematics themselves, not just watching the teacher do mathematics. • Teachers make writing a natural part of mathematics. • Teachers use activities that move students' understanding from concrete to abstract. • Teachers integrate assessment and instruction, including performance-based assessments. • Teachers use hands-on methods, when appropriate. • Students receive regular and appropriate feedback.

4. Students must be prepared for the middle school mathematics curriculum. • Students have a standards- based mathematics foundation from elementary school. • Students are responsible and are held accountable for their learning.	**5. Ongoing professional development must be available to all teachers.** • Professional development offers teachers clear and reasonable expectations about what to teach. • Professional development deals with implementation ideas. • Professional development is delivered at the school site when feasible. • Professional development is focused on content and the use of instructional strategies, including hands-on materials.	**6. The school administrators and infrastructure must support the mathematics program.** • Scheduling allows time for planning with peers. • There is articulation among mathematics teachers between and within grade levels. • There is articulation with feeder schools about mathematics expectations. • Access to technology, for both students and teachers, is readily available. • Class sizes are reasonable (maximum of 25 students). • Team approaches are used for intervention. • Teachers have sufficient resources and use them appropriately. • Data are used to inform instruction and assessment. • Students are placed in mathematics courses appropriately. • Students' progress is monitored continuously with immediate remediation when necessary. Tutoring support is available. • There is adequate time (at least 60 minutes) provided for mathematics instruction.	**7. There must be strong community support for the schools.** • Parents are involved in the school. • Parents support education and are accountable for their children's learning.

Appendix B.
Summary of Barriers and Suggested Solutions (* indicates areas with lack of consensus)

1. There is a shortage of qualified mathematics teachers.	2. The middle school curriculum is unfocused, that is, it is too broad in terms of the number of topics taught.	3. Students are unprepared (or underprepared) for the courses they are taking in the middle grades.	4. Professional development opportunities for teachers are lacking.	5. Early career teachers lack support.
• Make the profession attractive with enhanced salaries and better working conditions. • Increase salaries to reflect the importance of teachers to society. • Require middle-grades mathematics certification for all individuals teaching middle-grades mathematics. • Maintain the same standards for alternative and traditional routes to certification. • Maintain content-specific knowledge in the certification process. • Maintain the importance of content-specific pedagogy in the certification process. Eliminate methods course waivers. • Offer university programs to develop middle-grades mathematics teachers. • Focus professional development activities on developing conceptual understanding of content and pedagogy. • Implement recruitment/retention programs that focus on middle-grades mathematics teachers. • Use tuition waivers as incentives for prospective mathematics teachers.	• Ensure that the curriculum is challenging to middle-grades students. • Focus on teaching fewer topics at each grade level, but in greater depth. • Make the content standards grade-level specific. • Provide time for curriculum development and articulation. • Provide professional development	• Emphasize critical thinking and problem solving within the mathematics content in elementary school mathematics programs. • Schedule time for teachers in feeder patterns to engage in articulation. • Place students in courses objectively.	• Assign each middle school a well-trained mathematics resource teacher to facilitate professional development activities at the school and to provide classroom-level support. • Offer professional development at times conducive to teachers' schedules. • Make professional development activities available to remote sites. • Offer professional development activities over multiple sessions with follow-up. • Expand the definition of professional development to include such activities as collaborating with peers, attending content related conferences, and reading professional journals. • Provide teachers with instructional support materials and inservice on how to use the materials. • Involve teachers in determining the staff development objectives.	• Give first-year teachers a reduced teaching load. • Provide support for perfecting teaching skills. • Do not assign early career teachers to the most difficult schools or the most difficult classes. • Assign new teachers their own classrooms, rather than requiring them to

	opportunities regarding the curriculum. • Employ strategies to address the needs of students of all ability levels.	• Hold students and parents, as well as teachers, account-able for students' performance.	• Educate administrators (principals, etc.) about trends in mathematics education so they will recognize appropriate instruction. • Encourage universities to deliver professional development activities through alternate avenues. • Require professional development as part of teachers' regular workday and fund it at regular salary.	move from classroom to classroom. • Extend the internship to one-year with pay.
6. More articulation is needed between teacher preparation programs and school districts to ensure that the needs of school districts are met. • Encourage elementary teachers to specialize by content area. • Encourage articulation between districts and universities regarding teacher education programs. • Model instructional practices in university courses that are appropriate for future teachers.* • Emphasize Sunshine State	**7. Sufficient time for teaching, planning, articulation, and professional development is lacking.** • Extend the daily time for mathematics to a minimum of 60 minutes a day.	**8. Class sizes are too large to permit individualize d instruction and large class sizes make teachers reluctant to use active learning strategies.** • Limit class size to a	**9. Public perception of public schools in general, and of mathematics in particular, is negative.** • Market the profession in a positive light. • Use media campaigns to emphasize the importance of mathematics. • Encourage the media to report positive features about schools. • Develop effective community outreach plans. • Have media and policy	**10. There is the perception that teaching lacks the status of a profession.** • Increas e salaries to reflect the importance of teachers to society. • Have

Standards in content courses.* • Update the university curriculum to reflect the state of mathematics in Florida.* • Offer courses when convenient for practicing teachers. • Increase mathematics requirements for elementary teachers. • Design courses to enhance conceptual understanding of mathematics. • Structure pre-internship experiences in various settings. • Extend the internship to one-year with pay.	• Schedule courses so mathematics teachers can plan within and across grades. • Allot time for interdisciplinary team planning. • Extend the school year to allow for professional development.	maximum of 25 students. • Adjust class size to accommodate special needs students.	makers shadow a teacher for multiple days to understand the many demands on teachers. • Develop a campaign to educate parents and the media about curriculum changes in mathematics.	content knowledgeable individuals conduct evaluations. • Provide teachers with clerical support for non-teaching responsibilities.

Appendix C.
Solutions for Improving Middle-Grades Mathematics Achievement by Level of Responsibility
(* indicates areas with lack of consensus)

	1. Shortage of Qualified Teachers	2. Unfocused Curriculum	3. Prepared Middle School Students
Classroom	• Encourage students to enter teaching.	• Integrate mathematics with other content areas. • Balance conceptual understanding with procedural understanding. • Define the curriculum by the Sunshine State Standards, not the textbook.	• Provide adequate time daily for teaching mathematics at the K-5 level. • Capitalize on mathematics expertise with team teaching or specializing in the upper elementary grades. • Provide timely feedback on performance measures.
School	• Remove poor teachers so that only qualified teachers are in the classroom. • Provide support for struggling teachers. • Promote collegiality.	• Articulate mathematics content between grades and within a grade. • Support teaching fewer topics but at greater depth. • Provide support for the teaching of mathematics benchmarks in other curriculum areas.	• Develop a plan for remediation. • Monitor student progress and provide immediate remediation. • Provide timely feedback on performance measures.
District	• Recruit aggressively. • Use tuition assistance to grow your own teachers. • Develop professional opportunities to enhance content knowledge and pedagogical strategies. • Share best practices throughout the district. • Train administrators about reform in mathematics. • Promote the desirability of teaching mathematics. • Support recruitment bonuses for mathematics teachers.	• Articulate between feeder schools. • Provide professional development to increase teacher effectiveness with the Sunshine State Standards. • Adopt curriculum materials that represent a challenging, coherent, and focused curriculum from grade to grade.	• Use objective course placement procedures. • Institute an articulation plan K-16. • Encourage the advancement of the mathematics ability of all students.

State policy makers: **DOE** **Legislature** **Governor**	• Enhance teacher salaries. • Support alternative certification programs that meet the same standards as undergraduate university programs. • Clarify certification requirements. • Maintain high requirements for middle-grades mathematics certification. • Make middle-grades certification content-specific. • Create incentives for highly qualified students to enter teaching. • Provide financial support for education majors in critical areas. • Create incentives to retain teachers in critical need areas. • Support a media campaign to encourage entry into teaching.	• Encourage and fund articulation K-16. • Communicate clear expectations at each level K-16. • Have the Grade Level Expectations (GLE) at each grade level focus on fewer topics but at greater depth.* • Test content and skills only at the grade level at which mastery is expected.* • Obtain teacher and teacher educator input into curriculum content expectations. • Fund time for restructuring content expectations by grade.* • Support restructuring of assessments to allow for focused middle school programs.*	• Enhance mathematics requirements for K- 8 certification (i.e. require more courses that emphasize the development of conceptual understanding at the K- 8 level). • Create and enforce accountability policies for students and parents.
University	• Maintain entrance requirements to teacher education programs. • Articulate with districts about middle school preparation programs. • Align course offerings with district needs to support and develop middle-grades mathematics teachers. • Increase internship to a full year with pay. • Offer courses at convenient locations and times for teachers. • Regularly offer courses needed for certification.	• Help define topics to be taught in each grade.	• Develop appropriate mathematics courses for elementary and middle-grades teachers. • Develop and offer middle-grades mathematics certification programs (many schools do not). • Maintain high standards for elementary and middle school certification programs.
Overall			• Value mathematics literacy.

	4. Professional Development	5. Early Career Teachers	6. Teacher Education Programs
Classroom	• Implement professional development ideas with students. • Engage in classroom action research. • Work toward National Board Certification. * • Continue to grow professionally. • Use a various instructional approaches.	• Be assertive when asking for what you need. • Develop a personal, professional, and teaching philosophy. • Know school environment and school expectations. • Know district and state expectations.	• Pair preservice teachers with mentor teachers.
School	• Encourage the sharing of successful ideas. • Structure time for vertical and horizontal planning. • Support attempts at implementation of various instructional strategies. • Include time for ongoing professional development in the master schedule. • Incorporate professional development in the School Improvement Plan (SIP).	• Do not assign new teachers to the most difficult schools or classes. • Ensure that new teachers have their own classroom. • Provide school level and content-related support. • Provide resources for classroom needs. • Provide shadowing opportunities. • Provide mathematics-credentialed mentor teachers. • Support classroom discipline issues. • Provide mathematics leadership. • Support mathematics teachers' collaboration.	• Provide opportunities for teachers to become mentor teachers.
District	• Develop a coordinated long-term professional development plan. • Base professional development on individual teacher and school needs. • Integrate content, how students learn that content, and how to teach that content in staff development. • Provide school-based and ongoing staff development. • Develop accountability for professional development. • Use a cohort model for inservices.	• Provide a well-developed mentoring process. • Reduce the teaching load for first-year teachers.	• Help identify criteria and selection process for mentor-teachers. • Provide opportunities for preservice teachers to attend district inservices.

	• Utilize the expertise at local community colleges and universities. • Provide support for the use of performance-based assessments. • Encourage interdisciplinary approaches. • Provide mathematics resource teachers at each school.		
State policy makers: DOE Legislature Governor	• Continue to use Eisenhower funds, with special weight given to critical areas of mathematics and science. • Fund, administer, and facilitate summer institutes. • Support quality programs. • Evaluate professional development activities. • Develop networks for sharing ideas. • Use Area Centers for Educational Enhancement to provide training in areas of common need. • Sponsor an algebra summit. • Fund an extended school year to include professional development days. • Fund enhanced summer course offerings at universities.	• Fund yearlong internships for prospective teachers. • Fund the implementation of a quality beginning teacher program.	• Maintain high standards for teacher preparation programs and for alternate certification programs. • Repeal 120-hour rule so that teacher education programs can meet the needs of districts. • Provide teacher education programs with information provided to teachers and school districts.
University	• Coordinate efforts with districts. • Offer summer courses for teachers. • Publicize certification classes.	• Provide for ESOL training in preservice. • Plan for yearlong paid internships. • Provide seminars for beginning teachers. • Ensure that mathematics educators supervise mathematics interns.	• Be aware of district and state mandates.
Overall	• Expand the definition of staff development. • Focus professional development on student achievement.		

	7. Time	**8. Class size**	**9. Public Perception**	**10. Professionalization**

Classroom	• Use class time wisely.		• Inform parents about classroom practices.	• Join appropriate professional organizations. • Have a personal professional development plan.
School	• Limit class interruptions. • Provide teacher assistants. • Schedule time for planning and articulation among mathematics teachers. • Schedule time for planning and articulation among a team. • Establish set times for parent/teacher conferences. • Provide clerical assistance for teachers. • Limit the non-instructional duties of teachers. • Provide time for immediate remediation. • Consider using alternative/creative scheduling.	• Schedule smaller class sizes in mathematics.	• Inform parents about the detriments of absenteeism to achievement. • Provide media advanced notice of academic events.	• Market the teaching profession in a positive light. • Celebrate teachers' achievements and risk-taking instructional approaches.
District	• Schedule math classes to meet daily for 60 minutes minimum. • Minimize paperwork. • Schedule time for articulation K-16. • Minimize course assignment changes.	• Encourage a maximum class size of 25.	• Inform parents and the community about positive school efforts. • Develop proactive, not reactive, media relations.	• Recognize and award teachers' achievements.

State policy makers: DOE Legislature Governor	• Minimize paper work. • Have realistic time expectations to implement mandates. • Develop a long-term education plan not subject to political change. • Limit the frequency of policy changes so that there is sufficient time to implement changes and determine the effects.	• Fund middle schools equally with high schools. • Fund a real maximum class size of 25 students.	• Hire a public relations firm to advance teaching as a desirable profession. • Celebrate positive programs. • Fund recognition of academic achievement of students. • Shadow a teacher for several days. • Strive to prevent or alleviate the perception that teachers bear the total responsibility for student achievement.	• Develop a professional board similar to the American Medical Association to set the agenda for the profession. • Develop policies for recognizing superior teachers and for removing weak teachers.
University	• Have supervising teachers assist in mentoring. • Use the Internet for staff development offerings.			