Introduction

Background

In the mid-1980's, programs were implemented to prepare undergraduates to be certified as middle school mathematics teachers; these programs borrowed courses from already existing elementary or secondary programs. The result—an unfortunate hodgepodge of preparation—did not specifically address the unique needs of middle school teachers. From 1986 to 1991, the NSF funded nine projects to develop teacher preparation programs for middle school mathematics and science teachers. Those that involved mathematics include the *Middle Grades Teacher Preparation Project* at the University of Georgia, the *Middle School Math Program* at Illinois State University, *Preparing Pre-service Middle School Science and Math Teachers* at Lesley College, the *Development, Implementation, and Research for Educating Competent Teachers* (DIRECT) *Project* at Oklahoma State University, the *Middle School Math Project* at Portland State University, and the *Model Teacher Preparation Program* at SUNY-Potsdam.

A program for the preparation of teachers of middle grades mathematics should address the development of five types of knowledge: *Knowledge of Mathematics, Knowledge of the Teaching of Mathematics, Knowledge of the Learning of Mathematics, Knowledge of the Learner of Mathematics*, and *Knowledge of School Mathematics*.

Knowledge of Mathematics. The first issue in the design of a program of study for prospective middle grades mathematics teachers is to decide the precise mathematical content of the undergraduate curricula. In *A Call for Change*, the MAA recommends that "*special courses should be developed that provide the proper focus and breadth of experience for these teachers*" (Leitzel, 1991, p. 17). There is no clear consensus on what this curriculum should be. *On the Shoulders of Giants* offers themes that could be used to develop innovative course materials (Steen, 1990). A more traditional approach would be to start with one of the several lists of 'big ideas' in mathematics as a basis (Leitzel, 1994). A third approach would be to look at the changing nature of the middle grades curricula and design courses to provide a foundation and an overview for this content; for example, an undergraduate class on probability and statistics could be designed which would support the NCTM *Curriculum and Evaluation Standards* (1989). These possibilities need to be developed into courses and programs.

Knowledge of the Teaching of Mathematics. Attention needs to be paid to the pedagogy of the college classroom as well, for many feel that teachers teach as they were taught (National Research Council, 1989). Given the increasing acceptance of the constructivist theory of learning, the college classroom must become a more active place. Preservice teachers must experience the climate that they will be expected to create in their classroom. Teacher preparation programs must be attentive to this need.

Knowledge of the Learning of Mathematics. In terms of the children in the classroom, middle grades mathematics instruction is crucial in determining attitudes about the value and the usefulness of the subject and hence continued interest in studying mathematics (Leitzel, 1991; NSF, 1993). It is vital to train teachers of mathematics who know the wonder and beauty of the subject and can transmit it to their students. Peter Hilton, speaking at an East Carolina University (ECU) seminar series on improving the undergraduate preparation of teachers of mathematics, commented that the particular topics in mathematics learned by future teachers are not as important as their attitudes toward mathematics. He spoke of conveying the beauty of mathematics and the esthetic satisfaction of doing mathematics.

Knowledge of the Learner of Mathematics. Prospective teachers of middle school mathematics must be students of the psychology of learning and instruction of middle grades mathematics. During the middle school years, students are taught the mathematics of rational numbers and the operations of multiplication and division. Although it would appear that rational numbers are simply a generalization of whole numbers and that multiplication and division are just more advanced concepts than addition and subtraction, the learning of these concepts is much more complex than the mathematics of primary grades. Psychologically, they require the difficult process of reconstructing mental structures. Unfortunately, most students progress through the middle school grades without developing these mathematical concepts (Hiebert & Behr, 1988). In order to provide instruction that will confront the student with the need to re-construct their concepts, teachers need to understand the developmental process for each concept and must be able to assess the students' developmental stages in order to provide appropriate instruction (Fuson, 1988). Rather than waiting for students to make the transition from concrete to formal operational reasoning, many mathematical concepts can be taught and learned at a concrete level (Kloosterman & Gainey, 1993).

With the development of the Van Hiele levels of geometric understanding, middle school teachers have a framework by which necessary and appropriate geometry instruction can be selected, designed, and implemented (Geddes & Fortunato, 1993). Similarly, we now have a better understanding of how students develop algebraic concepts and which algebraic concepts can be effectively constructed by the middle school student (Wagner & Kieran, 1989). The research on the learning of mathematics should inform teachers as they make decisions in the classroom. Therefore, in the course of their undergraduate education, prospective middle school teachers should learn about this research and its use in the classroom.

Knowledge of School Mathematics. Middle level mathematics is important in the overall scheme of things, yet it has been criticized as a curriculum standing still. Very little new material has traditionally been covered in the course of grades five through eight (Flanders, 1987; NCTM, 1989). The NCTM *Curriculum and Evaluation Standards* attempted to address this problem by emphasizing the need to introduce pre-algebra and function concepts earlier in the curriculum.

It is important for university faculty to be aware of how the changes called for by NCTM have been interpreted and extended by these curriculum developers. University faculty need to know what their students will be expected to teach and how they will be expected to teach it. Teacher preparation programs should reflect these expectations. It is better to improve rather than repeat mathematics education (National Research Council, 1989).

A familiarity with the future middle school curriculum is, however, only a beginning. The next and most important step is to decide on the mathematical background desired for the teachers of this curriculum. Teachers need knowledge and understanding considerably deeper than what they are required to teach (Leitzel, 1991). They need to know how the mathematics builds on itself so they know what to emphasize in their classrooms (Hilton, 1994). The problem of identifying the nature of the mathematics needed by middle school teachers was the driving force behind NSF’s initiative to fund Middle School Science and

Mathematics Teacher Preparation Projects (Stake et al., 1993). The insights gained from these experiences should be useful in designing new programs.

We can also learn from the collective lessons of past experience. In its design, the MIDDLE MATH project addresses two criticisms raised in the *Teacher Preparation Archives*. First, in implementing any reform movement it is important to debate the issues, not to accept change blindly, and to look at underlying assumptions. This is why we felt that our program needed a national scope. Also, since all change is local, global models need to be adapted to the situation in home institutions (National Research Council, 1989; Stake et al., 1993).

In addition to the content and organization of preparation programs, it is necessary to understand how the undergraduate student learns. Research on how adults learn mathematics is now evolving (Ferrini-Mundy, 1994; Selden & Selden, 1993). Because of the changes in school mathematics, students entering college in the future will be different. The effects of these changes on the entering freshman and the implications these changes have for the undergraduate mathematics curriculum are currently being studied (Leitzel, 1993). One important difference will be students' greater knowledge and experience with technology. It is important to design the college curriculum carefully to take advantage of this new knowledge (Leitzel, 1991).

There is compelling evidence that existing teacher education programs will not produce the teachers with the knowledge and understanding necessary to teach the mathematics envisioned by the mathematics education community (Brown & Borko, 1992) or to handle the challenge of a diverse, multi-cultural population at the difficult stage of maturing emotionally, physically, sexually, morally, socially, and cognitively. We are compelled to reflect, study, and change our teacher preparation programs.

MIDDLE MATH Beginnings

MIDDLE MATH (1995-98) was an Undergraduate Faculty Enhancement Project funded by the National Science Foundation (DUE 9455152), the North Carolina Statewide Systemic Initiative, East Carolina University, and Texas Instruments. The MIDDLE MATH Project was designed to focus attention on improving the undergraduate preparation of teachers of middle grades mathematics.

The project started when, in the Spring of 1993, the East Carolina University's Mathematics Education faculty set as a goal the redesign of their program for preparing middle grades teachers of mathematics. A group of faculty from the Mathematics and Mathematics Education areas formed a task force to develop a longitudinal plan for improving the middle grades program. The Math Department provided funds to support a seminar series on improving the undergraduate preparation of teachers of mathematics. In addition to presenting a colloquium, each consultant met for several hours with the department's middle grades task force. The areas discussed with the consultants included the mathematics content, pedagogy, and structure of an improved preparation program for prospective middle school teachers of mathematics.

Based on the consultants' responses, the task force decided it needed much more input before it could comfortably set the design of a new middle grades program. The MIDDLE MATH project was thus conceived. The project reflects the needs identified by the task force: the commitment from additional mathematics and mathematics education faculty to participate in and collaborate on the project; a better sense of the changing content and pedagogical knowledge (reflective of the calls for reform) required to teach middle grades curricula; an increased familiarity with the experiential knowledge accrued by others who have set down this path; and an awareness of how the growing body of research on the teaching and learning of middle grades and undergraduate mathematics might impact a teacher preparation program.

MIDDLE MATH Goals and Objectives

The Middle Math project:

1. Supports the design of new models for the mathematics component of middle grades teacher preparation programs by providing an opportunity for university mathematicians and mathematics educators to:
    - learn about new and innovative middle school curricula that model and extend the NCTM *Standards*,
    - discuss the influences of middle grades curricula on teacher preparation programs with particular attention to content, pedagogy, technology, and management of a diverse student population,
    - analyze previous programs that addressed the issues of training middle school teachers,

- define the mathematics content preservice teachers should learn and how the content should be structured and taught,
- explore how changes advocated by the NCTM and the MAA should effect teacher preparation programs,
- review the research on teaching and learning of middle school mathematics and identify the resources that prospective teachers will need to continue their education as practicing teachers, and
- reflect on the changes in the undergraduate learner as a result of changes in the curriculum in the schools and anticipate the effect of the changes on college instruction.

2. Facilitates the development of working relationships between colleagues to support individual and team efforts to make program changes.
3. Encourages the implementation of these programs by:
   - providing support networks;
   - informing participants about funding sources for curriculum development;
   - sharing the curriculum implications of research on the teaching and learning of undergraduate mathematics.

The project was divided into five phases: recruitment and preparation, first summer conference, academic-year curriculum development, second summer conference, and dissemination.

Recruitment and Preparation

With the addition of new members, the task force became the MIDDLE MATH Advisory Board. Comprising the board are three mathematicians, a statistician, and five mathematics educators on the faculty of East Carolina University. During the spring semester of 1995, the board met twice a week, exploring a variety of ways to facilitate revision of the undergraduate preparation program for teachers of middle grades mathematics. They read and discussed documents from the various mathematical organizations calling for reform, reviewed the publications proposed as background reading for conference participants, and met with middle grades mathematics teachers to discuss their recommendations for changing undergraduate teacher preparation. They generated discussion questions and wrote reflections on the discussions they had. This shared interaction helped the advisory board design "homework" for MIDDLE MATH participants and refine the first conference agenda.

The recruitment phase was important for raising a national consciousness of the problem, as well as increasing the likelihood of participation of women, underrepresented minorities, and persons with disabilities. Notices were sent out. Nationally (that is, excluding North Carolina), the project received approximately one hundred applications from sixty-two different institutions. Of them, twenty-four people were accepted as paid participants (six others were invited and paid their own expenses). The chance to participate, therefore, was roughly one in four.

A natural diversity of perspectives for program development was encouraged by giving preference to collaborative teams (for example, mathematicians and mathematics educators from the same institution or faculty from a university and feeder two-year college). In order to maximize the project's potential impact, a high priority was put on local collaborations—the momentum for change is greatly enhanced when several of those involved understand and appreciate the unique level of peculiarities at a given college or university. (Recognizing this, the North Carolina Statewide Systemic Initiative supported the participation of faculty from universities, colleges and community colleges in North Carolina).

Out of the thirty-two applications from North Carolina, twenty-nine were accepted as participants representing fifteen different institutions. Because of the large number of applications, only sites with two or more applicants from outside of North Carolina were included. Selections were also based on the quality of the responses to the open-ended questions on the application.

The project's fifty-nine participants included representatives of four-year institutions empowered by their states to prepare teachers of middle level mathematics for certification or endorsement, and four participants from two-year feeder colleges (with mathematics courses that transfer into the middle grades level mathematics programs of the four-year institutions). Participants included research, teaching, and administrative faculty. The mathematics faculty included both pure and applied mathematicians as well as statisticians. The mathematics education faculty included faculty actively pursuing research on the teaching of mathematics, the learning of mathematics, and/or the design of curricula to support the teaching and learning of mathematics.

Once selected, participants prepared for the first summer conference by

1. reviewing the National Council of Teachers of Mathematics (NCTM) *Curriculum and Evaluation Standards for School Mathematics* for grades 5-8 and the Mathematical Association of America (MAA) recommendations for changing the nature of the mathematical preparation of the middle grades teacher, *A Call for Change,*
2. reviewing and reflecting on *Teacher Preparation Archives: Case Studies of NSF-Funded Middle School Science and Mathematics Teacher Preparation Projects, 1986-91* which offered some insight into what nationally recognized work has already taken place in teacher preparation,
3. considering the nature of college mathematics that the middle grades teacher should experience as reflected in the text *On the Shoulders of Giants*, and
4. interviewing a middle grades teacher to ensure that teachers' input and viewpoints would be heard and incorporated into the process even though middle grades teachers would not be present at the conferences.

The five bi-weekly "homework" assignments the project sent to participants included suggested readings, a set of focus questions, and a journal assignment. This shared knowledge base would be used as a foundation for discussions at the MIDDLE MATH conferences.

Participants also gathered information on their state's requirements and guidelines for the preparation of middle grades mathematics teachers, their state's current curriculum for middle grades students, and their own current programs and courses for preparing middle grades teachers. This information was shared at the first summer conference so that participants could compare their current middle grades teacher preparation program with other programs and program models.

The First Summer Conference

The MIDDLE MATH First Summer Conference was held from August 2–6, 1995 at East Carolina University in Greenville, North Carolina. The conference provided an opportunity for participants to look back at their own programs after reviewing five NSF-funded Middle School Mathematics Teacher Preparation Projects (1986-1991), and to look ahead to the changing needs of future middle-level mathematics teachers and the changing nature of the mathematical background, modes of instruction, and assessment methods of the high school graduate.

A Look Back: Voices of Experience

The successes and failures of the NSF-funded Middle School Mathematics Teacher Preparation Projects should inform any new attempt at designing teacher preparation programs. Therefore, the Middle Math Project invited representatives from these projects to speak at the first conference. Jane Swafford from Illinois State University, James Choike from Oklahoma State University and Michael Shaughnessy from Portland State University were able to attend, sharing activities and speaking about their projects. They gave brief overviews of their programs and talked about what had gone well, what had not, and the changes they made in their programs and courses (from those proposed in the original NSF grant) to keep a successful and viable middle grades mathematics program thriving at their institutions. Each offered experientially-based suggestions on how to begin to design or redesign such programs at other institutions.

Middle School Math Program: Illinois State University
Jane Swafford

The *Middle School Math Program* has evolved since its NSF-project funding. Consisting of 30 semester hours of mathematics (including 18 hours mandated by the state that every elementary education major must take in either reading, writing or arithmetic), the program requires courses in problem solving, probability and statistics, and calculus as well as a capstone modeling-course—all specifically designed for the K-8 teacher.

Swafford discussed a variety of assessment tools used throughout the program at Illinois State, describing, in particular, many of the alternative assessment ideas she has experimented with in her elective course on Modern Algebra. Three of these stand out: first, using reflective journals as a vehicle for students to talk to the teacher about the troubles and successes they experience in a course. Students seemed to find writing much easier than coming up to the teacher's office to talk about the course. Second, Swafford advocated the use of portfolios. For her Modern Algebra portfolio, she had students submit four pieces, one for each of the NCTM *Standards* processes: problem solving, communication, reasoning, and mathematical connections. For the connection piece, students had to write an essay about the connection between modern algebra and K-8 curriculum. “While they would not believe me [at first],” Swafford comments, “what they find is amazing to them. When they write this essay, and many of them do a detailed analysis of the K-8 textbooks, they come back saying ‘It's all the way through this’.” The students end up with a real understanding of why they have spent time learning Modern Algebra. Perhaps, they see how the mathematics builds on itself so they know what to emphasize in their classrooms (Hilton, 1994). The value of reflection is in helping students make connections between what they observe in classrooms, what they read, and what they believe.

Swafford’s advice to those redesigning their middle grades program: first, be very cognizant of state requirements in designing a program. Once the program is established, she recommends recruiting heavily—use posters, visit prerequisite classes, put advertisements in the student newspaper, hold informational forums in the evenings, and send letters to students with high grade point averages and undeclared majors. Their selling point: “If you want a good job, have a concentration in mathematics.” Her one caution was to rethink the pedagogy in mathematics courses. Each of the courses in the program was developed with a mathematician and a math educator. She warned against mathematicians going it alone. Involve math educators in the development of each course. The partnership between educators with these two backgrounds is necessary and powerful.

DIRECT: Oklahoma State University
James Choike

Jim Choike, of the DIRECT project at Oklahoma State, espoused a different philosophy, feeling that you should not design mathematics courses especially for middle grades teachers. Rather, you should design good (interactive and problem-centered) mathematics courses that could be taken by any math major. This philosophy grew out of the NSF grant to Oklahoma State to design both a science and mathematics program for middle grades teachers. The science part of the program, with its specialized courses that no one wanted to teach, no longer exists, while the mathematics part is thriving. Also contributing to his philosophy is his firm belief that those preparing to teach mathematics need to see and learn mathematical content in the same way that people are going to do mathematics. The strong and rigorous mathematical content of the DIRECT program reflects these beliefs.

Choike spoke about the difficulties of creating a new program, mentioning the various stakeholders, all with criteria to be satisfied: individual faculty, departments (mathematics and curriculum and instruction), college (Arts and Sciences and Education), and, of course, state Departments of Education. He told stories of faculty who would not participate due to a lack of professional incentive in departments where only research is valued, or fearful of losing their pet course. He emphasized the need for extensive pre-planning, unilateral faculty and administrative involvement, and especially, building consensus.

Choike echoed Swafford's belief regarding the importance of giving prospective middle grades teachers a consistent model for teaching. He was greatly troubled that while all the new mathematics courses in the program embraced such inquiry-based instruction (that is, learning-by-discovery teaching methods), the majority of courses taken by the students in the program were lecture-based. He felt these frustrated students, creating a concern needing to be addressed in DIRECT, as well as any middle grades mathematics program. His last bit of advice was "when you are designing programs, ownership is a key word." The more ownership you have invested in a program, the more you will invest in seeing it continue.

Middle School Math Project: Portland State University
Michael Shaughnessy

Because of the characteristics of Portland State, the middle grades program developed there differed from the others described at the conference in three significant ways. First, all of the courses emphasized visual thinking as an important tool for doing mathematics. The Math Learning Center housed at Portland State, a not-for-profit math education company, has developed K-8 curriculum materials emphasizing visual thinking and has established extensive professional development programs. Second, the people who worked on the *Middle School Math Project* were also working on curriculum development at the Center at the same time; Shaughnessy observed that this led to "very, very dramatic" cross connectors between these two projects. As with the other projects creating teacher preparation programs, discussion within a community of scholars was key to successfully developing the program. Third, because of the in-service programs at the Center and the urban location of the university, most of the students in the middle school math program are already teachers working part-time on a masters degree, obtaining a middle school certificate or an endorsement in math. Although all of the courses in the program are colisted as undergraduate courses, most of the students are graduate students.

Prior to this program at Portland State, middle school teachers were taking courses with secondary teachers, finding them very inappropriate for their needs. All eight courses in the program have “for Middle School Teachers” in their title (e.g., Concepts of Calculus for Middle School Teachers). They include Computing in Mathematics, Experimental Probability and Statistics, Problem Solving, Geometry, Arithmetic and Algebraic Structures, Historical Topics, and a methods course. The courses, all taught in the mathematics department, run cyclically, and students can start the program with any one of them.

Program courses include no lectures, centering instead on small-group problem solving. Visual models are heavily used. Shaughnessy feels so strongly about the need to emphasize visual thinking that he wants visual models included in the list of multiple representations used in mathematics (along with tables, graphs and symbols). In addition to students “discussing and listening to how others think, and sharing different approaches to problems” in class, the program strongly emphasizes a writing component. Students are encouraged to write about how they got to solutions of problems or how they thought about a problem. Shaughnessy describes passing a folder of work back and forth between student and teacher. The students write, the teacher comments on their writing, and then the students respond. To be able to engage in a reflective analysis of one’s thinking processes is one of the program goals. In all of these courses, students are asked to write comments on their own growth and development several times throughout the course. They talk about things they are learning, things they are stuck on, and things they still need to do.

Conclusions from *A Look Back*

In comparing the preparation programs for teachers of middle grades mathematics developed at these three universities, one is struck by some key similarities. Most obvious is the need to change from lecturing to a more interactive and problem-centered mode. All three speakers emphasized the crucial nature of a cooperative learning environment based on a constructivist philosophy. They seek to model the type of teaching they expect their students to use in the middle grades classroom. Secondly, collaboration and cooperation between mathematicians and mathematics educators in creating courses enriches the courses and programs in ways far greater than may be expected. Third, because programs differ primarily based on the individual needs of the schools, departments or personnel involved, each program must emphasize the strengths of the university where it is developed.

Conference participants benefited from interactions with the speakers in several ways. Some found confirmation of ideas they already held, glad to find their current or proposed program in line with the ideas of others. Some found new ideas they had not tried before, some precisely what they were looking for in their program (e.g., the calculus materials developed at Portland State were mentioned several times). Resources were freely shared, from course guides to modeling problems. Discussions of anticipated difficulties in designing a program and ways to cope with them were sought out. The speakers interacted with the participants throughout the conference.

Striking were the differing views of mathematics which we hold. One speaker emphasized the visual; another the need for rigor; another the creative nature of mathematics. One speaker believed the preservice teacher's attitude toward mathematics is the most important thing to be molded in a preparation program. Another commented that to be a facilitator in a mathematical discussion or to teach mathematics on an as-needed basis, the preservice teacher needs a depth of mathematical knowledge; yet another preparation program is remarkable for its breadth of mathematics. To design an effective teacher preparation program, it seems we need to air our views of mathematics and, where possible, come to a consensus upon what to base the program. The MIDDLE MATH Project offered everyone involved an opportunity to engage in this debate.

NSF-funded Middle Grades Mathematics Curricula

In addition to benefiting from these speakers' insights, conference participants spent a significant portion of their time actively introduced to the five NSF-funded Middle Grades Mathematics Curricula then under development (*Connected Mathematics, Mathematics in Context: A Connected Curriculum for Grades 5-8, Middle-School Mathematics through Applications Project, Seeing and Thinking Mathematically Project,* and *Six Through Eight Mathematics*). With the NCTM *Standards* as a starting point, they offer five different possibilities for the middle school curriculum in the twenty-first century.

Prior to the conference, each NSF-funded Middle Grades Curriculum Project wrote a paper answering "What are the characteristics of a preservice program that would prepare teachers to implement your curriculum effectively?" Their responses were to center around the themes of *Knowledge of Mathematics, Knowledge of School Mathematics, Knowledge of the Teaching of Mathematics, Knowledge of the Learning of Mathematics,* and *Knowledge of the Learner of Mathematics*. These themes set by the advisory board recurred throughout the first conference, curriculum development and subsequent presentations on it at the second conference, and in the projects' evaluation materials. Establishing these five areas as a way to look at the needs of preservice teachers enabled all involved to delve deeper into how to structure a program to meet these needs. Each project's written responses were given to the conference participants at the end of its workshop. Details of some of the unique features of these curricula and the implications they have for preparing teachers for their implementation are provided later as Part I of this monograph.

On the third day of the conference, participants divided into working groups of about five persons each, discussing for two hours issues raised by their interactions with the new middle school curricula. The morning concluded with a panel discussion. The panel, comprised of the representatives from the five middle grades projects, reacted to questions on the implications of their curricula on changing university programs for preparing middle grades teachers. Discussed was the need for teachers to have a deep mathematical understanding in order to make connections between mathematical concepts and the activities and problems in the curricula. Also discussed were the implications of progressive mastery, alternative assessment, the need to understand student thinking, and the need to be more reflective as a teacher. Lesson plans need more flexibility to deal with starting and stopping breaks, and the whole learning environment in which preservice teachers are taught mathematics needs to be more active. Through the panel discussion, participants heard and reacted to developers' perspectives on how curriculum change should affect teacher preparation.

In the afternoon, participants returned to their working groups. This time the goal was to arrive at a plan for what they would attempt to do to improve the middle school teacher preparation at their home institutions. The representatives from the NSF-funded Middle School Mathematics Teacher Preparation Projects (1986-1991) participated in these working groups. Discussion began by brainstorming a wish list for an ideal middle grades mathematics teacher preparation program, initially assuming no institutional or collegial barriers. Participants discussed the input they received from their interviews with middle grades teachers, and then shared those aspects of their existing programs that they felt were already in line with their changing goals and directions. They also suggested new courses or modifications in existing courses that they would like to see. By the final morning of the conference, the working groups had re-formed around areas of common interest, including courses to be worked on (e.g., Algebra and Modeling) or networking options (e.g., North Carolina schools). Participants soon designed skeletons of new course syllabi for the courses they were proposing to develop during the following academic year and outlined a tentative model of what the middle grades teacher preparation program should look like at their institution.

After a report to the large group from each of the working groups, the conference closed with a panel presentation offering three reflections on the conference proceedings. Robert Bernhardt spoke from the perception of a mathematician, Sunday Ajose from that of a mathematics educator, and Ann Hutchens as a middle grades specialist. These members of the project's advisory board reminded participants that some of the responsibility for the success of reform must be placed on students as well as educators, that we have yet to develop a model for training facilitators of learning, and that we must take the needs and characteristics of the young adolescent learner into account. They provided closure by looking back at their own experiences during the conference and looking ahead to the goals and directions for the remainder of the project.

Academic-Year Curriculum Development

During the academic-year (1995-96) of curriculum development, each MIDDLE MATH participant was expected to revise or develop both a model for the middle grades teacher preparation program at their institution and at least one course to be used in the preparation of middle grades mathematics teachers.

The AMTE bulletin board provided a vehicle to allow MIDDLE MATH participants to use electronic mail to maintain *across the hall* collegial relationships in which they could raise issues, ask specific nitty-gritty questions, make comments, and share working papers.

In addition to the AMTE bulletin board keeping participants loosely connected and informed as to what others were doing, participants were sent a newsletter summary of how some were progressing with the tasks they undertook as participants in the MIDDLE MATH Project.

This information came from the status report participants were asked to file, which answered the following questions:

1. How have you revised or developed a middle grades program for the preparation of mathematics teachers at your institution?
2. What course(s) are you modifying or developing and testing to fit into this program? How are you progressing with the course(s)?

Participants were expected to make presentations on their efforts to improve their middle grades teacher preparation programs at the second MIDDLE MATH conference.

Second Summer Conference

The MIDDLE MATH Second Summer Conference was held from June 7–9, 1996 at the Best Western Hotel in the Research Triangle Park and the Friday Center of the University of North Carolina at Chapel Hill. The second conference served as a working-meeting in which participants shared with each other the insights they had gained over the last year in trying to improve their middle grades math program for pre-service teachers. Therefore the same participants were invited back for the second conference. A total of 49 participants attended, 42 of whom had attended the First Summer Conference; the others were either replacements for participants who could not return or guests who attended at their own expense.

The second conference was designed to provide project participants with a catalyst for change. Participants were asked to prepare drafts of their proposed program models, course syllabi, and any related publications on which they were working. These were collected and distributed to the participants prior to the conference.

Participants were also asked to present information regarding the courses and programs they created and tested. Fourteen posters were presented at the conference. Poster sessions had a poster and handouts set up for two hours on the first day and a half of the conference. Groups of listeners would rotate through the posters every fifteen minutes so that the presenters could speak to each group about what they had done. Although the amount of time allotted to any one poster was short, participants got enough information to know who they wanted to talk to in greater detail later and received valuable handouts as well as some good project and activity ideas.

As an alternative to poster sessions, participants had two other options on how to present this material. The second option was a formal presentation of about 30 minutes. They could speak on the course(s) they had modified, the structure of their middle grades program, or a specific topic in teacher preparation that fit with what they had been working on. The third option was to facilitate or make a significant contribution to a "talk about" session on a variety of issues, including some that the participants suggested. Participants participated in three out of a possible nine of these "talk-about" discussion groups whose topics were: *Intra-University Collaboration and Other Political Issues*; *Changing Pedagogy*; *Data Analysis, Statistics and Probability*; *Field Experiences*; *Number/Algebra/Pre-Calculus/Calculus*; *Math Modeling/Discrete Math/Geometry*; *Alternative Forms of Student Assessment*; *Technology*; or *Math Methods Courses*.

In addition to the presentations by conference participants, two keynote speakers shared their insights—Lee Zia from the National Science Foundation, Division of Undergraduate Education, and Joan Ferrini-Mundy, Director of the Mathematical Sciences Education Board, National Research Council. Zia addressed the issue of funding; he talked about the nature of the NSF, how to write a grant proposal, gave examples of currently funded grants, and cited the existing sources of funding supporting the development of new curricula. This information gave participants insight into opportunities that future NSF funding may provide for improving the undergraduate preparation of teachers of middle grades mathematics.

Ferrini-Mundy spoke as a member of the faculty of the University of New Hampshire on *The Preparation of Teachers of Mathematics: Considerations and Challenges*, which is the title of a letter report from MSEB that she helped produce. First, she questioned the subject matter of teacher preparation and how we might view the intersection of mathematics and pedagogy. She suggested that we are engaged in the study of mathematics teaching problems. Teacher educators could use proxies for middle grades classrooms, such as video tapes, case studies, middle grades teachers' journals with classroom episodes, new middle grades curriculum materials, or actual middle grades classrooms with a change of focus to study with their preservice teachers how to manage the dilemmas that arise when teaching mathematics, to study mathematics in the context of teaching problems. She went on to challenge the assumptions on which we have based reform and offer questions that need to be further researched: Do we know if teachers teach as they were taught? How are real world experiences in industry or scientific studies beneficial for prospective teachers' future teaching? Given all of the different prevailing views about mathematics education, how do we position teachers to effectively defend and articulate to parents what they're trying to do? The issues and challenges she highlighted provided considerable discussion and food for thought.

Working groups were established to help participants review and refine their products. With the information provided them on sources for externally funding the development of their proposed curricula, and ways to use research on the learning of undergraduate mathematics to support and inform their curriculum development efforts, participants were encouraged to continue their reform efforts. Some participants were additionally provided travel support to share their efforts with others at professional meetings.

The conference closed with reports and summaries of the talk-about session and a small group discussion of the content and format of the MIDDLE MATH monograph. The monograph is divided into three parts. Part I includes abstracts prepared by the five NSF-funded Middle Grades Curriculum Programs and a statement concerning the changes that will need to be made in our undergraduate programs to prepare teachers to implement the new curricula.

Rather than summarize the participants' sessions for the monograph, we gave participants the opportunity to write a case study for their institution in which they highlighted some of the ways they were attempting to improve the preparation of teachers of middle grades mathematics. Participants submitted proposals and thirteen *cases* were selected based on the size and type of program involved. Part II consists of the case studies from these MIDDLE MATH colleges and universities. Each case study provides some detail on the nature of the institution, the program they have for preparing middle grades mathematics teachers, the accomplishments they have made in improving their program, and the challenges and issues that remained at that time. A *Case Study Matrix* is provided to help the reader locate which cases address specific topics of interest. Collectively, the case studies provide a series of snap shots of the initial efforts made by colleges and universities to change the way they prepare teachers for the middle grades mathematics classroom. While the universities have no doubt moved on from these initial efforts, the cases can be used to measure your own university's initial change efforts.

Finally, Part III provides individual participants' perspectives on some of the issues that emerged during the *talk about* sessions. These papers may serve to facilitate discussions regarding issues related to improving the methods and mathematics courses used in the preparation of teachers of middle grades mathematics. Other topics include the way the programs of study and individual courses prepare teachers for the diversity of their learners, address alternative forms of assessment, and model the implementation of technology to enhance mathematical learning. The monograph closes with one participant's reflective examination of the assumptions we make and our need "to keep exploring, listening, thinking, and studying our assumptions."

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