Preface

Over the past decade there has been increased focus on the mathematical preparation of teachers at all levels as one of the main tools in improving mathematics education in this country. The mathematical knowledge of teachers arguably involves not only solid procedural and conceptual mastery of key mathematical processes and phenomena, but also understanding how mathematics content fits into and extends the school curriculum. In their coursework and professional development, teachers need to experience the process of learning and doing mathematics: experimenting, conjecturing, justifying, generalizing. and struggling. Teachers also need to experience consistently the beauty and power of mathematics.

Middle school mathematics teachers occupy a unique place in the mathematical development of students. These teachers need to be proficient in all elementary mathematics topics, together with some secondary mathematics topics. They demand a special kind of preparation that differs from both that of their elementary and secondary colleagues. *The Mathematics Education of Teachers* (MET) document published by the Conference Board of the Mathematical Sciences set forth criteria for the preparation of mathematics middle school teachers which made it critical that special programs and courses for this group emerge. All middle school teachers need to know the mathematics content for elementary teachers. In addition, in the strand of number sense and operation, middle school teachers need to be fluent with the number line model for the real numbers, proportional reasoning, and elementary number theory. They need to be able to distinguish among rational and irrational numbers and their representations. In the algebra strand, middle school teachers need to see algebra not simply as a generalization tool but also as a study of linear, polynomial, and exponential functions and as a body of techniques for equation solving. In the geometry strand, middle school teachers need to be proficient with transformational plane geometry, congruence and similarity, and connections of geometry to art and nature. They also need to be able to use a variety of strategies for developing and using formulas for areas of plane figures and volumes of polyhedra. In the strand of probability and statistics, middle school teachers need to experience the design and execution of a small statistics project, and get familiar with normal curves and sampling distributions, and the basis of inferential statistics. Some of the pedagogical techniques that facilitate the learning for middle school teachers are hands-on approaches, cooperative learning, effective classroom discourse, writing, and technology.

This collection of articles is in response to the MET document and the result of several gatherings of mathematics educators and mathematicians training middle school teachers. We, the editors of this volume, under the sponsorship of the Committee on the Mathematical Education of Teachers, organized two contributed paper sessions at the Joint Mathematics Meetings entitled "Content Courses for the Mathematical Education of Middle School Teachers" in 2007 and "Curriculum Materials for Pre-service Middle School Mathematics Teachers" in 2008. We invited participants from these two sessions as well as colleagues heavily involved in the mathematics education of middle school teachers to write articles on both programs and courses.

We have chosen the articles that appear in this volume for several purposes: to disseminate various middle school programs structures, to detail methods of teaching specific middle school teachers content courses, and to share materials and resources. While each article describes the unique program or course of its respective institution, each also includes a common core of information to provide some consistency to the volume. In particular, all articles describing middle school programs contain information about the host institution, a history of the program, degree and testing requirements for the program and for state licensure, learning goals and objectives for the program and courses, and any available assessment data. When applicable information is included about particular courses, for example, some articles provide sample activities or syllabi and some have a description of courses in the appendix. Most articles have links to websites containing further information about the program, courses, state requirements, or resources that can be downloaded and used directly.

Each article in the second half of the volume describing courses provides information on the history, purpose and learning objectives of the course. It also gives the structure and format of the course as well as a summary of the content and essential course elements. In addition, many contain or link to sample class activities, assignments, teaching notes, class projects, syllabi, assessment materials or dedicated course websites. The articles provide a rich set of readily available, classroom-tested resources.

We expect that the reader of this volume will be either a faculty member who is new to the teaching of courses for middle school mathematics teachers or a seasoned teacher of pre-service teachers who is interested in trying some new approaches and perhaps starting a middle school program at his or her institution. In either case, we hope that the reader find these expositions beneficial and stimulating.

Programs for Middle School Teachers

We begin this volume by showcasing several pre-service training programs. We asked each contributor in this section to incorporate as many components of the following outline into the description of their program as possible.

Core Program Paper Outline

    I. Instructional Information

        A. Size and location of school

        B. Student participation in the program

   II. Program History

        A. Intended audience

        B. Program beginning

        C. Background and philosophy of the program

  III. Degree Requirements

        A. State requirements (in appendices)

        B. Learning goals and objectives

            1. For the program

            2. For the courses

        C. Certification tests

        D. Courses requirements

            1. Mathematics courses

            2. Mathematics education courses

        E. Mathematics education courses

            1. Instructor information

            2. Course list specifically for middle school mathematics teachers

            3. Enrollment for these courses

            4. Syllabi links

            5. Activities

                a. Resources

                b. Connection to classroom

                c. Connection to program and course learning goals and objectives

  IV. Assessment

        A. Student reaction

        B. Student employment perspective

        C. Middle school administrators' reactions

        D. Student performance on required state examinations

        E. Retention in education

   V. References and links

Author responses

Angel Abney, Nancy Mizelle, and Janet Shiver discuss the collaborative effort of mathematics and education faculty at Georgia College and State University in delivering a successful program. Cheryl Beaver, Rachel Harrington, and Klay Kruczek show an example of a program built around the quarter system that is both rigorous and nurturing. Ira J. Papick focuses on the program at the University of Missouri; this program motivated the development of a series of middle school teacher curriculum materials centered on making connections between concepts in the middle school and the college classrooms. Finally, Jennifer Szydlik, John Beam, Eric Kuennen, and Carol Seaman describe the structure of the program for middle school teachers at the University of Wisconsin Oshkosh.

We then showcase several in-service teachers' programs. These articles illustrate how institutions have created effective, rigorous, in-service programs for middle school teachers even when faced with the many challenges resulting from the busy schedules and varying mathematical backgrounds of in-service teachers. Julie Belock shares experiences establishing the only middle school teachers' preparation program in Massachusetts. Ruth M. Heaton, W. James Lewis, and Wendy M. Smith discuss a mathematics institute for middle school teachers. M. Elizabeth Mayfield and Christy Danko Graybeal give an example of an effective professional development program for in-service middle school teachers in Maryland.

Courses for Middle School Teachers

The second part of this volume focuses on specific course descriptions and resources. We asked each contributor in this section to incorporate as many components of the following outline into the descriptions of their courses as possible

Core Course Paper Outline

   I. Introduction and Background

      A. Course history, development of course

      B. Course structure

      C. Prerequisite and enrollment information

  II. Course materials and resources

      A. Syllabi

      B. Teaching Notes

      C. Classroom materials

 III. Course structure and format

 IV. Course content

  V. Essential course elements (possible)

      A. Assignments

      B. Student Experiences

      C. Class Projects

      D. Assessment

 VI. References and links

VII. Appendices (possible)

      A. Table of contents for author written materials

      B. Assessment materials

Author responses

There are two approaches to discrete mathematics offered, one by Tanya Cofer, Valerie A. DeBellis, Cathy Liebars, Joseph G. Rosenstein, Bonnie Saunders and Margaret Wirth and one by Mary Flahive and Reva Kasman. Both articles

present a wealth of ideas of what such a course could involve. Bethany Noblitt describes her geometry course for middle school teachers with a variety of exciting activities and ideas. Michael Mays and David Miller write about their number theory course which is largely taught online, while Theresa Jorgensen focuses on pre-calculus and calculus ideas. Laurie Burton and Klay Kruczek present an intriguing way to teaching algebra with visual techniques. The University of Wisconsin Oshkosh group discusses a probability and statistics course. Finally, there are two articles on integrated courses: one by George Ashline and Marny Frantz about the Vermont Middle Level Mathematics Initiative, and one about a series of courses at the University of Nebraska Lincoln by Ruth M. Heaton, W. James Lewis, Michelle R. Homp, Steven R. Dunbar, and Wendy M. Smith.

It has not been our intention to write the definitive volume on how to teach mathematics to middle school teachers. Indeed, students can have successful learning experiences in many different types of programs. Included here are only a portion of the programs and courses that are now being developed. We hope, however, that the ideas contained in this volume will stimulate readers to think about programs at their own institutions and courses they could develop specifically for middle school teachers.

The editors would first of all like to thank the authors of the articles for their interest in the project and their patience throughout the editing process. Special thanks go to Professor Stephen B Maurer who has guided us through this entire process and to the entire MAA Notes Editorial Board, especially the unnamed members who were on our review panel, for their careful reading and valuable suggestions. We are grateful for the insightful evaluations done by the Notes Editorial Board as we worked to prepare a final document. We thank Beverly Ruedi and the rest of the production staff at MAA headquarters

We appreciate the continuing support of our institutions, Southern Connecticut State University, Western Oregon University and Worcester University. This project would not have been possible without the hard work of the folks at the Mathematical Association of America. With all this support and encouragement, we have been able to create a volume that will, we think, have an important impact on the mathematical education of middle school teachers.