

Oregon Mathematics Education Council

Recommendations¹ for the Mathematics Preparation of Teachers: Early Childhood, Elementary, Middle School and Secondary Mathematics Authorizations

June 2002

The Oregon Mathematics Education Council (OMEC) endorses the recommendations on the mathematics preparation of teachers made by the Conference Board of the Mathematical Sciences² (CBMS) and the Oregon Collaborative for Excellence in the Preparation of Teachers³ (OCEPT) and draws on these sources in presenting the following recommendations.

These recommendations are addressed to university, college, and community college mathematics departments whose courses are taken by future teachers. A companion document with recommendations for teacher education programs is under development by OMEC.

Recommendations Part I: Mathematics Department Characteristics

The college mathematics department has a responsibility to offer a mathematics program appropriate for the preparation of future teachers. The department should include the following characteristics and components:

- Regular communication and coordination with teacher education programs on mutual expectations for student learning and achievement in mathematics courses.
- Availability of designated advising staff for prospective teachers.
- Information readily available to mathematics majors on pre-professional programs leading to teaching – in the college or university catalog, departmental brochures, career seminars, and/or other outreach methods.
- Availability of a teaching option within the established mathematics major, a dual mathematics/education major, or a mathematics education minor or concentration.
- Instruction in mathematics and technology that is appropriate to the authorization grade level and subject matter endorsement for teacher certification.
- Opportunities for students to tutor other students in mathematics or visit K-12 classrooms (early field experiences) as a means of exploring teaching as a career.
- Active participation by mathematics students and faculty in a Future Teachers Club or similar interest group.

¹ Developed as a result of several years of focused discussion among teachers, professors, mathematicians and professional organizations.¹

² In 2001, the Conference Board of the Mathematical Sciences (CBMS) a consortium representing all the major mathematics and mathematics education organizations in the United States, released The Mathematical Education of Teachers. This report is compatible with the National Council of Teachers of Mathematics (NCTM) Principles and Standards for School Mathematics (2000) as well as other recent national reports on school mathematics.

³ In 1999, the Oregon Collaborative for Excellence in the Preparation of Teachers (OCEPT) National Science Foundation grant project developed its “Indicators for the Selection of Mathematics and Science Content Courses Appropriate for Future Teachers.”

Recommendations Part II: Characteristics of the Instructor

All mathematics faculty should demonstrate instruction that

- Takes students' prior knowledge into account when planning for instruction.
- Engages students interactively in instruction.
- Models thinking and study skills important for succeeding in the course.
- Models enthusiasm for student inquiry (exploration, conjecture, and proof) in content and learning.
- Promotes a sense that all students can succeed in the course.
- Emphasizes the value of science, mathematics and technology for all people of all ages.
- Advocates for mathematics education at all levels and the teaching profession in general.

In addition, the mathematics faculty teaching mathematics courses designed specifically for teachers should have specialized backgrounds and documented interest in K-12 education and current issues in mathematics education.

Recommendations Part IIIa: Mathematics Course Characteristics

The following characteristics are recognized as sound educational practice and are of particular benefit to future teachers in the classroom. The characteristics should be integral parts of most mathematics courses but not necessarily included in every course.

- Students engage in problem solving and inquiry and experience conceptual development through a variety of methods: hands-on activities, laboratory experiences, spreadsheets, and educational technologies.⁴
- Lecture portion of course closely coordinates with laboratory, discussion and/or recitation sections.
- Course content integrates relevant issues of mathematics, technology and society and helps students make connections across and within the disciplines.
- Where appropriate, course content links to fundamental ideas in mathematics as found in the K-12 curriculum.
- A variety of assessment⁵ methods provide feedback on instruction and student progress as well as the basis for course grades.

Courses including the above incorporate many national and/or state standards in their design. For more information, refer to CBMS Mathematical Education of Teachers, American Association for the Advancement of Science (AAAS) Benchmarks, National Council of Teachers of Mathematics (NCTM) Principles and Standards, and the Oregon Content Standards.

⁴ OMEC recommends that all educators study and utilize current research-based instructional methods such as those described in Mathematical Education of Teachers (CBMS), Adding it up (National Research Council), and How People Learn (National Research Council).

⁵ For example, The Assessment Standards for School Mathematics (NCTM) suggests: Assessment should enhance mathematical learning; reflect the mathematics that students should know and be able to do; promote equity; be an open process; promote valid inference; and be a coherent process.

Recommendations Part IIIb: Mathematics Course Content⁶

The mathematical knowledge needed by teachers at all levels is substantial yet often different from that required by students pursuing other mathematics-related professions.

1. Prospective teachers need mathematics courses that develop a deep understanding of the mathematics they will teach.
 - Learning how fundamental mathematical principles underlie classroom practice enables prospective teachers to teach mathematics to diverse groups of students as a coherent, reasoned activity and to communicate an appreciation of the elegance and power of the subject.
 - Prospective teachers need to develop a thorough mastery of the mathematics in several grades beyond the grade levels they will be endorsed to teach as well as the mathematics in earlier grades.
2. While the quality of mathematical preparation is more important than the quantity, ... the following [are] recommendations for the amount of mathematics coursework for teachers.
 - Prospective early childhood and elementary grade teachers should be required to take at least 9 semester-hours of mathematics courses on fundamental ideas of elementary school mathematics.
 - Prospective middle grade mathematics teachers should be required to take at least 21 semester hours of mathematics that includes at least 12 semester-hours on fundamental ideas of school mathematics appropriate for middle school teachers.
 - Prospective high school teachers of mathematics should be required to complete the equivalent of an undergraduate major in mathematics that includes a 6-hour capstone course connecting their college mathematics courses with high school mathematics.
3. Courses about school mathematics should focus on a thorough development of basic mathematics ideas. All courses designed for prospective teachers should develop careful reasoning and mathematical ‘common sense’ in analyzing conceptual relationships and in applied problem solving.
 - Attention to broad and flexible applicability of basic ideas and modes of reasoning is preferable to superficial coverage of many topics.
 - Prospective teachers should learn in a coherent fashion that emphasizes the interconnections among mathematical theory, procedures and applications.
 - Prospective teachers should learn how basic mathematical ideas combine to form the framework on which a curriculum is built. (For example, the ideas of number and function, along algebraic and graphical representation of information, form the basis of most high school algebra and trigonometry.)
4. Along with building mathematical knowledge, mathematics courses for prospective teachers need to develop the habits of mind of a mathematical thinker and to demonstrate flexible, interactive styles of teaching⁷.

⁶ These four course content recommendations are based on Chapter 2 “Mathematics Curriculum and Instruction for Prospective Teachers” of The Mathematical Education of Teachers, CBMS, 2001. Supporting material has been slightly modified in this summarization. Chapters 3-5 of the CBMS report give recommendations for mathematics courses for prospective teachers at different grade levels. Chapters 10-12 develop these recommendations in greater detail.

- Mathematical thinkers search for patterns of all types (including the identification of attributes like linearity, periodicity, continuity, randomness, and symmetry). Mathematical thinkers take actions like representing, experimenting, modeling, classifying, visualizing, computing, and proving.
- In demonstrating flexible, interactive teaching, prospective teachers need to learn to look at problems from multiple points of view and to ask good questions (as well as get right answers).
- Most of all, prospective teachers need to learn how to learn mathematics.

For more information:

For more information about OMEC go to <http://www.omec.org>

For more information about CBMS go to <http://www.cbmsweb.org>

The Mathematical Education of Teachers is available through <http://www.ams.org/bookstore>

⁷ Results of international studies, such as Stigler and Hiebert's *The Teaching Gap* [Free Press, 1999], indicate that U.S. school instruction places a comparatively low priority on engaging students to develop an understanding of mathematics. To foster more of this activity in schools, prospective teachers need to experience such instruction in their college mathematics classes and to learn that there are multiple ways to engage students in mathematics.