

How Well Are Secondary Mathematics Teacher Education Programs Aligned with the Recommendations Made in *MET II*?

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Introduction

For many years the mathematics community has been concerned with how best to prepare school mathematics teachers [1], [2], [3]; the most recent set of recommendations for the mathematical preparation of teachers appeared in *The Mathematical Education of Teachers II* [*MET II*, 4]. As noted by Ferrini-Mundy and Graham [5], over the years questions have been raised, not just about the nature and extent of the mathematics courses required

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by teacher education programs, but also about the integration of mathematics and pedagogy, and who should have a voice in making decisions about the preparation of mathematics teachers.

Until recently, little research has been done that examined the requirements of mathematics teacher education programs or the effects of these requirements [6], [7]. In this article, we report results from a national survey of secondary mathematics teacher education programs. The survey investigated a number of questions related to the preparation of secondary mathematics teachers and several reports are in progress.¹ Specifically, we address the question: How do current secondary mathematics teacher education program course requirements align with the recommendations described in *MET II* [4]? In particular, we report on the extent to which current teacher education program course requirements are aligned with

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parts ii and iii of *MET II*'s Recommendation 2 (i.e., the course recommendations for middle and high school mathematics teachers).

Recommendation 2. Coursework that allows time to engage in reasoning, explaining, and making sense of the mathematics that prospective teachers will teach is needed to produce well-positioned beginning teachers. Although the quality of mathematical preparation is more important than the quantity, the following recommendations are made for the amount of mathematics coursework for prospective teachers...

ii. Prospective middle grades (5–8) teachers of mathematics should be required to complete at least twenty-four semester-hours of mathematics that include at least fifteen semester-hours on fundamental ideas of school mathematics appropriate for middle grades teachers.

iii. Prospective high school teachers of mathematics should be required to complete the equivalent of an undergraduate major in mathematics that includes three courses with a primary focus on high school mathematics from an advanced viewpoint. [4, pp. 17–18]

Procedures

In November 2012 we sent, via email, a survey link to contacts at 400 secondary school mathematics teacher education programs in the United States; the sample was stratified based on the institutions' Carnegie classification (i.e., Bachelor's, Master's, or Doctoral). In some institutions, contacts were in mathematics departments; at others, they were in departments or colleges of education.

Two questions from the survey asked about the type and size of the programs offered at the institution. One asked if the program(s) offered were middle grades only, high school only, or combined middle school and high school. Another asked which type of program (in cases where there were multiple programs) graduated the largest number of pre-service secondary mathematics teachers; detailed data were collected only for the institution's program graduating the largest number of pre-service teachers. The survey also asked questions about three categories of courses that are related to the *MET II* recommendations: (a) mathematics courses (e.g., Linear Algebra), (b) mathematics courses primarily designed for teachers (e.g., Algebra for Teachers), and (c) mathematics education courses (e.g., Teaching Middle School Mathematics). For each category, respondents were asked to select required courses from a given list, to name any additional courses in each category, and to state the total number of courses and credits for each course type. We received valid responses from one hundred thirty-one programs in forty-two states. These programs produced from one to fifty-one graduates per year during the last three years, with a mean of nine graduates and a median

of five graduates per year; seventy-five percent of the programs awarded a Bachelor's degree. Among eighty programs that provided responses to the questions about specific course requirements, two were middle grades only, sixteen were high school only, and sixty-two were combined middle and high school programs.

Results

Middle Grades Recommendations

For the analysis reported in this section, we used the data from sixty-four programs (two middle grades only and sixty-two combined middle and high school programs) to examine alignment with *MET II*'s recommendations for middle grades programs. All sixty-four programs that reportedly prepare middle grades only or middle and high school teachers together in their largest program met *MET II*'s recommendation of at least twenty-four required semester-hours of mathematics. On average these programs required thirty-six semester-hours of mathematics courses at the level of pre-calculus or higher.

Mathematics for teachers. None of the programs reported requiring *MET II*'s recommended fifteen semester-hours of courses designed for middle grades teachers. The maximum number of required credits reported by any program was twelve semester-hours (four programs) and the average number of required credits of this type was three. Most commonly required in this category were Geometry for Teachers (thirteen programs), Statistics and Probability for Teachers (four programs), Algebra for Teachers (three programs), and Capstone Course for Teachers (fifteen programs). *MET II* also recommended six semester-hours related to Number and Operations; however, such courses were almost nonexistent in the programs responding to our survey.

Additional mathematics courses. *MET II* called for at least nine semester-hours of other mathematics courses "carefully selected from mathematics or statistics department offerings that are both useful and accessible to undergraduates in the institution's middle-level teacher education program" (*MET II*, p. 47). All sixty-four programs met this requirement of nine additional credits of advanced mathematics. Specifically, *MET II* recommended that these other mathematics courses should be selected from among introductory statistics, calculus, number theory, discrete mathematics, history of mathematics, and modeling. Table 1 indicates the percentage of programs that required each of these courses. Most programs that prepare middle school teachers required them to take calculus, statistics, and discrete mathematics. However, few required them to take the other three courses recommended by *MET II*.

Middle grades methods courses. *MET II* recommended two middle grades-focused methods

Table 1. Mathematics Courses Recommended in MET II for Middle School Teachers that Are Required in Programs Preparing Middle Grades Teachers

Course	Number of Programs	Percentage of Programs ($n=64$)
Calculus	63	98%
Probability and Statistics	58	91%
Discrete Mathematics	45	70%
Number Theory	22	34%
History of Mathematics	12	19%
Mathematical Modeling	9	14%

courses for programs preparing middle grades mathematics teachers. Although the average number of mathematics methods courses per program was 1.8, only sixteen (twenty-five percent) of the programs required a course whose title indicated explicitly that it was for middle grades and no program reported requiring two such courses.

High School Recommendations

For the analysis reported in this section, we used the data from seventy-eight programs (sixteen high school only and sixty-two combined middle and high school programs) to examine alignment with *MET II*'s recommendations for high school programs.

Specific mathematics courses. *MET II* recommended three specific mathematics courses or sequences of courses for programs preparing high school mathematics teachers: (a) a three-course calculus sequence, (b) an introductory statistics course, and (3) an introductory linear algebra course. Of the seventy-eight programs that reportedly prepare high school teachers in their largest program, sixty-three (81 percent) required a three-course calculus sequence; the mean number of calculus courses across the programs was 2.8. Sixty-nine programs (88 percent) required at least one probability and/or statistics course; it is not possible to separate the statistics courses from

the probability courses given the combined course title offered for selection in the survey. Almost all programs ($n=76$, 97 percent) required students to take at least one linear algebra course.

Other advanced mathematics courses. *MET II* recommended eighteen additional semester-hours of advanced mathematics beyond the calculus, probability and statistics, and linear algebra courses, including three courses (nine semester hours) focused explicitly on high school mathematics from an advanced standpoint. All programs satisfied the additional eighteen-hour requirement for advanced mathematics. Table 2 summarizes the frequency (in decreasing order) of these courses, including any courses represented in at least five programs.

Several programs reported that they offered special sections of mathematics courses for teachers; most common was a section of geometry designed for teachers required by thirteen programs (17 percent). Other courses with special sections for teachers included linear algebra, abstract algebra, discrete mathematics, probability and statistics, and reasoning and proof. Only eight programs (10 percent) reported meeting the nine semester-hours of high school mathematics from an advanced perspective.

Table 2. Advanced Mathematics Courses Required in Programs Preparing High School Teachers

Course	Number of Programs	Percentage of Programs ($n=78$)
Geometry	70	90%
Abstract Algebra	61	78%
Discrete Mathematics	52	67%
Reasoning and Proof	47	60%
Mathematics Capstone Course	36	46%
Differential Equations	27	35%
Number Theory	24	31%
Real Analysis	23	29%
History of Mathematics	14	18%
Mathematical Modeling	12	15%

Mathematics methods courses. *MET II* recommended methods courses focused on instructional strategies for high school mathematics rather than generic instructional methods. Almost all programs ($n=74$, 95 percent) required at least one mathematics-specific methods course; the mean number of mathematics methods courses per program was 1.8.

Summary and Discussion

This study provides data from a national survey sample about course requirements in contemporary secondary mathematics teacher preparation programs. In general, teacher preparation programs for middle school and/or high school met the recommendations of the mathematics community described in *MET II* for the number of hours of mathematics required. However, programs that prepared teachers for middle grades did not typically require students to take the number theory, history of mathematics, or mathematical modeling courses suggested by *MET II*; and both the middle school and the high school preparation programs generally failed to meet the recommended number of courses and/or semester-hours for courses designed for teachers to study K–12 school mathematics from an advanced perspective.

The small number of programs meeting the recommendations for mathematics courses designed for teachers to study school mathematics from an advanced perspective is disappointing, given that the earlier version of *MET* [3], published more than a decade ago also called for such courses. If those involved in secondary mathematics teacher education programs are committed to the goal of assisting future mathematics teachers to better understand school mathematics, much more work needs to be done toward creating and staffing such courses. Several challenges likely prevent development in this area. First, programs preparing small numbers of secondary mathematics teachers each year are challenged to justify staffing courses, particularly sections to serve only pre-service teachers. Second, not enough information has been shared or research conducted about such courses in order to better understand their effect on future teachers' content knowledge and mathematical knowledge for teaching.

Although the data used for this analysis proved useful for the goals of the study, several limitations are worth mentioning. First, much of the data used in the middle grades and high school analyses were, in fact, the same data because sixty-two of the seventy-eight programs prepare both middle and high school teachers. In fact, only two of the sixty-four programs examined in the middle grades program analysis were “middle grades only” programs. Therefore, sixty-two “combined middle and high school” programs were analyzed through two distinct, but closely related, sets of *MET II*

recommendations. Given that a large percentage of secondary mathematics programs are preparing teachers to teach both middle and high school mathematics, it seems that special consideration must be given to the unique demands of teaching the mathematics topics required at different levels; these differences must be given attention during program design and course development. Second, we cannot make claims about middle grades teacher education programs, in general, from our data because many middle grades mathematics teachers are not graduating from secondary mathematics teacher education programs; rather, many of them are prepared in elementary education programs.

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