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# Mathematics Content Courses for Teachers: An Analysis of Colleges and Universities in Texas

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## Abstract

*Teachers' mathematics content knowledge has been shown to be correlated with children's learning. Because teachers often enter teacher preparation programs with weak content knowledge, the college-level mathematics courses they take can have a significant impact on the development of that knowledge. The present study examines the mathematics content courses for prospective teachers offered by Texas four-year baccalaureate-granting institutions over one academic year. Data on the number of mathematics courses for prospective teachers, the content of these courses, and information about the background of instructors of those courses were collected from publicly available resources. Findings revealed that the majority of institutions are not meeting current recommendations about the number and content focus of mathematics courses for prospective teachers. Further, findings indicate that instructors who teach mathematics courses for teachers have different characteristics than mathematics professors in general.*

***Keywords**:* mathematics teacher education, prospective teachers, mathematics content courses, teacher content knowledge

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## Introduction

The importance of PreK-12 teachers' mathematical content knowledge is central to discussions about the preparation and continued development of teachers. For example, Hill (2010) stated, "Few other topics have been the focus of such concern and resource investment over the past dozen years. Rarely can a national mathematics panel or commission meet without pointedly noting that teachers require strong knowledge of content to be effective" (p. 513). However, many prospective teachers matriculate into teacher education programs with insufficient knowledge of the mathematics content taught in PreK-12 schools (CBMS, 2001). To help prospective teachers develop this mathematical content knowledge for teaching, many colleges and universities offer mathematics content courses specifically designed for the unique needs of prospective teachers.

The current study examined all of the mathematics content courses designed specifically for prospective elementary, middle, and secondary teachers offered over one academic year at all public and private four-year colleges and universities with teacher preparation programs in Texas. Information about the number of such courses offered, course content, and the instructor of each course was

gathered. The findings provide a one-year snapshot of teacher preparation as delivered through mathematics departments in one of the most populous and diverse states.

## Literature Review

Historically, a common misconception is that teachers will become well-prepared to teach PreK-12 mathematics by taking advanced mathematics courses in college (Shulman, 1986). Researchers have come to the conclusion that an in-depth study of the mathematics they will actually teach, rather than (or in addition to) a study of advanced mathematics, is what is needed to prepare teachers of mathematics (Ball & Wilson, 1990). As stated by the Conference Board of the Mathematical Sciences (CBMS, 2012), "A major advance in teacher education is the realization that teachers should study the mathematics they teach in depth, and from the perspective of a teacher" (p. 23).

Shulman (1986) outlined several types of knowledge that teachers must possess. One of these, pedagogical content knowledge (PCK), Shulman described as knowledge "for the most regularly taught topics in one's subject area, the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations…. Pedagogical content knowledge also includes an understanding of what makes the learning of specific topics easy or difficult" (p. 9). Since then, the notion of PCK has grown into a body of research on mathematics knowledge for teaching (e.g., Hill, 2010; Hill, Schilling, & Ball, 2004). What is similar between the concepts of PCK and mathematics knowledge for teaching is that teachers need a different and deeper understanding of the content they teach than do professionals in other fields (Shulman, 1986; Ball, Thames, & Phelps, 2008). For this reason, traditional college mathematics courses may not adequately prepare teachers with the mathematics content knowledge needed for teaching.

The stance that teachers need more in-depth knowledge of the mathematics they will actually teach has implications for the courses that are included in teacher education programs. In past decades, prospective teachers, including elementary teachers, were required to take traditional entry-level college mathematics courses, such as college algebra, while recent recommendations have promoted mathematics courses for teachers that are more tailored to the knowledge needs of teachers (CBMS, 2012). As stated by the CBMS, "It bears emphasizing that familiar mathematics courses such as college algebra, mathematical modeling, liberal arts mathematics, and even calculus or higher-level courses are not appropriate substitutes for the study of mathematics for elementary teachers, although they might make reasonable additions" (CBMS, 2012, p. 32). Various entities have made recommendations about the number and content focus of mathematics courses that should be included in prospective teachers' programs of study (e.g., CBMS, 2012; NCTM, 2005; Greenberg & Walsh, 2008). For example, the CBMS makes specific recommendations about the number of courses with a focus on the key ideas of school mathematics that prospective teachers at each certification level should take (elementary, 12 hours; middle school, 15 hours; and high school, nine hours).

Because mathematics courses for teachers are vital in ensuring that they have the necessary content knowledge, these courses should be taught by individuals who are able to "make connections between the mathematics being studied and the mathematics prospective teachers will teach" (CBMS, 2001, p. 7). Studies on the jobs related to mathematics education available at these institutions have reported that approximately half of the jobs are offered through mathematics departments and approximately half are offered through schools of education (Reys, 2008; Reys, Reys, & Estapa, 2013). However, there have been few studies that paint a picture of the body of professionals who teach mathematics courses for teachers in institutions of higher education (e.g., Masingila, Olanoff, & Kwaka, 2012; McCrory & Cannata, 2011).

Two recent studies investigated the number of mathematics courses for teachers offered by various institutions and the individuals that teach these courses. The CBMS conducts a survey on mathematics education every five years; the 2010 survey (Blair, Kirkman, & Maxwell, 2013) included data on the

mathematics preparation of teachers. Whereas CBMS 2010 reported on the preparation of both elementary and secondary teachers, Masingila et al. (2012) focused specifically on prospective elementary-school teachers.

The CBMS 2010 survey (Blair et al., 2013) included a "special project" related to the mathematical education of pre-college teachers. The CBMS 2010 report provided data on the mathematics courses and instructors at both two-year and four-year programs. Among many other findings, the CBMS 2010 survey stated that each of the four major mathematics strands (number/operations, algebra, geometry/measurement, statistics/probability) were addressed in a mathematics course for teachers by more than 50% of the institutions, although multiple strands could be covered in a single course. The CBMS 2010 survey also stated that 62% of the mathematics courses for teachers are taught by tenured or tenure-track faculty members.

Masingila et al. (2012) sent surveys to all higher education institutions in the United States that offer mathematics courses and received responses from 825 institutions (42.8% response rate). Of these, approximately 79% offered mathematics content courses specifically for prospective elementary teachers. Masingila et al. concluded that "most institutions are not meeting the recommendation of requiring prospective elementary teachers to complete nine credits hours of mathematics content courses" designed specifically for teachers. Masingila et al. also found that 22% of the instructors of mathematics courses for elementary teachers have K-6 teaching experience and that more than half of the institutions do not provide training and/or teaching support for the instructors of these courses.

The purpose of the present study is to examine the number and nature of the mathematics courses for prospective teachers and the characteristics of the instructors who teach these courses for all four-year colleges or universities with teacher education programs in the state of Texas. Specifically, the following research questions were addressed: (1) How many mathematics courses for prospective teachers were offered during the 2012-2013 academic year? (2) What is the content focus of these courses? (3) Do these courses address mathematics content only or integrate mathematics content and pedagogy? and (4) What are the characteristics of the instructors of these courses? The findings are then considered in light of the aforementioned recommendations.

## Methods

**Data Collection.** Data on mathematics courses for prospective teachers were collected for each baccalaureate degree-granting institution in Texas for the 2012-2013 academic year. For a course section to be included in this study, it needed to meet the criteria: (1) offered by the mathematics department; (2) designated as an undergraduate course; (3) primarily focused on mathematics content rather than methods of teaching mathematics; and (4) designed specifically for individuals seeking teacher certification.

From the Texas Higher Education Coordinating Board, the researchers obtained a list of Texas baccalaureate degree-granting institutions. For the academic year 2012-13, this list comprised 76 colleges and universities. These schools were divided among the members of the research team, with two researchers assigned to each institution. Then, for each institution, the researchers identified courses meeting the aforementioned criteria. To determine whether a course met the criteria for inclusion in the study, each researcher independently examined multiple sources including the course title, course description, and degree plans. For a course to be included in the data, at least two of these sources needed to indicate that the undergraduate mathematics content course was specifically designed for prospective teachers. For example, College Algebra may be included on the degree plan for elementary education majors, but because College Algebra is open to students pursuing other majors, it did not meet the inclusion criteria. On the other hand, a course on the elementary education degree plan titled *Mathematics for Elementary Teachers* with a description indicating that it was limited to elementary education majors met the inclusion criteria.

For the courses that met the inclusion criteria, the researchers determined which ones were offered during the 2012-2013 academic year, including summer, by accessing each institution's course schedule posted online. For each course section offered, both of the researchers assigned to the institution independently compiled the following information:

- Course number, name, and description;
- Degree plan(s) to which the course corresponds (elementary, middle grades, and/or secondary education);
- Instructor's name, gender, and position (tenure track, full-time instructor, or adjunct);
- Instructor's highest degree (doctorate, master's, or bachelor's), year degree was earned, and field of degree (education, mathematics, or other); and
- Instructor's research area.

To collect information about the instructors, the researchers searched the website of each institution. All public higher education institutions in the state of Texas are required to make available on the institution's website the course syllabus and the curriculum vitae for the instructor of each undergraduate course. For some of the private institutions in our study, this information was not available on the institution's website. In these cases, the researchers conducted an internet search to obtain each instructor's vita, doctoral dissertation or master's thesis, and any other pertinent sources.

Once data on course sections and instructors were gathered independently by the two researchers assigned to each institution, the two sets of data were compared. In some cases, there were discrepancies. In the case of a discrepancy, the two researchers re-checked their sources. If the two researchers were unable to reconcile the discrepancy, the third researcher conducted an independent search and made a decision.

**Data Analysis.** The 76 institutions were categorized in several ways. First, each college or university was identified as private or public as indicated by the Texas Higher Education Coordinating Board. Further, utilizing the 2010 Carnegie Classification of Institutions of Higher Education (Carnegie, 2011), each institution was labelled according to its Basic Classification (baccalaureate, master's, or doctoral) and according to its size (very small and small [less than 3,000 students], medium [between 3,000 and 10,000 students], or large [more than 10,000 students]). Because only three of the institutions were "very small", these were included in the "small" category.

**Number of course offerings per institution.** All institutions with an approved Texas State Board for Educator Certification preparation program offering teacher training as a part of an undergraduate degree program in elementary generalist (early childhood through sixth grade), middle school (grades four through eight), or secondary mathematics (grades seven through 12) were included in the analysis for the number of course offerings. In total, 72 of the 76 institutions had such a teacher preparation program and were included in the analysis. The number of course offerings for the 2012-2013 academic year was identified for each institution. When several sections of one course were offered over the study period, they were counted as one distinct course. Relative frequencies were reported for all 72 institutions as well as across the three categorizations (private versus public, Carnegie size, and Carnegie Basic Classification).

**Course content.** For each course offering in the 2012-13 academic year, two aspects of the course content were determined from the course description. First, each course description was coded according to the mathematics targeted in the course: (1) Number and Operations, (2) Algebra, (3) Geometry and/or Measurement, (4) Data Analysis and/or Probability, and/or Statistics, (5) Advanced Mathematics, (6) Combination of more than one of these. The first four codes represent the NCTM

(2000) Content Standards, with Geometry and Measurement merged. The code Advanced Mathematics was used to describe courses such as Calculus and Introduction to Proof, if those courses were intended specifically for prospective teachers. The Combination code was assigned to courses with course descriptions that indicated more than one of the areas of mathematics from codes (1) through (5). For instance, the description of one course coded as Combination was: "Study of concepts and principles of geometry and measurement, probability and statistics and their applications as specified by national and state standards for teaching EC-6 mathematics."

Second, each course description was coded according to whether the course incorporated only mathematics content or both mathematics content and pedagogy. To determine if a course included pedagogy, the course description needed to include phrases referencing instructional strategies such as "developmentally appropriate instructional strategies" or "techniques to implement the [NCTM] standards."

Two hundred fifty-five distinct course offerings were identified in the data set. Course descriptions were unavailable for four course offerings (e.g., *Selected Topics* courses for which the description would change depending on the topics), so they were not included in the analysis. Thus, 251 course descriptions were coded for their mathematics content and inclusion of pedagogy. Relative frequencies were reported for these 251 course offerings overall as well as across the three categorizations (private versus public, Carnegie size, and Carnegie Basic Classification).

**Instructors.** Data on the instructor were found for 570 of the 575 course sections. (For the other five sections, the instructor was listed as "staff" or data beyond the instructor name was not available.) Instructor data collected included the instructor's gender, position (tenure-track, full-time instructor, or adjunct), highest degree (doctorate, master's, or bachelor's), and field of degree (education, mathematics, or other). Relative frequencies were reported for these 570 instructors as well as across the three categorizations (private versus public, Carnegie size, and Carnegie Basic Classification).

## Findings

Findings within each of the three descriptors (number of course offerings, course content, and instructors) are reported overall and for each category of institution (public/private, small/medium/large Carnegie size, and baccalaureate[B]/master's[M]/doctorate[D] Carnegie Basic Classification). The results provide a snapshot of mathematics courses for prospective teachers over one academic year.

**Number of Course Offerings per Institution.** For each institution, the number of mathematics course offerings for prospective teachers in the 2012-2013 academic year was identified (Table 1). Thirteen (18%) of the 72 institutions did not have any mathematics courses offerings for prospective teachers. The median number of course offerings was three; 36% of institutions had either two or three course offerings. The distribution for the relative frequency of the number of course offerings was skewed right. Two outliers presented; two large public institutions had 11 and 18 course offerings.

**Public versus private.** The relative frequency distributions for the number of course offerings at public versus private institutions demonstrated some distinctions. For the 35 private institutions, the number of course offerings ranged from zero to seven, with the interquartile range (IQR) between zero and three courses. The mode was zero course offerings (31% of private institutions) and median was two course offerings (29% of private institutions). For public institutions, the range for the number of course offerings was larger, spanning from zero to 18. The IQR, between three and six courses, demonstrated a greater number of course offerings as compared to private institutions. A much smaller percentage (5%) of public institutions, as compared to private institutions, had zero course offerings. In contrast, the

mode was three distinct course offerings (22% of public institutions) and the median was four course offerings (16% of public institutions).

**Table 1**

*Relative Frequency Distributions of the Number Course Offerings*

| Number of Course Offerings | Overall *n* = 72 | Private *n* = 35 | Public *n* =37 | Small *n* = 32 | Medium *n* = 26 | Large *n* = 14 | B *n* = 15 | M *n* = 36 | D *n* = 21 |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 18% | 31% | 5% | 34% | 4% | 7% | 33% | 17% | 10% |
| 1 | 4% | 9% | 0% | 6% | 4% | 0% | 7% | 3% | 5% |
| 2 | 18% | 29% | 8% | 28% | 15% | 0% | 33% | 17% | 10% |
| 3 | 18% | 14% | 22% | 13% | 27% | 14% | 13% | 17% | 24% |
| 4 | 10% | 3% | 16% | 6% | 19% | 0% | 7% | 17% | 0% |
| 5 | 11% | 9% | 14% | 13% | 8% | 14% | 7% | 17% | 5% |
| 6 | 7% | 0% | 14% | 0% | 8% | 21% | 0% | 6% | 14% |
| 7 | 8% | 6% | 11% | 0% | 8% | 29% | 0% | 6% | 19% |
| 8+ | 6% | 0% | 10% | 0% | 8% | 14% | 0% | 3% | 14% |
| Median | 3 | 2 | 4 | 2 | 3.5 | 6 | 2 | 4 | 3 |
| Maximum | 18 | 7 | 18 | 5 | 9 | 18 | 5 | 11 | 18 |

*Note. n* represents the number of institutions in each category.

**Institution size.** The relative frequency distributions for the number of course offerings according to Carnegie size (small, medium, and large) also show dissimilarities. For the 32 small institutions, the number of course offerings ranged from zero to five with the IQR falling between zero and three courses. As the size of the institution increased, the range increased as well (zero to nine for medium institutions and zero to 18 for large institutions). The IQR also shifted to a greater number of course offerings (three to five for medium institutions and five to seven for large institutions). For small institutions, the mode was zero course offerings (34%) and the median was two course offerings (28%). In contrast, only 4% of medium institutions and 7% of large institutions had zero course offerings. For medium institutions, the mode was three course offerings (27%) and the median was 3.5 course offerings. The mode (seven distinct courses [29%]) and median (six distinct courses [21%]) also demonstrated the shift to a greater number of course offerings at larger institutions.

**Institution type.** The relative frequency distributions for the Carnegie classification (baccalaureate, master's and doctoral degree-granting institutions) did not show as strong a distinction as the previous two comparisons. Just like small institutions, the number of course offerings in baccalaureate institutions ranged from zero to five with the IQR falling between zero and three. Although the ranges for master's and doctoral institutions were greater (zero to 11 and zero to 18, respectively), the IQR for each overlapped with each other as well as with the IQR for baccalaureate institutions (two to five for master's institutions and two to seven for doctoral institutions). The modes for baccalaureate institutions were zero and two course offerings with 33% of the institution for each. Fourteen percent of both master's and doctoral institutions had zero course offerings. For master's institutions, the modes were two, three, four, and five course offerings (17% each), and the median was four course offerings. The median and mode for doctoral institutions was three course offerings at 23%.

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## Course Content

Course descriptions from 251 distinct course offerings were coded for their content. If a course at an institution was offered in multiple sections or in more than one semester of the study period, the course was only included once in the data. Together with the above information about number of course offerings, this data describes how the content of mathematics for prospective teachers may be distributed across different courses at different institutions.

**Strand of mathematics**. The declared content focus of 41% of the course sections was identified to be a single strand of mathematics (Table 2). The three most common single strands were Geometry and Measurement [G&M] (12% of the course sections), Number and Operations [N&O] (9%), and Advanced Mathematics [Adv.] (10%). The other course sections addressing a single strand were equally distributed across Algebra [Alg.] (5%) and Data Analysis and Probability [DA&P] (5%). The remaining 59% of the course sections targeted a combination of strands of mathematics.

**Table 2**

*Relative Frequency Distributions of the Strand of Mathematics in Course Offerings*

| Strand | Overall *n*=251 | Private *n*=69 | Public *n*=182 | Small *n*=59 | Medium *n*=101 | Large *n*=92 | B *n*=26 | M *n*=128 | D *n*=97 |
|---|---|---|---|---|---|---|---|---|---|
| N&O | 9% | 9% | 9% | 7% | 9% | 9% | 12% | 8% | 9% |
| G&M | 12% | 13% | 12% | 7% | 16% | 12% | 8% | 13% | 12% |
| Alg. | 5% | 3% | 6% | 5% | 4% | 7% | 4% | 3% | 7% |
| DA&P | 5% | 7% | 4% | 7% | 4% | 5% | 8% | 4% | 6% |
| Adv. | 10% | 7% | 12% | 3% | 8% | 14% | 4% | 10% | 12% |
| Comb. | 59% | 61% | 58% | 71% | 59% | 53% | 65% | 62% | 53% |

*Note. n* represents the number of distinct course offerings.

***Public versus private.*** Public institutions had a higher percentage of courses devoted to Advanced Mathematics than did private institutions. The percentage of courses addressing the other four strands of mathematics were similar at public and private institutions. The percentage of courses devoted to a combination of strands was 61% at private institutions and 58% at public institutions.

***Institution size.*** The percentage of combination courses decreased as the size of the institution increased from small (71%) to medium (59%) to large (53%). The percentage of courses devoted to Geometry was lower at small institutions (7%) than at medium (16%) and large institutions (12%). The percentage of Advanced Mathematics courses increased as the size of the institutions increased from small (3%) to medium (8%) to large (14%).

***Institution type.*** There were similar patterns for institution types as for institution sizes. The percentage of combination courses decreased from baccalaureate (65%) to master's (62%) to doctoral-granting institutions (53%). The percentage of Advanced Mathematics courses increased from baccalaureate (4%) to master's (10%) to doctoral granting institutions (12%).

**Inclusion of pedagogy.** Overall, 21% of the course descriptions mentioned pedagogy and 79% of the course descriptions mentioned mathematics content only (Table 3). Courses at private institutions were more likely to include pedagogy; 32% of the private-school course descriptions mentioned pedagogy compared to 17% at public institutions. The percentage of courses that included pedagogy decreased as the size of the institution increased from small (29%) to medium (25%) to large (14%). Similarly, the percentage of courses that included pedagogy decreased from baccalaureate (31%) to master's (23%) to doctoral granting institutions (15%).

**Instructors.** In the data set, instructor data was collected from 570 course sections (representing 251 distinct course offerings). Note that if instructors taught multiple courses or multiple sections of the same course, their data are included for each section. This provides a view of instructor information corresponding, in some measure, to the impact of each instructor (as weighed by the number of course sections).

**Table 3**

*Relative Frequency Distributions of Inclusion of Pedagogy in Course Offerings*

| | Overall *n*=251 | Private *n*=69 | Public *n*=182 | Small *n*=59 | Medium *n*=101 | Large *n*=92 | B *n*=26 | M *n*=128 | D *n*=97 |
|---|---|---|---|---|---|---|---|---|---|
| Math Content Only | 79% | 68% | 84% | 71% | 75% | 86% | 69% | 77% | 85% |
| Content & Pedagogy | 21% | 32% | 17% | 29% | 25% | 14% | 31% | 23% | 15% |

*Note. n* represents the number of distinct course offerings.

**Highest degree held by instructor.** Overall, 62% of the instructors of mathematics courses for teachers held a doctorate, compared with 37% whose highest degree was a master's degree (Table 4). This distribution was similar for private (66% doctorate, 32% master's) and public (61% doctorate, 38% master's) institutions. Within the comparison across institution size, small institutions had a greater percentage of instructors with doctoral degrees (75%) than medium and large institutions (57% and 62%, respectively). A similar comparison holds across institution type with 89% of instructors at baccalaureate granting institutions holding a doctoral degree as compared to 59% at masters and 62% at doctoral granting institutions.

**Table 4**

*Relative Frequency Distributions of Highest Degree Held by Instructor of Course*

| Highest Degree Held by Instructor | Overall *n*=570 | Private *n*=94 | Public *n*=476 | Small *n*=79 | Medium *n*=226 | Large *n*=265 | B *n*=33 | M *n*=267 | D *n*=270 |
|---|---|---|---|---|---|---|---|---|---|
| Doctorate | 62% | 66% | 61% | 75% | 57% | 62% | 76% | 60% | 62% |
| Master's | 37% | 32% | 38% | 23% | 42% | 37% | 24% | 38% | 38% |
| Bachelors | 1% | 2% | 1% | 2% | 1% | 0% | 0% | 2% | 0% |

*Note. n* represents the number of course sections with corresponding instructor.

**Gender of instructor.** Overall, 55% of instructors were female and 45% were male (Table 5). The instructor gender distribution was similar for public institutions (53% male and 47% female), but for private institutions, 67% of the instructors were female. Within the comparison across institution size, the instructor gender distribution for small schools mirrored that for the overall group (54% female and 46% male). However, medium institutions had a higher percentage of female instructors (65%) than large institutions (46%). For institution type, at baccalaureate granting institutions, 75% of the instructors were female. In contrast, master's and doctoral degree granting institutions had a lower percentage of female instructors (52% and 56%, respectively).

**Field of Highest Degree Held by Instructor** Looking across all 570 course sections (Table 6), the highest degree held by the instructor of the course was roughly equally distributed between mathematics and education (48% of instructors held highest degree in mathematics, 50% of instructor held highest degree in education). There was little disparity from this equal distribution of field of degree within

public schools (49% mathematics, 51% education), though at private schools, the instructor was more likely to hold a degree in education (45% mathematics, 58% education). Within the comparison across institution size, large size institutions roughly mirrored the overall distribution (51% mathematics, 49% education). However, medium size institutions had a higher percentage of instructors whose highest degree was in education (56%) than small institutions (40%). For institution type, at baccalaureate granting institutions, 52% of the instructors of the mathematics courses for prospective teachers held their highest degree in education. In contrast, master's granting institutions had a lower percentage (40% in education) and doctoral degree granting institutions had a higher percentage of instructors with a degree in education, rather than mathematics (60% education).

**Table 5**

*Relative Frequency Distributions of Gender of Instructor of Course*

| Gender of Instructor | Overall *n*=570 | Private *n*=94 | Public *n*=476 | Small *n*=79 | Medium *n*=226 | Large *n*=265 | B *n*=33 | M *n*=267 | D *n*=270 |
|---|---|---|---|---|---|---|---|---|---|
| Female | 55% | 67% | 53% | 54% | 65% | 46% | 79% | 51% | 56% |
| Male | 45% | 33% | 47% | 46% | 35% | 54% | 21% | 49% | 44% |

*Note. n* represents the number of course sections with corresponding instructor.

**Table 6**

*Relative Frequency Distributions of Field of Highest Degree Held by Instructor of Course*

| Field of Highest Degree | Overall *n*=570 | Private *n*=94 | Public *n*=476 | Small *n*=79 | Medium *n*=226 | Large *n*=265 | B *n*=33 | M *n*=269 | D *n*=270 |
|---|---|---|---|---|---|---|---|---|---|
| Mathematics | 48% | 45% | 49% | 52% | 43% | 51% | 48% | 56% | 40% |
| Education | 50% | 58% | 51% | 40% | 56% | 49% | 52% | 40% | 60% |
| Other | 2% | 7% | 0% | 8% | 1% | 0% | 0% | 3% | 0% |

*Note. n* represents the number of course sections with corresponding instructor.

**Instructor Position** Overall, 47% of the instructors were either tenure-track or tenured (Table 7). Forty-one percent were full-time instructors and 12% were employed as adjuncts. When the data are parsed by institution characteristics, some stark distinctions become apparent. At private institutions, 68% of instructors of mathematics courses for prospective teachers were tenure stream, contrasted with 43% of instructors in the tenure track or tenured at public institutions. Within the comparison across institution size, medium and large schools have somewhat similar distributions for the title/position of the instructors (medium size institutions: 45% tenure stream, 37% instructor, 18% adjunct; large size institutions: 40% tenure stream, 50% full-time instructor, 10% adjunct.) However, courses taught at small institutions were much more likely to have a tenure stream instructor (75% tenure stream). Eighty-two percent of the instructors of mathematics courses for prospective teachers at baccalaureate institutions were tenure stream faculty, contrasted with 56% at master's degree granting institutions and only 34% at doctoral granting institutions.

## Discussion

The present study shares the findings of an analysis of the mathematics course offerings for prospective teachers at all four-year institutions with a teacher education program in the state of Texas for the 2012-2013 academic year. Specifically, the evaluation addresses the number of courses offered, the content focus of the courses, and the characteristics of the instructors of these courses. The discussion section compares these findings in the three areas to recommendations about and/or other surveys or studies of the mathematics departments and the courses they offer for prospective teachers.

Then, to synthesize the findings, profiles of the most common types of institutions are presented. The section closes with implications, limitations, and directions for future research.

**Table 7**

*Relative Frequency Distributions of Position Held by Course Instructor*

| Instructor Position | Overall *n*=570 | Private *n*=94 | Public *n*=476 | Small *n*=79 | Medium *n*=226 | Large *n*=265 | B *n*=33 | M *n*=269 | D *n*=270 |
|---|---|---|---|---|---|---|---|---|---|
| Tenure Stream | 47% | 68% | 43% | 75% | 45% | 40% | 82% | 56% | 34% |
| Full-time Instructor | 41% | 27% | 43% | 19% | 37% | 50% | 18% | 32% | 52% |
| Adjunct | 12% | 5% | 14% | 6% | 18% | 10% | 0% | 12% | 14% |

*Note. n* represents the number of course sections with corresponding instructor

The MET II (2012) makes specific recommendations about the number of semester-hours of mathematics courses prospective teachers should complete by grade band. Specifically, elementary prospective teachers should complete 12 semester-hours (or four three-hour courses), middle school prospective teachers should complete 15 semester-hours (or 5 courses), and high school prospective teachers should complete nine semester-hours (or three courses). Table 8 presents a comparison of the MET II recommendations to the findings of Masingila et al. (2012) and the findings presented herein segregated by grade band. Two observations emerge from this analysis. First, the percentages of schools offering each number of courses at the elementary level closely parallel those of Masingila and colleagues. Second, 4% of institutions meet the elementary recommendations, 26% meet the middle school recommendations, and 17% meet the high school recommendations. Notably, at the high school level, about 30% of the schools offer no courses. Therefore, at all grade bands, institutions in general are not meeting the MET II recommendations.

**Table 8**

*Comparison of MET II Course Number Recommendations by Grade Band to Findings of Present Study*

| | | Percent of Schools with | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of Courses/ Level | MET II | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8+ |
| Masingila et al. (2012) Elementary | 4 | 0 | 16 | 57 | 17 | | | 10 | | |
| Elementary | 4 | 3 | 15 | 58 | 20 | 2 | 2 | 0 | 0 | 0 |
| Middle School | 5 | 12 | 12 | 25 | 15 | 10 | 14 | 3 | 5 | 4 |
| High School | 3 | 30.5 | 30.5 | 22 | 8 | 7 | 2 | 0 | 0 | 0 |

The MET II also makes recommendations about the content focus of mathematics courses for prospective teachers. For example, elementary prospective teachers should complete six hours of courses devoted to "number and operations, treated algebraically with attention to properties of operations" (CBMS, 2012, p. 31) and another six hours devoted to further ideas in algebra, measurement and data, and geometry. Middle school prospective teachers should complete six semester-hours focused on number and operations and three semester-hours each on geometry and measurement, algebra and number theory, and statistics and probability. More than half (59%) of the course descriptions in the present study mentioned a combination of strands; therefore, assessing whether programs with these combination courses meet the MET II recommendations is not feasible. However, given the low percentages of courses that specifically address the various content strands (Table 2) in conjunction with

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the aforementioned findings about number of mathematics courses for prospective teachers, many institutions are likely not meeting the recommendations regarding courses that focus on these specific strands.

The present study focused on courses for prospective teachers offered through mathematics departments. Perhaps unsurprisingly, most of the course descriptions (79%) mentioned mathematics content only and did not reference pedagogy or methods of teaching mathematics. However, the MET II advocates, "when possible, program designers should consider courses that blend the study of content and methods" (CBMS, 2012, p. 32). The findings herein indicate small institutions and private schools are more likely to have mathematics courses that include pedagogy than large institutions and public universities. Since smaller, private institutions offer fewer mathematics courses for prospective teachers overall, they may combine content and methods in the interest of efficiency.

The American Mathematical Society (AMS) conducts an annual survey that provides information about mathematical sciences departments within four-year colleges and universities located in the United States. The survey reports on faculty characteristics including faculty highest degree, gender, and position. In contrast, the present study concentrates on instructors of mathematics courses for prospective teachers (in Texas). In comparing the data reported in the 2012 AMS survey (Cleary, Maxwell, & Rose, 2014) to the findings herein, notable distinctions emerge. The percentages of instructors, who teach mathematics courses for prospective teachers, with a doctoral or master's degree are higher while the percentage of instructors with a bachelor's degree is lower than the respective percentages reported by AMS. The gender of instructors teaching mathematics courses for prospective teachers is roughly evenly distributed, with an advantage to females, whereas overall faculty in mathematical sciences departments have a higher percentage of males. With respect to position, the percentages of instructors who teach mathematics courses for prospective teachers are higher for full-time non-tenure stream and lower for tenure stream and adjuncts. The AMS survey does not report on the field of highest degree, an important contribution of the present study.

The Texas four-year, higher education institutions that had undergraduate teacher education degree programs were categorized according to three variables: classification (doctoral, master's, and baccalaureate), size (small, medium, or large), and primary source of funding (private or public). Table 9 presents the number of institutions of each type. For the four types (bold numbers in Table 9) with the greatest number of institutions, a profile is presented integrating the various analyses conducted.

**Table 9**

*Number of Institutions Categorized by Classification, Size, and Primary Funding Source*

| | Small | | Medium | | Large | | |
|---|---|---|---|---|---|---|---|
| Classification | Private | Public | Private | Public | Private | Public | Total |
| Doctoral | 0 | 1 | 3 | 6 | 1 | **10** | 21 |
| Master's | **11** | 6 | 6 | **10** | 0 | 3 | 36 |
| Baccalaureate | **13** | 1 | 0 | 1 | 0 | 0 | 15 |
| Total | 24 | 8 | 9 | 17 | 0 | 13 | 72 |

**Profile 1: Small, Private, Baccalaureate-granting Institution.** Small, private, baccalaureate-granting institutions in Texas (Table 10) are more likely to offer zero or two mathematics courses specific to prospective teachers. At the institutions that do offer such courses, they are more likely to address a combination of strands and twice as likely to focus on mathematics content only. The instructors of these courses are more likely to have a doctoral degree; the field of the degrees is roughly equally distributed between mathematics and education. The position of the instructor is highly likely to be tenure stream, and the gender of the instructor is more likely to be female.

**Profile 2: Small, Private, Master's-granting Institution.** At small, private, master's-granting institutions in Texas (Table 11), there is a high probability that no mathematics courses for prospective teachers are offered. At the institutions that do offer such courses, they are more likely to address a combination of strands. Further, the courses are more likely to focus on mathematics content only. The instructors of these courses are very likely to hold a doctoral degree, and the degree is more likely to be in the field of mathematics. The position of the instructor is more likely to be tenure stream; the gender of the instructor is almost twice as likely to be male than female.

**Table 10**

*Profile for Small, Private, Baccalaureate-granting Institutions*

| Number of Courses | *n*=13 | Course Content | *n*=22 | Highest Degree | *n*=25 | Field of Degree | *n*=25 |
|---|---|---|---|---|---|---|---|
| 0 | 31% | N&O | 14% | Doctorate | 72% | Math | 56% |
| 1 | 8% | G&M | 5% | Master's | 28% | Education | 44% |
| 2 | 38% | Alg. | 5% | Bachelors | 0% | Other | 0% |
| 3 | 15% | DA&P | 9% | | | | |
| 4 | 0% | Adv. | 5% | Position | *n*=25 | Gender | *n*=25 |
| 5 | 8% | Comb. | 64% | Tenure stream | 80% | Female | 76% |
| 6 | 0% | | | Full-time Instructor | 20% | Male | 24% |
| 7 | 0% | Math Content Only | 68% | Adjunct | 0% | | |
| 8+ | 0% | Content & Ped. | 32% | | | | |

*Note.* $n_1$ represents the number of institutions, $n_2$ represents the number of distinct course offerings, and $n_3$ represents the number of course sections with corresponding instructor.
*The total percent is greater than 100% due to rounding.

**Profile 3: Medium, Public, Master's-granting University.** At medium, public, master's-granting institutions in Texas (Table 12), the range of the number of mathematics courses for prospective teachers is between three and seven with the majority of institutions offering three or four courses. These courses are more likely to focus on a combination of strands. The courses are also more likely to address mathematics content only. The highest degree of instructors is distributed equally across doctoral and master's degrees. The instructors' degree is twice as likely to be in the field of mathematics than the field of education. The instructor's position is equally distributed across tenure stream and full-time instructor with a smaller percentage of adjunct instructors. The gender of the instructors is roughly equally distributed.

**Profile 4: Large, Public, Doctoral-granting Institutions.** At large, public, doctoral granting institutions in Texas (Table 13), the range of mathematics courses for prospective teachers is fairly spread out. Of these 10 institutions, three have seven courses, two have six courses, and two have only three courses. At the institutions that do offer such courses, about half of the courses address a combination of strands with the other half specifically addressing one of the content strands. In addition, the courses are highly likely to focus on mathematics content only. The instructors of these courses are more likely to have a doctoral degree; the field of the degrees is roughly equally distributed between mathematics and education. The position of the instructor is more likely to be a full-time instructor, and the gender of the instructor is roughly equally distributed.

**Table 11**

*Profile for Small, Private, Master's-granting Institutions*

| Number of Courses | *n*=11 | Course Content | *n*=14 | Highest Degree | *n*=23 | Field of Degree | *n*=23 |
|---|---|---|---|---|---|---|---|
| 0 | 55% | N&O | 0% | Doctorate | 96% | Math | 61% |
| 1 | 9% | G&M | 14% | Master's | 4% | Education | 17% |
| 2 | 9% | Alg. | 0% | Bachelors | 0% | Other | 22% |
| 3 | 9% | DA&P | 14% | | | | |
| 4 | 0% | Adv. | 7% | Position | *n*=23 | Gender | *n*=23 |
| 5 | 18% | Comb. | 64% | Tenure stream | 83% | Female | 35% |
| 6 | 0% | | | Full-time Instructor | 13% | Male | 65% |
| 7 | 0% | Math Content Only | 57% | Adjunct | 4% | | |
| 8+ | 0% | Content & Ped. | 43% | | | | |

*Note.* $n_1$ represents the number of institutions, $n_2$ represents the number of distinct course offerings, and $n_3$ represents the number of course sections with corresponding instructor.
*The total percent is less than 100% due to rounding.

**Table 12**

*Profile for Medium, Public, Master's-granting Institutions*

| Number of Courses | *n*=10 | Course Content | *n*=43 | Highest Degree | *n*=103 | Field of Degree | *n*=103 |
|---|---|---|---|---|---|---|---|
| 0 | 0% | N&O | 9% | Doctorate | 52% | Math | 65% |
| 1 | 0% | G&M | 16% | Master's | 48% | Education | 34% |
| 2 | 0% | Alg. | 5% | Bachelors | 0% | Other | 1% |
| 3 | 30% | DA&P | 5% | | | | |
| 4 | 30% | Adv. | 7% | Position | *n*=103 | Gender | *n*=103 |
| 5 | 20% | Comb. | 58% | Tenure stream | 44% | Female | 46% |
| 6 | 10% | | | Full-time Instructor | 40% | Male | 54% |
| 7 | 10% | Math Content Only | 74% | Adjunct | 16% | | |
| 8+ | 0% | Content & Ped. | 26% | | | | |

*Note.* $n_1$ represents the number of institutions, $n_2$ represents the number of distinct course offerings, and $n_3$ represents the number of course sections with corresponding instructor.

The findings of the present study show that a majority of four-year institutions in Texas are not meeting the MET II (CBMS, 2012) recommendations with respect to number and content focus of mathematics courses for prospective teachers. Although these findings and profiles represent a group of institutions, the most immediate implications are at the individual institution level. Each mathematics department should build its own profile, collecting data on the number of mathematics courses for prospective teachers (at each grade band), the content focus of these courses, and the instructors of these courses. Mathematics departments are well positioned to obtain rich data about the instructors. Beyond the field of their degree, mathematics departments can gather data on instructors' current research areas, prior experiences working in the PreK-12 arena, involvement with local schools and the continued development of teachers, and collaborative efforts with mathematics teacher educators. MET II states: "At institutions that prepare teachers or offer professional development, teacher education must be recognized as an important part of a mathematics department's mission and should be undertaken in collaboration with mathematics education faculty" (CBMS, 2012, p. 19). The data collection provides a baseline for mathematics departments to have focused discussions about mathematics courses for

prospective teachers ensuring that these courses address "the fundamental ideas of school mathematics" (CBMS, 2012, p. 18) and meet the recommendations with respect to number and content; to make purposeful decisions about who teaches these courses; and to build collaborations with teacher educators within the institution and the community.

**Table 13**

*Profile for Large, Public, Doctoral-granting Institutions*

| Number of Courses | *n*=10 | Course Content | *n*=54 | Highest Degree | *n*=168 | Field of Degree | *n*=168 |
|---|---|---|---|---|---|---|---|
| 0 | 10% | N&O | 9% | Doctorate | 64% | Math | 45% |
| 1 | 0% | G&M | 13% | Master's | 36% | Education | 55% |
| 2 | 0% | Alg. | 11% | Bachelors | 1% | Other | 0% |
| 3 | 20% | DA&P | 6% | | | | |
| 4 | 0% | Adv. | 15% | Position | *n*=168 | Gender | *n*=168 |
| 5 | 10% | Comb. | 46% | Tenure stream | 34% | Female | 46% |
| 6 | 20% | | | Full-time Instructor | 5% | Male | 54% |
| 7 | 30% | Math Content Only | 89% | Adjunct | 11% | | |
| 8+ | 10% | Content & Ped. | 11% | | | | |

*Note.* $n_1$ represents the number of institutions, $n_2$ represents the number of distinct course offerings, and $n_3$ represents the number of course sections with corresponding instructor.
*The total percent is greater than 100% due to rounding.

These efforts can also be extended to the regional, state, and national level. For instance, the aforementioned profiles indicate that different types of institutions have different characteristics. Therefore, collaboratives of similar-type universities can be formed to consider ways to meet recommendations within their unique circumstances, such as department size, program size, and available personnel. At the state and national level, organizations and entities can consider strategies to support institutions in the evaluation and enhancement of the preparation of mathematics teachers. The Association of Mathematics Teacher Educators (AMTE, 2017) recent publication, *Standards for Preparing Teachers of Mathematics*, can serve as a guiding framework for this ongoing process.

Based on data collection procedures, the findings present a snapshot of the characteristics of the mathematics courses for prospective teachers and the instructors who teach these courses for all four-year institutions in Texas over one academic year. The nature of the procedures also leads to some limitations and suggestions for the direction of future research. Since the data on courses were based on the offerings for the specific academic year, the snapshot does give a view of what courses are actually being taught, as opposed to courses only listed in catalogs. However, mathematics courses for prospective teachers that were not offered during the study period are not represented for these particular institutions. As well, mathematics teacher preparation courses at Texas two-year colleges are not included in the data set. The analysis of the focus of the course (content strand and incorporation of pedagogy) is limited to what is reported in course descriptions. The content focus and means of instruction may differ in the course implementation. The instructor information differs from the data in the AMS annual survey in that it specifically reports on instructors who teach mathematics courses for prospective teachers. In addition to data on highest degree, position, and gender, the field of highest degree (mathematics, education, or other) was also examined. However, the field of highest degree does not necessarily indicate instructors' experiences in or with the PreK-12 community, data that was not gathered. For instance, the researchers attempted to gather data about instructors' research area but could

not report the data with any reliability. Further, the study did not take into account courses offered through colleges of education and how mathematics departments interact with colleges of education.

The present study reported data for all four-year institutions with teacher education programs in one state. The findings specific to elementary grade-band aligned with those of Masingila et al. (2012), who collected data from a national sample. However, future research could replicate the study with a national stratified sample. Further, the research could be conducted over two academic years to capture courses offered on a rotating basis. Additionally, approaches to gather rich, reliable data about instructors need to be devised and implemented. The greater time period from the initial publication of the MET II could provide information about the development, or lack thereof, of programs of study for prospective teachers with respect to mathematics. Recommendations from documents published after the MET II can also be considered (e.g., Franklin, Bargagliotti, Case, Kader, Scheaffer, & Spangler, 2015; Tucker, Burroughs, & Hodge, n.d.). Lastly, qualitative methods (e.g., case study) can be used to provide thick descriptions of how particular types of institutions are creatively working to meet the recommendations for the preparation of teachers of mathematics.

## Conclusion

The findings of the present study indicate that the majority of four-year institutions with teacher education programs in Texas are not meeting recommendations for the quantity and content on mathematics courses for prospective teachers. The publication of the AMTE (2017) *Standards for Preparing Teachers of Mathematics* presents an opportunity for mathematics departments to examine their programs with respect to these courses. In collaboration with their teacher education colleagues, members of mathematics departments can collect data similar to those presented here and assess and revise their programs with respect to recommendations and standards (e.g., Met II and AMTE) while living within the constraints of their own setting.

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