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The Mathematical Education of Elementary Teachers: The Content and Context of Undergraduate Mathematics Classes for Teachers

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Abstract

This paper reports on one aspect of a study of mathematics classes for prospective elementary teachers in three states. Here, we provide results of a survey of 57 mathematics departments in institutions that offer undergraduate elementary teacher certification programs in these states. Results suggest that most students are required to take 2 or 3 mathematics classes, with the average of 2.18 falling below recommendations from CBMS of 3 mathematics courses (9 credits) minimum for elementary certification. States now require middle school mathematics certification and institutions are approaching the CBMS recommendation of 7 mathematics classes. We provide data about differences by type of institution, size of elementary education program, and selectivity of institution.

The Mathematical Education of Elementary Teachers: The Content and Context of Undergraduate Mathematics Classes for Teachers

Mathematics departments have primary responsibility for teaching mathematics to prospective K-12 teachers. For K-6 teacher preparation, mathematics requirements come in a variety of flavors including courses that meet general education requirements, courses for liberal arts majors, those designed specifically for elementary education majors, and, in some cases (for those who "test out"), no courses at all. In this research, we investigate the mathematics classes required for elementary certification, considering what courses are required, who teaches them, what their content includes, and what materials are used.

Why this study?

The importance of elementary teachers' knowledge of mathematics is undeniable. Study after study – from Ball's dissertation in 1988 (Ball, 1988) to Ma's influential 1998 book (Ma, 1999) and beyond – has shown that U.S. elementary teachers have weak understanding of the mathematics they teach. Yet the problem of teachers' mathematical knowledge – what they need to know and how they can learn it – remains "unsolved" (Ball, Lubienski, & Mewborn, 2001). Recent research has provided new insights into the mathematics that might be beneficial, moving away from lists of topics toward a more nuanced conceptualization of mathematics for teaching including how it differs from the mathematics taught in school and from the mathematics used by people in other professions (e.g., Conference Board of the Mathematical Sciences, 2001; Hill, Rowan, & Ball, 2005).

Over the last two decades, there have been a number of studies of preservice teachers' knowledge of mathematics, often aimed at particular topics or processes (Ball, 1990; Borko, Eisenhart, Brown, Underhill, Jones, & Agard, 1992; Eisenhart, Borko, Underhill, Brown, Jones, & Agard, 1993; Even, 1990; Graeber, Tirosh, & Glover, 1989; Ma, 1998; Simon, 1993; Simon & Blume, 1994, 1996; Tirosh, Fischbein, Graeber, & Wilson, 1999; Wilson, 1994). In general, these studies indicate that although preservice teachers may be able to do the mathematics of elementary school and obtain correct answers, they often cannot give adequate explanations, provide representations of ideas, or generate illustrative problems. Their understanding of elementary mathematics appears to be quite weak, and this is true even for students who have more extensive mathematics coursework than might be typical of elementary education majors (Borko et al., 1992). Ma (1998) contrasts the knowledge of elementary teachers in China and the US, and identifies the difference as "profound understanding of fundamental mathematics."

One obvious leverage point for influencing teachers' mathematical knowledge is in their undergraduate teacher preparation, particularly the mathematics classes they are required to take. Whatever background students bring to teacher preparation, and whatever additional professional development they receive later in their career, undergraduate mathematics classes provide an opportunity for focused attention to mathematics that is unlikely to occur elsewhere in their education or careers.

What do we know?

Curiously, research on the content of mathematics classes for K-6 teacher certification is sparse. The Conference Board of the Mathematical Sciences (CBMS) does a survey every five years that includes a few questions about such courses. The CBMS study is a carefully designed survey using a national probability sample of mathematics

departments. Preliminary results from the 2005 survey are consistent with results from the 2000 study: across all types of institutions, most elementary education majors are required to take two mathematics classes. In recent years, however, certification for teaching mathematics in later grades (grades 4, 5 or 6 through 8 or 9, including middle school[1]) has become more common and those students average over five required classes. The courses most likely to be taken by elementary education students vary somewhat by type of institution (PhD, MA or BA), but in all cases, a multi-term sequence of mathematics classes for elementary education majors is most common for K-3 certification, while calculus, geometry, and statistics are the three most common for later grades certification.[2] Nearly all institutions that offer multiple sections of mathematics classes for elementary teachers use a single textbook. These classes are most often taught by regular tenure-stream faculty and are rarely taught by graduate teaching assistants (Lutzer, Maxwell, & Rodi, forthcoming).

The CBMS survey does not include questions about the content of the classes and that is where this study picks up.

Research Design

The data for this paper come from a phone survey of the mathematics departments of all colleges and universities that offer undergraduate programs for elementary teachers in Michigan, South Carolina, and New York City. These three locations were chosen to reflect a range of state policy activity in regards to teaching quality initiatives. Institutions that offer programs leading to elementary school certification were identified through state department of education websites and state reports at the Title 2 website.[3] The mathematics department chair or the chair's designated representative completed the survey through a phone interview in the summer and fall of 2006. Survey data were

complemented by demographic information on the institutions from the National Center for Education Statistics (NCES), selectivity characteristics from *US News and World Report*,[4] classification information from the Carnegie Foundation for the Advancement of Teaching,[5] and estimated number of elementary teacher candidates from the Title 2 website.

Table 1 shows the sample size and response rate for the department survey. Overall, 81.4% of departments responded to the survey. Response rates did vary by location, ranging from 42.9% in New York City to 96.7% in Michigan.

Table 1

Response Rates and Sample Size

Site	Attempted sample size	Achieved sample size	Percent responding
All	70	57	81%
Michigan	30	29	97%
South Carolina	26	22	85%
New York City	14	6	43%[a]

[a]Interviews with mathematics departments in New York City will continue when Institutional Review Board approvals are obtained.

The chair of the mathematics department was the initial contact for the phone survey. Department chairs could designate a representative who was more knowledgeable about mathematics courses for prospective elementary teachers. Table 2 shows the distribution of titles of the individuals who completed the phone survey. Over half of the surveys were completed by the department chair. The next most common respondent was a faculty member. Often, this faculty member taught courses designated for prospective elementary teachers.

Table 2

Title of Survey Respondent

Respondent (n=57)	Percent
Chair	53%
Program coordinator or director	7%
Staff member	2%
Dean	4%
Other faculty member	34%

This study also makes comparisons between institutions to look for patterns in the organization of prospective teachers' mathematics courses. Institutions are compared by size of elementary teacher education program, selectivity, and Carnegie classification. The selectivity measure was taken directly from *US News*. Table 3 shows the number of institutions by these characteristics. Slightly less than half of the institutions are Masters level institutions and have less than 50 students in their elementary education program. Bachelors institutions have smaller enrollments and PhD institutions have larger programs. PhD institutions also are not considered less selective.

The survey asked more detailed questions about a focal course. If an institution requires more than one course, the focal course is the first course in a sequence or the course that prospective elementary teachers are more likely to take first.

Table 3

Number of Institutions by Size, Selectivity, and Carnegie Classification

Characteristic	All	Bachelors	Masters	PhD
All institutions	57	17	26	14
Size of elementary cohort				
Less than 50	25	12	10	3
50 to 149	15	3	10	2
150 or more	14	0	5	9
Selectivity of institution				
Less selective	11	4	7	0
Selective	29	7	15	7
More selective	17	6	4	7

Findings

Number and Organization of Courses

The survey asked about the mathematics content requirements for prospective elementary teachers. The mean number of mathematics content courses required was 2.18 (SD=1.2; Mode=2). Table 4 shows the percentage of institutions that required various numbers of courses. Just over 49% of institutions required prospective elementary teachers to take 2 content courses in mathematics and 23% required 3 courses. About 5% of institutions did not require prospective elementary teachers to take any mathematics content courses. The required number of courses does not include courses that are considered prerequisites but may be waived through a placement test for the course

requirements. For example, Michigan State University requires prospective elementary teachers to take two courses, Math 201 and 202. Math 201 has a prerequisite that students may place out of through a placement test. The numbers also do not include mathematics methods courses.

Table 4

Number of Mathematics Content Courses Required

Number of Required Classes	Percent of Institutions
0	5.3
1	15.8
2	49.1
3	22.8
4	5.3
5 or more	1.8

Table 5 shows how the course requirements vary by institution type.[6] The basic requirements for all prospective elementary teachers do not vary greatly by institutional type. The exception is that small programs of less than 50 students require slightly fewer courses than larger programs. This may be due to resource constraints in small programs, perhaps they cannot staff more courses for prospective elementary teachers and thus cannot require more courses.

Table 5

Number of Required Mathematics Content Courses by Institutional Characteristics

	Requirements for basic certification		Percent with mathematics specialization	Courses required for mathematics specialization
	Mean	SD	Percent	Mean
All Institutions	2.18	1.17	36.84	6.9
Type of institution				
PhD	2.00	.96	50.00*	6.29
Masters	2.31	.79	46.15*	6.82
Bachelors	2.12	1.80	11.76*	9.50~
Size of elementary cohort				
Less than 50	1.96~	.84	16.00**	8.00
50-149	2.67	1.63	40.00**	7.50
More than 150	2.29	1.07	71.43**	5.89~
Selectivity of institution				
Less selective	2.18	.75	18.18	7.00
Selective	2.14	.83	37.93	6.55
More selective	2.24	1.86	47.06	7.43

~ p<0.1, p<0.05, ** p<0.01.

Table 5 also shows the percentage of institutions that allow prospective teachers to have elementary teaching majors or minor in math. Determining the number of courses required by all elementary teachers is a complex issue. Many institutions, often driven by

state requirements, require students to choose disciplinary teaching majors or minors. That is, prospective elementary teachers may have a major or minor in math, in addition to a planned program for preservice elementary teachers. The required number of courses described here represents the minimum number of courses required for elementary teachers, or the required number of mathematics content courses for students who do not elect to have an elementary math major or minor. CBMS distinguishes between institutions based upon whether the requirements vary for those who want to teach early grades and those who want to teach later grades. In our phone interviews, respondents indicated a distinction between requirements for all prospective elementary teachers and those with an elementary mathematics teaching major or minor. It is likely that prospective teachers who wish to teach mathematics in the later grades choose mathematics major or minor. For simplicity, we call this a "mathematics specialization".

Overall, more than one-third (36%) of institutions have mathematics specializations for elementary teachers. Doctoral institutions are more likely to have specializations for elementary teachers and Bachelors institutions are the least likely. Interestingly, while Bachelors institutions are less likely to offer mathematics specializations to elementary teachers, those that do have more course requirements than doctoral institutions. Doctoral institutions require prospective elementary teachers with a math specialization to take 6.29 courses, while Bachelors institutions require an average of 9.50 courses. The same pattern is present when comparing institutions by size. Institutions with over 150 elementary education graduates each year are the most likely to offer math specializations but require students to take fewer courses for the major than smaller programs.

In recent years, more states have been requiring subject matter specializations for middle grades teaching. Michigan and New York both have a middle school mathematics

certification requirement, and South Carolina is phasing in a policy that will be completely implemented by 2008.[7] Michigan requires a mathematics major (30 hours minimum) or minor (20 hours minimum) and satisfactory performance on the Michigan subject area test. New York requires 30 semester hours of mathematics, student teaching specifically in mathematics in middle school, and acceptable performance on the NY mathematics content area test. In South Carolina, the policy requires an undergraduate major in mathematics and satisfactory performance on the PRAXIS II content area test.

Table 6 presents the average number of sections institutions offer of the focal course each year and average enrollment in these sections. On average, institutions offer 4.1 sections of the focal course each year and have 25.8 students in each section. Not surprisingly, smaller programs offer fewer sections and fewer students per section than larger programs. Mid-size programs have the largest sections while programs with over 150 students have the most sections. The phone interviews indicated that institutions try to ensure similar student learning experiences across multiple sections, although officially nearly all of the institutions have independent sections with no common meeting time across the sections. Respondents also indicated they put enrollment caps—most often 25 or 30 students—on these courses.

Table 6

Number of sections and student enrollment for focal course

		Sections				Student Enrollment			
		Mean number	Std Dev	Min	Max	Mean per section	Std Dev	Min	Max
All institutions	4.1	4.1	3.68	1	18	25.8	9.56	0	60
Type of Institution									
PhD		4.1	3.48	1	13	31.3	19.82	0	60
Masters		4.6	4.27	1	18	25.2	5.75	15	36
Bachelors		2.7	1.16	1	10	23.6	5.32	15	32
Size of Institution									
Less than 50		3.0*	2.37	1	10	21.4*	4.64	15	30
50-149		4.1	3.35	2	15	28.9~	4.36	25	36
More than 150		6.6*	5.35	1	18	28.7	15.34	0	60
Selectivity of institution									
Less selective		4.0	2.54	1	10	23.1	4.58	15	30
Selective		4.0	3.47	1	18	28.1	10.54	15	60
More selective		4.5	4.82	1	15	24.2	10.75	0	36

* p<0.05, ** p<0.01

Table 7 presents information on the organization of the required mathematics content courses for prospective elementary teachers. About 80% of institutions offer mathematics content courses that are designed specifically for prospective elementary teachers while the remaining institutions require elementary teachers to take mathematics

courses from the general curriculum. About 72% of institutions have course requirements that are sequential, requiring students to successfully complete one course before enrolling in the next. Nearly three-quarters of institutions have prerequisites before students are allowed to take the courses for elementary certification. The most common prerequisites include college or intermediate algebra. Many institutions allow students to place out the prerequisite with an ACT or SAT score above a cut point or a passing score on a college placement test.

Table 7

Organization of Required Courses

	Designed for elementary teachers	Sequential courses	Prerequisites required
All institutions	79.6%	72.1%	74.5%
Type of institution			
PhD	80.0	72.7	92.3*
Masters	73.9	73.9	79.2*
Bachelors	90.9	66.7	50.0*
Size of elementary cohort			
Less than 50	73.7	64.7	72.7
50-149	78.6	84.6	78.6
More than 150	90.0	66.7	76.9
Selectivity of institution			
Less selective	62.5	80.0	60.0
Selective	87.5	66.7	80.8
More selective	75.0	77.8	73.3

* $p<0.05$

Content of Courses

Table 8 shows the primary and secondary content areas covered by the required mathematics courses. Among all required mathematics courses, 25% include number and operations as their primary content area and another 14% include number and operations as a secondary content area. Over 21% of all required courses include geometry and measurement as a primary content area and another 21.9% include geometry as a secondary content area.

Comparing the primary content area across the required courses shows a progression from number and operations to geometry and measurement. The focal course for this study is the first course taken in a sequence or the course most students take first. Just over half of the focal courses have number and operations as their primary content area. About 40% of the second courses in a sequence cover geometry and measurement.

Another way to assess the content of the mathematics courses is to examine the textbooks used in these classes. All institutions that have multiple sections of the focal course use the same textbook for all sections. Table 9 presents the percentage of institutions that used various textbooks. There are several textbooks that are designed specifically for mathematics content courses for prospective elementary teachers. Many institutions used one of these textbooks. In particular, Billstein, Libeskind, and Lott (2004) and Musser, Burger and Peterson (2003) were the most popular textbooks. About 26% of institutions used the Billstein book and 15% used the Musser book. Just over 6% of institutions used the Long and DeTemple (2006) or Wheeler and Wheeler (2005) book. Another 13% of institutions used another textbook specifically designed for prospective elementary teachers.

Table 8

Content areas for required mathematics courses

	All required courses		Primary content	
	Primary content	Secondary content	Focal course	Second course
Data and statistics	16.7%	21.7%	5.7%	26.2%
Number and operations	25.0	14.2	50.9	9.5
Problem solving	10.0	20.8	18.9	4.8
Number theory	6.7	22.5	11.3	4.8
Geometry and measurement	21.7	21.9	7.6	40.5
Algebra and pre-algebra	8.3	21.8	11.3	4.8
Logic and/or set theory	5.8	16.8	13.2	0.0

Note: Respondents were asked to choose one primary content area. However, some respondents indicated two content areas of equal importance and could not choose just one area. For this reason, the percentages of primary content area do not add to 100. The percentages for secondary content area do not add to 100 because respondents were allowed to choose multiple areas.

Table 9

Percentage of institutions that used various textbooks

Book	All courses	Courses designed for teachers	Not designed for teachers
Billstein, et al.	26.1%	18.8%	0.0%
Musser, et al.	15.2	18.8	0.0
Long and DeTemple	6.5	6.3	0.0
Wheeler and Wheeler	6.5	9.4	0.0
Other textbook designed for teachers	13.0	18.8	0.0
Other textbook not designed for teachers	23.9	18.8**	80.0**
Non-textbook materials	17.4	15.6	20.0

** $p<0.01$

Textbooks designed for courses for prospective elementary teachers that were mentioned by survey respondents (including the most popular ones) are listed below. We include only the current edition since often the respondent did not specify an edition. Note that two of these books mention learning in the title (Cathcart, 2006; and Van de Walle, 2007), suggesting that they might also be used in methods courses.[8]

Bassarear, T. (2001). *Mathematics for elementary school teachers* (2nd ed.). Boston: Houghton Mifflin.

Beckmann, S. (2005). *Mathematics for elementary teachers*. Boston: Addison-Wesley.

Bennett, A. B., & Nelson, L. T. (2007). *Mathematics for elementary teachers : a*

conceptual approach (7th ed.). Boston: McGraw-Hill Higher Education.

Billstein, R., Libeskind, S., & Lott, J. W. (2007). *A problem solving approach to mathematics for elementary school teachers* (9th ed.). Boston: Pearson Addison Wesley.

Cathcart, W. G. (2006). *Learning mathematics in elementary and middle schools: A learner-centered approach* (4th ed.). Upper Saddle River, N.J.: Pearson Merrill Prentice Hall.

Long, C. T., DeTemple, D. W., & Millman, R. S. (2007). *Mathematical reasoning for elementary teachers* (5th ed.). Boston, Mass.: Pearson.

Musser, G. L., Burger, W. F., & Peterson, B. E. (2006). *Mathematics for elementary teachers: A contemporary approach* (7th ed.). Hoboken, NJ: J. Wiley.

Parker, T. H., & Baldridge, S. J. (2004). *Elementary mathematics for teachers (Volume 1)*. Okemos, MI: Sefton-Ash Publishing.

Sonnabend, T., & Sonnabend, T. (2004). *Mathematics for teachers: An interactive approach for grades K-8* (3rd ed.). Belmont, CA: Thomson Brooks/Cole.

Van de Walle, J. A. (2007). *Elementary and middle school mathematics: Teaching developmentally* (6th ed.). Boston, MA: Pearson /Allyn and Bacon.

Wheeler, R. E., Wheeler, E. R., & Wheeler, R. E. (2005). *Modern mathematics for elementary educators* (12th ed.). Dubuque, Iowa: Kendall/Hunt Pub. Co.

Some institutions used more general textbooks that are not designed for prospective elementary teachers. Slightly less than one-quarter of institutions used such textbooks. Not surprisingly, institutions that do not have courses specifically designed for prospective elementary teachers are more likely to use general textbooks. 80% of institutions that require prospective elementary teachers to take general mathematics courses used general

mathematics textbooks. Textbooks mentioned in the survey are (current edition is indicated):

Aufmann, R. N., Barker, V. C., & Nation, R. (2002). *College algebra* (4th ed.). Boston: Houghton Mifflin Co.

Beem, J. K. (2006). *Geometry connections*. Upper Saddle River, NJ: Pearson Education.

Bello, I. (2006). *Topics in contemporary mathematics* (9th ed.). Boston, MA: Houghton Mifflin Co.

Bittinger, M. L. (2005). *Introductory algebra* (10th ed.). Boston: Pearson Addison Wesley.

Bluman, A. G. (2005). *Mathematics in our world*. Boston: McGraw-Hill Higher Education.

Burger, E. B., & Starbird, M. P. (2005). *The heart of mathematics : an invitation to effective thinking* (2nd ed.). Everyville, CA: Key College Pub.

Jacobs, H. R. (1994). *Mathematics, a human endeavor : a book for those who think they don't like the subject* (3rd ed.). New York: W.H. Freeman.

Miles, T. J., & Nance, D. W. (1997). *Mathematics : one of the liberal arts*. Pacific Grove, Calif.: Brooks/Cole Pub.

Miller, C. D., Heeren, V. E., & Hornsby, E. J. (2004). *Mathematical ideas* (10th ed.). Boston: Addison Wesley.

About 17% of institutions used instructional materials other than a textbook. Often, these included materials locally designed by instructors specifically for this course. Some institutions used materials developed by others for elementary teachers, including materials used for in-service professional development of elementary teachers.

These courses focused on the content of mathematics. However, many respondents indicated they also included elements of the K-8 curriculum, NCTM standards, or use of mathematical teaching tools and manipulatives in these courses. Respondents suggested in the phone interviews that it was important to show the relationship between the mathematics content covered in the courses and the elementary school curriculum. The desire to familiarize prospective elementary teachers with the K-8 curriculum or manipulatives was cited by respondents as reasons to use non-textbook materials or textbooks designed for elementary teachers.

Instructors

Table 10 presents the positions held by instructors of the focal (first) mathematics courses for prospective elementary teachers. About 59% of instructors hold tenured or tenure-eligible positions in their institutions. Almost 20% of instructors are part-time faculty members. In the phone interviews, most respondents indicated these part-time faculty are adjunct instructors, many of whom are full-time K-12 teachers. Just less than 13% of instructors are full-time instructors who do not have a PhD and 5% are full-time instructors with PhDs but not in tenure track positions. This may overestimate the percentage of instructors who have PhDs as respondents indicated that some institutions do not require a PhD to hold a tenured or tenure-eligible position. Least selective institutions are most likely to have instructors with a PhD who hold full-time positions, while those that are somewhat selective are most likely to have full-time instructors without a PhD.

Table 10

Position of instructors of focal course

	Tenured or tenure eligible	Other full-time with PhD	Other full-time without PhD	Part-time faculty	Graduate teaching assistant
All institutions	58.5	5.1	12.8	19.7	4.3
Type of institution					
PhD	46.4	10.7	7.1	17.9	17.9**
Masters	63.5	1.9	15.4	19.2	0.0**
Bachelors	62.5	8.7	17.4	13.0	0.0**
Size of elementary cohort					
Less than 50	66.7	0.0	11.4	22.9	0.0*
50-149	55.6	8.3	11.1	25.0	0.0*
More than 150	54.8	2.4	16.7	14.3	11.9*
Selectivity of institution					
Less selective	57.9	16.7*	11.1~	16.7	0.0**
Selective	63.2	0.0*	19.3~	17.5	0.0**
More selective	52.4	7.1*	4.8~	23.8	11.9**

~ p<0.1, * p<0.05, ** p<0.01

Less than 5% of instructors are graduate teaching assistants, all found in doctoral level institutions. This is not surprising as these institutions have graduate students to serve as teaching assistants. Large institutions and selective institutions also are more

likely to have graduate teaching assistants, although this may be due to the fact that doctoral institutions tend to be larger and more selective.

Table 11 shows the department affiliation of instructors and the percentage of instructors who are teaching the course for the first time. Almost 80% of instructors are members of the mathematics department. This is not surprising as these courses are listed by mathematics departments in all institutions in the survey except one. Few instructors have positions in the department or school of education, although doctoral level institutions are more likely to have instructors from education departments. 18% of instructors hold positions in neither the mathematics nor the education department.[9] Interviews indicated that most of these instructors in "other" departments are adjunct instructors, and thus have no departmental affiliation.

Overall, 7.3% of instructors of the focal course are teaching the course for the first time. Doctoral institutions and more selective institutions are most likely to have first time instructors. Many of the first time instructors are also graduate teaching assistants. The presence of first-time instructors in doctoral institutions may reflect their use of graduate teaching assistants.

Table 11

Department Affiliation of Course Instructors and Percentage First Time Instructors

	Department affiliation			First time instructor
	Mathematics	Education	Other	
All institutions	79.4%	2.8%	17.8%	7.3
Type of institution				
PhD	72.7	13.6**	13.6	20.7**
Masters	82.4	0.0**	17.7	3.9**
Bachelors	90.5	0.0**	9.5	0.0**
Size of elementary cohort				
Less than 50	81.8	3.0	15.2	2.4
50-149	72.7	0.0	27.3	13.9
More than 150	81.1	5.4	13.5	7.0
Selectivity of institution				
Less selective	87.5	0.0	12.5	0.0**
Selective	81.1	3.8	15.1	1.7**
More selective	73.7	2.6	23.7	19.1**

** $p<0.01$

Table 12 shows how difficult respondents thought it was to find instructors for the mathematics content courses for prospective elementary teachers. Most departments (56%) found it easy to find instructors for these courses. The phone interviews suggested it was easy to find instructors because many institutions hire instructors specifically for these

courses and have the same instructors teach it every year. Doctoral institutions, however, do find it difficult to find instructors for these mathematics courses. Two-thirds of doctoral institutions found it very difficult to find instructors for courses for prospective elementary teachers.

Table 12

Difficulty of finding instructors

	Easy	Somewhat difficult	Very difficult	Chi-sq statistic[a]	Prob.
All institutions	56.8	24.3	18.9		
Type of institution					
PhD	11.1	22.2	66.7	19.19	.001
Masters	66.7	27.8	5.6		
Bachelors	80.0	20.0	0.0		
Size of elementary cohort					
Less than 50	71.4	21.4	7.1	3.34	.503
50-149	60.0	20.0	20.0		
More than 150	41.7	25.0	33.3		
Selectivity of institution					
Less selective	87.5	12.5	0.0	5.59	.232
Selective	41.2	35.3	23.5		
More selective	58.3	16.7	25.0		

[a]The chi-square statistic tests whether the distributions are the same. For "type of institution", the null hypothesis can be rejected at the .001 level and suggests that the difficulty of finding instructors is different across degree levels. The other chi-sq statistics suggest that institutions do not vary from expected values by "size" and "selectivity".

Respondents provided reasons for the difficulty of finding instructors. The two main reasons were the lack of qualified instructors and the lack of willing instructors. Few institutions had formal policies about the qualifications for instructors, although most said they expected instructors to have at least a master's degree in mathematics or mathematics education. They also valued experience teaching in K-12 schools, familiarity with the K-12 curriculum. They look for faculty who are interested in working with prospective teachers and who understand that students in these courses often have weak mathematical backgrounds. Respondents who indicated they had difficulty due to lack of willing instructors said that many faculty members prefer to teach advanced level mathematics courses and avoid courses in which most students have limited mathematical background.

Conclusions and Discussion

Overall, 76% of institutions in our survey require their preservice elementary teachers to take two or fewer courses focusing on the content of mathematics. CBMS (2001) recommended prospective elementary teachers have nine credit hours, or an average of three courses, to ensure elementary teachers have the deep mathematical knowledge needed to teach the elementary curriculum. These data suggest that most institutions are not yet meeting the CBMS standard. There are indications of considerable change in recent years in the courses required: between the 2000 and 2005 CBMS surveys, the average number of required classes increased from 2.4 to 2.7, with the biggest change at the PhD level, which increased from 2.2 to 3.3 required classes (Lutzer, Maxwell, & Rodi, 2000; Lutzer et al., forthcoming).

Bigger changes are seen at the middle school level, as preservice elementary teachers with a mathematics specialization are required to take an average of 6.9 mathematics content courses. These numbers are vastly different from the CBMS 2000 survey, when the average was 3 mathematics classes for elementary teachers. CBMS 2005 is much closer to our data, reporting an average of 5.6 required classes for "later grades" certification. The *Mathematical Education of Teachers* (CBMS, 2001) recommends that teachers of middle grades take 21 credit hours, or approximately seven courses, and it appears that states and institutions are aligning themselves with this recommendation.

Courses for prospective elementary teachers are organized in similar ways across institutions. Most are part of a sequence of courses designed specifically for elementary teachers. Most institutions also require students to fulfill a prerequisite before enrolling in these courses, such as successfully completing college algebra or scoring above a cut off point on a placement test. This organization is relatively constant across institutions.

The content of the course is more variable across institutions. While many institutions organize the course sequence as one course on number and operations and one course on geometry and measurement, many also included problem solving or data and statistics as primary content areas in these courses. This organization of the content follows the organization of the major textbooks used in these courses.[10] The data presented here do not allow us to determine whether the content of the textbooks determine the content of the courses or if the content of the courses determine which textbook the instructors choose.[11] Still, any attempt to reform the number or content of courses required for elementary teachers should also attend to the content of the textbooks designed for these courses.

Most instructors of courses for preservice elementary teachers are full-time instructors at their institutions. Many hold tenured or tenure-eligible positions. While few instructors overall are graduate teaching assistants, doctoral institutions—which tend to have larger programs and serve more students—are more likely to have graduate teaching assistants teach these courses. These graduate assistants are often teaching the course for the first time. Institutions also rely on adjunct instructors to fill these courses. These adjuncts often have experience teaching in K-12 schools, although not necessarily elementary schools.

Most institutions do not have much difficulty finding instructors for these courses, although the lack of difficulty is often due to the fact that institutions hire individuals specifically to teach courses in mathematics education. Doctoral institutions had the most difficulty finding instructors. Institutions that did not rely on the same instructor or set of instructors each year had difficulty finding instructors with the necessary background in K-12 education or a willingness to teach students with a weak mathematics background.

In our interviews with mathematics department chairs, we were surprised at the level of involvement and knowledge of the chairs about the mathematical education of teachers. The reported schism between mathematicians and mathematics educators did not hold true in this sample of schools. Department chairs, especially at smaller schools, knew the details of their programs for elementary education students and were often passionate about the importance of their work in educating these future teachers. Whether from the chair or a designated representative, we heard many passionate explanations of the importance of these courses and the struggles departments experience as they try to ensure that elementary teachers are qualified to teach mathematics. We learned of departments that offer extensive tutoring, high-stakes computation tests with multiple chances to

achieve mastery, instructor-written textbooks or materials, and many more examples of efforts aimed at solving the complex problems of the mathematical education of elementary teachers.

In other papers, we report on results from textbook analyses, assessments of student learning, and the relationship of these classes to policy and high stakes testing. Analysis of data from instructor surveys is still underway, with preliminary results expected in Summer 2007. The next step in our analysis is to tie all these pieces together to gain a wider view of opportunities to learn in mathematics classes for prospective elementary teachers.

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Appendix

ME.ET Survey of Mathematics Departments, May 2006

Link to the document here

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Footnotes

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[1]The exact grade levels vary by state, with nearly all including grades 6-8 in the middle school designation.

[2]This question asks for the three classes most likely to be taken. The classes are not rank ordered.

[3]www.title2.org

[4]www.usnews.com/usnews/edu/college/rankings/rankindex_brief.php, 2006 version.

[5]www.carnegiefoundation.org

[6]In all the tables that follow, chi-squared ($\chi 2$) significance tests are used to compare distributions of dichotomous variables, while t-tests compare means between groups for variables treated as continuous. In all cases, the p-value reports the probability of incorrectly rejecting the null hypotheses: for dichotomous variables, that the reported values differ significantly across categories; for continuous variables, that the significant entries differ from the mean of the other categories combined.

[7]One surprising finding of this research is the variability of access to information about certification requirements. It is extremely hard to find in some states (Michigan) and quite easy in others (New York). At the start of the project, before states were selected (2004-5), we investigated over 20 states in depth, and found that the information available to prospective teachers is often obscure if not impossible to find and/or decipher. Although certification requirements are quite complex because they address so many different contingencies, it seems counter-productive to make it so hard for prospective teachers to

learn what they need to do to become teachers. New York has one of the best systems we have seen at http://eservices.nysed.gov/teach/certhelp/CertRequirementHelp.do.

[8]In fact, the second author has used the Van de Walle text to teach mathematics methods to prospective elementary teachers.

[9]The survey instrument also asked whether instructors belonged to mathematics education department. No instructors hold positions in mathematics education departments.

[10]Someesults from the ME.ET textbook analysis are presented in a paper by Siedel in this AERA symposium.

[11] Results from the ME.ET Instructor Survey will be reported elsewhere. Data are still being analyzed.