Doctoral Programs in Mathematics Education in the United States:

2007 Status Report

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Individuals with doctorates in mathematics education have many different career options, including positions in higher education, K-12 district supervisor, state departments of education, and the publishing industry (Glasgow, 2000). In higher education, the positions are about equally split between mathematics departments, and colleges/schools of education. In either case, the supply of faculty with doctorates in mathematics education fall short of the demand of such individuals (Reys, 2000; 2002). For example, over 40% of institutions of higher education searching for mathematics education faculty in 2005-06 were unsuccessful in filling those positions (Reys, 2006).

Doctoral programs in mathematics education have the responsibility of preparing students to enter any of these positions, and this need to prepare graduates for such a wide range of career choices makes designing and implementing a doctoral program in mathematics education challenging. Although the number of programs that award doctorates in mathematics education has grown over the past 4 decades, the production of doctorates in mathematics education has not increased significantly (Reys and Kilpatrick, 2001). So what do we know about the nature of doctoral programs in mathematics education? This paper addresses that question and provides a summary of the current status of doctoral programs in the United States. It is based on a national survey of doctoral programs in mathematics education conducted in early 2007 and was done in preparation for a National Conference on Doctoral Programs in Mathematics Education.

For this report we contacted a representative from each institution whose doctoral program was listed on the AMTE website of doctoral programs (see www.amte.net) was contacted. In addition, institutions that graduated at least three doctorates during each of the last two decades and institutions with recently initiated doctoral programs in mathematics education were contacted. The union of these groups produced an initial list of 95 different institutions. An email was sent to one faculty member in mathematics education at each institution asking her/him to complete an on-line survey (See the survey at `http://matheddb.missouri.edu/surveys/dpsurvey/start.php`). In response to the e-mail, eight institutional representatives reported their universities did not have a doctoral program in mathematics education. (e.g., American University, University of Chicago, Harvard University, University of South Dakota). The initial e-mail together with a follow-up to those not responding to the initial request produced information on 70 of the 87 remaining institutions for an 80% return rate (see Appendix A for a list of the 70 institutions represented in the survey.) All results reported are based on the information self-reported by these institutional representatives. Taken collectively, the 70 institutions responding account for over 80% of doctorates in mathematics education in the United States from 1990 to 2005.

Doctoral Programs within Institutions

Institutions award different doctoral degrees in mathematics education with over two-thirds awarding only a Ph.D. Thirteen percent award only the Ed.D. and about 15% award both the Ed.D. and Ph.D. The programs are housed within different colleges and departments across institutions. The majority of institutions (76%) report their doctoral program in mathematics education resides in a College/School of Education. Twelve programs (17%) are located in other colleges, such as the, College of Arts and Sciences or Natural and Health Sciences, including four programs that are jointly administered by College/School of Education and Arts and Sciences.

Each institution reported how long its doctoral program in mathematics education has been in existence (see Figure 1). As noted, one-third of the institutions have had a program for over 40 years. On the other hand, 14% of institutions started new programs in the last 10 years.

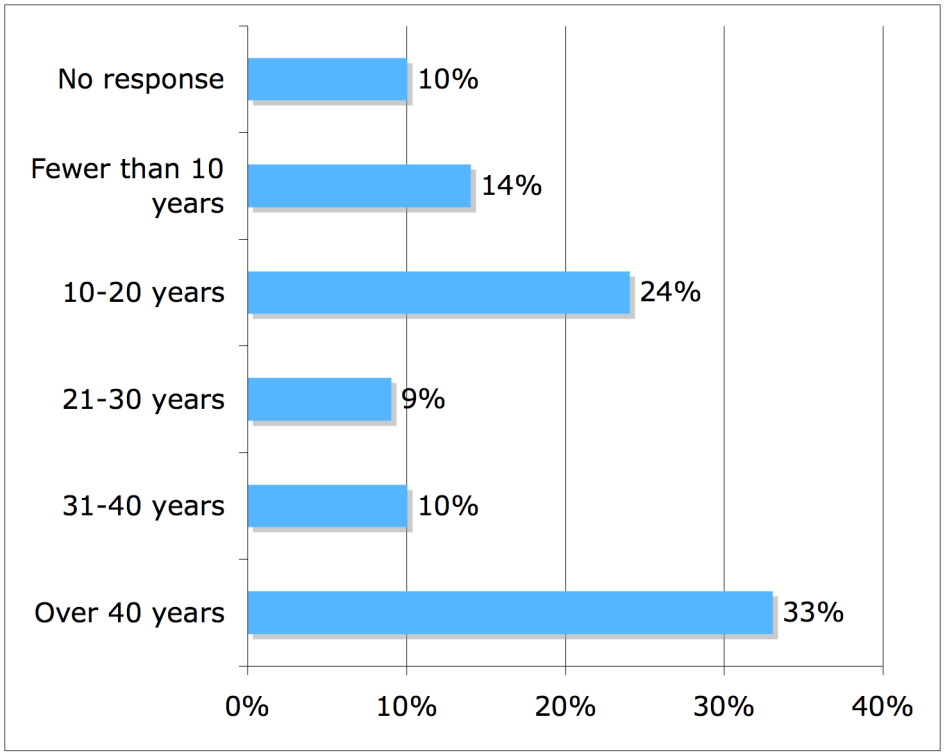

Figure 1. Percent of institutions reporting the number of years their doctoral program in mathematics education program has existed (N=70).

Doctoral Program Faculty

As noted earlier, a shortage of doctorates in mathematics education exists. In addition, previous surveys have indicated a large percentage of current faculty members in the area are approaching retirement age. The survey collected data on current faculty serving the 70 doctoral programs in mathematics education.

Faculty size. The 70 institutions had a total of 366 full-time faculty members, of which 201 (55%) were tenured. The number of mathematics education faculty at an institution ranged from 2 to 19, with the mode being four. Faculty members were predominately in the College of Education, but 25 institutions had at least one member of their faculty in the mathematics department. In fact, all or nearly all of the mathematics education faculty members at six institutions (Illinois State University, Montclair State University, Portland State University, Texas State University, University of Northern Colorado, and Western Michigan University) have an academic home in the mathematics department.

Sixteen institutions reported a post-doc position in mathematics education at their institution, and six of them reported having more than one post-doc. The majority of these post-doc positions are funded externally, but five institutions reported that internal funds are available to support post-doc appointments.

Faculty turnover. Fifty-six institutions reported 115 faculty members either moved from their institution or retired during the last five years. Thirty-four institutions reported faculty members moving from their institutions. A total of 60 retirements from 38 different institutions were reported. While the majority of institutions reported one retirement, 10 institutions reported two retirements, one institution reported four, and another reported five.

Projected retirements. In order to gather data about possible retirements, respondents were asked "How many of your faculty members are eligible for retirement in one or two years?" Twenty-eight institutions reported that collectively 42 faculty members were eligible for retirement within two years and an additional 34 more faculty members would be eligible for retirement within five years. These numbers reflect a combined projected loss of about 20% of current mathematics education faculty members in doctoral programs over the next five years.

Although the projected retirement rate is high, it is not as dramatic as the data reported in the 1999 survey. In the earlier survey, institutions were asked to make the same predictions of faculty eligible to retire. One of the stunning findings was that two-thirds of the faculty members in mathematics education in 1999 were eligible to retire by 2004 (Reys, Glasgow, Ragan & Simms, 2001). A comparison of retirement information from 39 institutions that participated in the 1999 and 2007 surveys confirms that for the last 5 years mathematics education faculty have been retiring steadily as they become eligible to retire or perhaps a few years after they are eligible. Thus, the prediction from 1999 survey for a large number of retirements appears to be coming to fruition, even if a few years delayed.

Hiring faculty. Given the faculty turnover in higher education mathematics education positions, one would suspect that most institutions would be regularly searching for and hiring new faculty. In fact, over 90% (64/70) of institutions reported making at least one hire in mathematics education during the last 5 years. Eighteen institutions made one hire, 24 made two hires, nine made three hires, eight made four hires, four made five hires and one institution made six hires. The latter institution is in the process of establishing a new doctoral program in mathematics education.

Respondents were asked, "Do you have any unfilled positions in mathematics education for 2006-07?" About one-third of the institutional representatives reported that they had at least one unfilled position. In response to a question that asked respondents to "rate the current supply and demand for faculty with doctorates in mathematics education," over 95% said there would be "more or many more mathematics education jobs than qualified applicants." When asked to rate the future supply (in 5 to 10 years), almost 95% provided a similar response. It seems clear that the shortage of doctorates in mathematics education is recognized in the mathematics education community and that the shortage is likely to continue, given current graduation rates (Reys, Glasgow, Teuscher, & Nevels, Conference paper 1).

Over 80% of the institutional representatives reported they would be searching for one or more positions in 2007, and 50 reported they would be doing a search for new faculty members in mathematics education in 2008. Of these institutions, over one-half reported searching for one position and another 20 said they will be searching for two or more positions.

Admission Requirements

Admission requirements for entering a doctoral program in mathematics education vary depending on program emphasis and career goals of the candidates. For example, some institutions differentiate requirements according to whether the candidate seeks an elementary (K-8) or secondary (7-12) emphasis. The survey sought to collect information on all programs related to prerequisite mathematics content background and K-12 teaching experience.

Figure 2 displays the prerequisite mathematics content background for doctoral applicants who wish to pursue an elementary emphasis in mathematics education. Just over one-half of the institutions require or strongly encourage students to enter their program with a BS/BA in Mathematics or Mathematics Education, and about the same number of institutions require or strongly encourage students to enter the program with a MS/MA/MEd in Education.

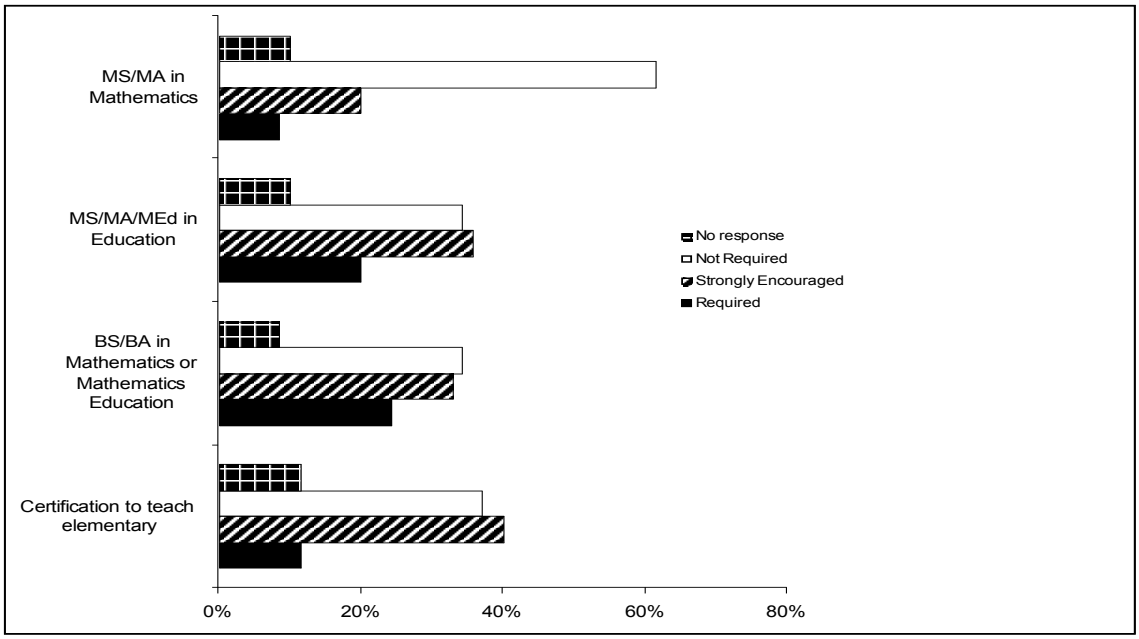

Figure 2. Levels of mathematics background for admittance to programs with an elementary mathematics education emphasis (N=70).

Figure 3 displays the levels of teaching experience for doctoral applicants who wish to pursue an elementary emphasis in mathematics education. About one quarter of the institutions reported a requirement for elementary teaching experience and about one-half (47%) reported they strongly encourage students to have this experience. Although middle, secondary, and college teaching experience were not required, about one-third of the institutions strongly encouraged doctoral applicants to gain such experience. Only 11% of the institutions require doctoral students seeking an elementary emphasis to have an elementary teaching certificate; however, 40% strongly encourage students to have this certificate.

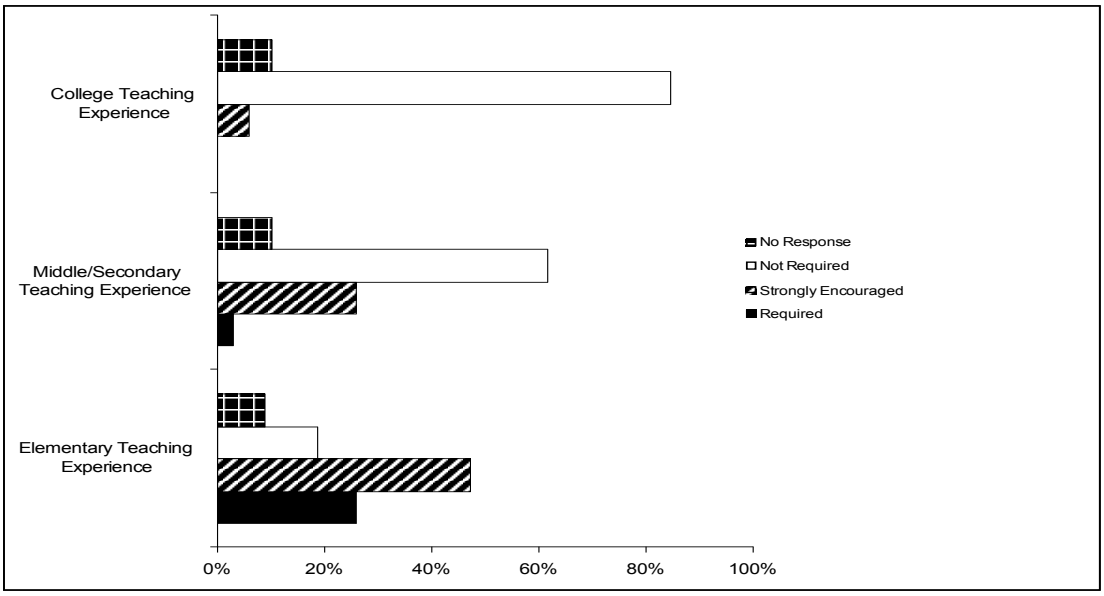

Figure 3. Levels of teaching experience for elementary emphasis (N=70).

As one might suspect, a different level of mathematics knowledge is required for students who wish to pursue an emphasis in secondary or K-12 mathematics education. Figure 4 shows that over half of the institutions require entering students to have a BS/BA in Mathematics or Mathematics Education, and over half of the institutions strongly encourage students to have either an MS/MA/MEd in Mathematics Education or an MS/MA in Mathematics before entering the program.

In contrast to admittance requirements for applicants seeking an elementary emphasis, nearly three-fourths of institutions require or strongly encourage entering students seeking a secondary emphasis to have a teaching certificate at the middle or secondary level. A little over a quarter of the institutions require entering students to take a qualifying exam, although no details were gathered regarding the nature and scope of this exam.

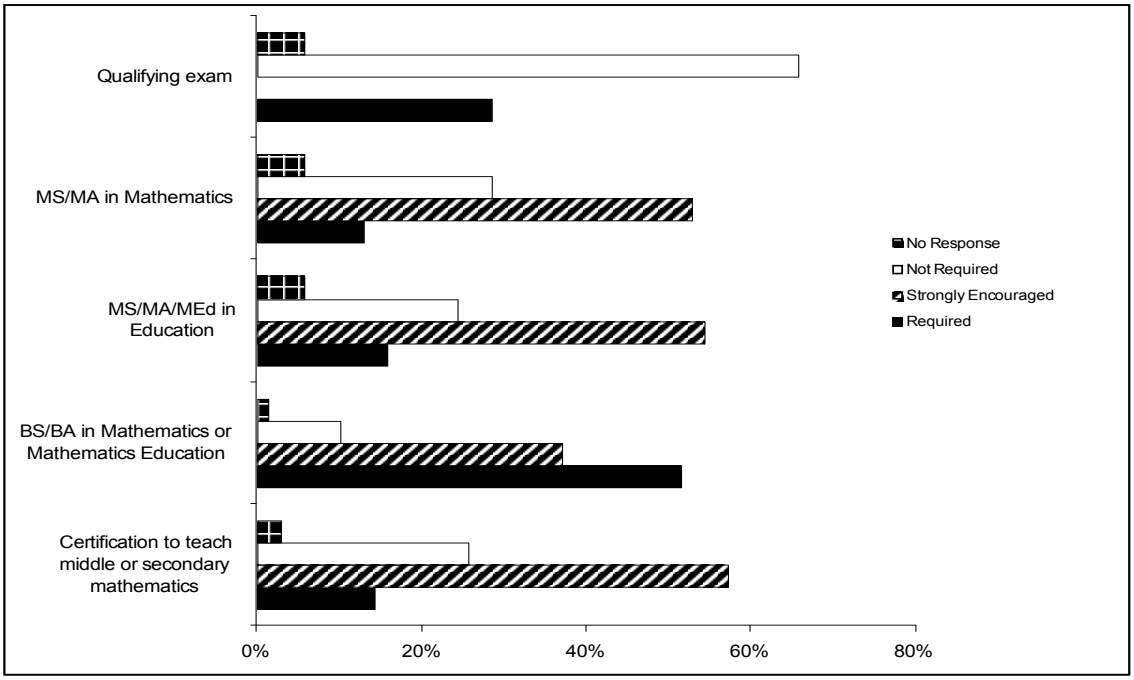

Figure 4. Levels of mathematics background for applicants seeking a secondary or K-12 emphasis in mathematics education (N=70).

Figure 5 displays information about teaching experience for doctoral students wishing to pursue a secondary or K-12 emphasis in mathematics education. Twenty-seven percent of the institutions require middle or secondary teaching experience prior to entering their doctoral program, and over half (54%) report they strongly encourage students to have this experience.

In addition to reviewing academic backgrounds and teaching experiences, most institutions (87%) require applicants to take the Graduate Record Examination (GRE). Additional requirements for entering doctoral students in mathematics education include letters of recommendation, writing samples, statement of purpose, TOEFL score for international students, and faculty interviews. Other considerations noted in the selection process are depth of mathematics content knowledge, evidence of research experience, and determination of

whether the goals and interests of the applicant align with the institution's doctoral program in mathematics education.

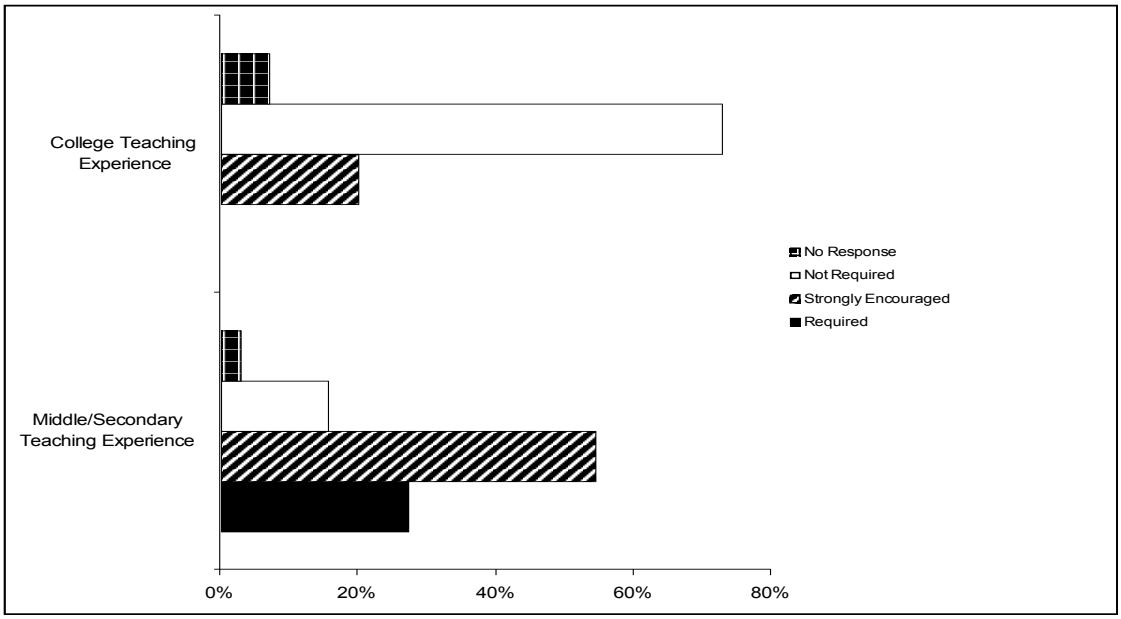

Figure 5. Levels of teaching experience for applicants seeking a secondary or K-12 emphasis in mathematics education (N=70).

Recruitment Strategies

Institutions differ greatly in the intensity of their recruitment efforts for doctoral students in mathematics education. Some institutions rely completely on 'walk-in' graduate students to enter their doctoral programs. Other institutions cast a wide net to attract potential doctoral students by recruiting nationally. Among the most cited local recruitment strategies is communication with former masters' students and local/regional teachers with encouragement to consider a doctoral degree.

Other strategies cited by respondents include posting information about doctoral programs on websites of professional organizations, such as AMTE, and also by being visible at conferences or professional meetings. Dedicating a web page to doctoral programs is also a commonly cited way to attract students. Advertising in professional journals was not generally cited as a common recruitment strategy.

The single most often mentioned recruitment strategy cited was word of mouth. That is, current doctoral students and past graduates were recognized as ambassadors for recruiting new students into a doctoral program. Therefore, institutions producing more graduates are also producing more ambassadors. These ambassadors may contribute to the success of large established doctoral programs continuing to attract large numbers of doctoral students in mathematics education.

When a student expresses interest in a doctoral program, personal follow-up from a faculty member was frequently cited as valuable in establishing an ongoing line of communication.

Delegating one faculty member to provide continuous communication with potential graduate students appears to be an effective strategy. This arrangement places a heavier responsibility on one faculty member but it also insures a common source of information is provided to each student, and that students have individual questions answered in a prompt and consistent manner. Furthermore, the potential students know whom to contact when new questions arise.

Institutions serving full-time doctoral students listed the ability to offer substantial funding to their students as the single most effective recruitment strategy, while others indicated the lack of available funding as detrimental to their recruitment efforts. Institutions reported that financial support was about equally split among doctoral students for teaching assistantships and research assistantships. Teaching assistantships ranged from $11,000 to about $15,000 (median of $13,000) for the academic year, while research assistantships were slightly more, ranging from $11, 900 to about $16,000 (median of $13,500). In addition to assistantships, about one-third of doctoral students receive additional fellowships/scholarships. These fellowships/scholarships ranged from $300 upward to $10,000. In addition, 86% of the institutions reported a full-tuition waiver for students receiving a teaching or research assistantship. Two-thirds of the institutions also provided health insurance for full time graduate students.

Demographics of Current Doctoral Students

Institutions reported that 60% of the current doctoral students in mathematics education are female and over one-half (56%) are full-time doctoral students. This dominance of females continues a two decade trend of more females graduating with doctorates in mathematics education than males (See Table 5 in Reys, Glasgow, Teuscher, & Nevels, Conference paper 1). The ethnicity of current doctoral students includes American Indian or Native Alaskan (0.6%), Hispanic Americans (3.0%), African Americans (8.4%), White (non-Hispanic) Americans (61%), and Asian Americans or Pacific Islanders (8.0%). The percent of minority groups represented is consistent with the data reported earlier (See Table 6 in Reys, Glasgow, Teuscher, & Nevels, Conference paper 1). Nearly one-fifth of the current doctoral students in mathematics education were international students (19%). Figure 6 provides information on both ethnicity and gender for all groups of doctoral students.

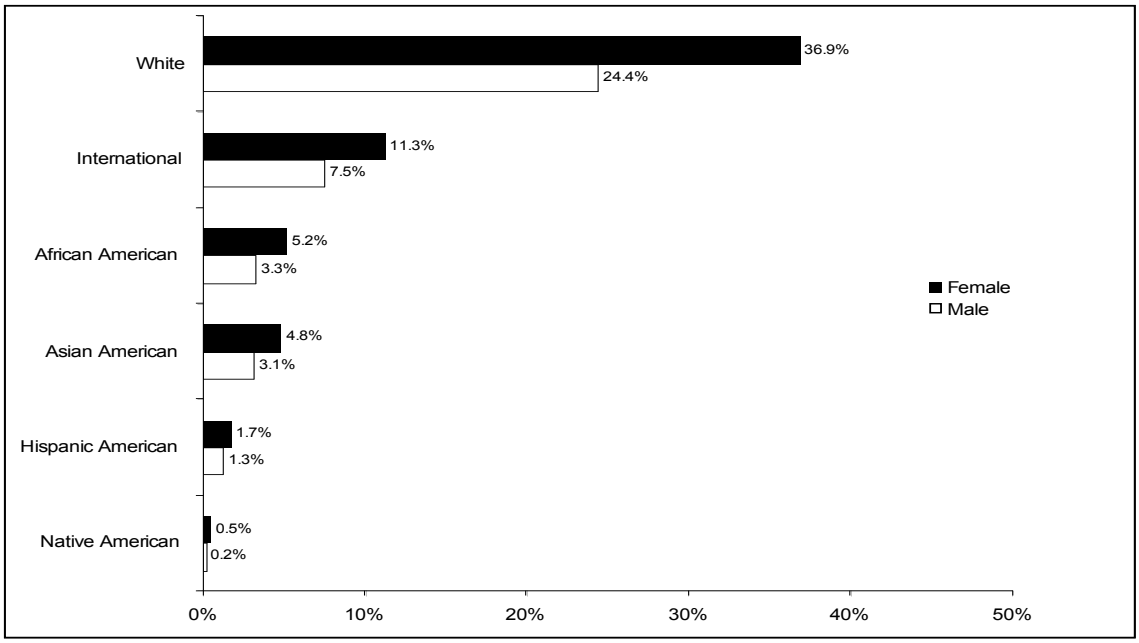

Figure 6. Gender and ethnicity of current mathematics education doctoral students.

Employment graduates pursue. Respondents were asked to rank order positions taken by their students upon completion of a doctorate in mathematics education. Positions in higher education, either colleges/schools/departments of education or mathematics departments were the two most often cited positions. Joint appointments in education and mathematics were also ranked high. Over 85% of the respondents ranked a position in higher education as the number one type of position taken by their mathematics education doctoral program graduates. The popularity of jobs in higher education for graduates with doctorates in mathematics education reported here is consistent with earlier research done by Glasgow (2000). While doctorates in mathematics education have many different job opportunities outside of academia, the overwhelming majority of doctorates are employed in higher education. Another 13% of respondents ranked positions as K-12 classroom teachers or Mathematics Coordinators as the top position taken by their graduates. About 2% indicated some other type of position as their graduates' top ranked employment. When asked in the survey to describe these other job opportunities for graduates, employment at junior/community colleges was the most frequently mentioned.

Program Requirements

About one-half the institutions reported a requirement of 81-100 graduate semester hours (post bachelors degree) to complete a doctorate, with more than one-third of the institutions requiring fewer than 81 semester hours. In an effort to determine how these hours were distributed across different areas, a question was asked about course requirements in different areas. Responses are reported in Figure 7.

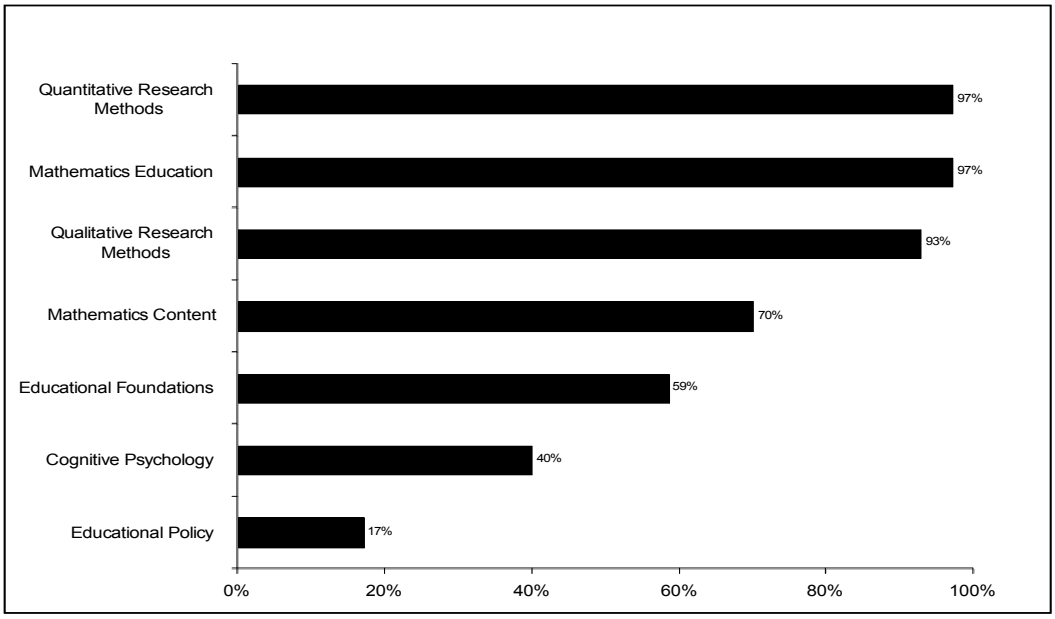

Figure 7. Percent of institutions reporting required courses in specific disciplines (N=70).

Figure 7 confirms that required courses are distributed across different areas, with only two areas (Education Policy and Cognitive Psychology) below the 50% level. Note that most, but not all of the programs require coursework in mathematics.

In an effort to get another perspective of the emphasis placed on coursework, respondents were asked to rate the attention given to courses in different areas. Responses are summarized in Figure 8.

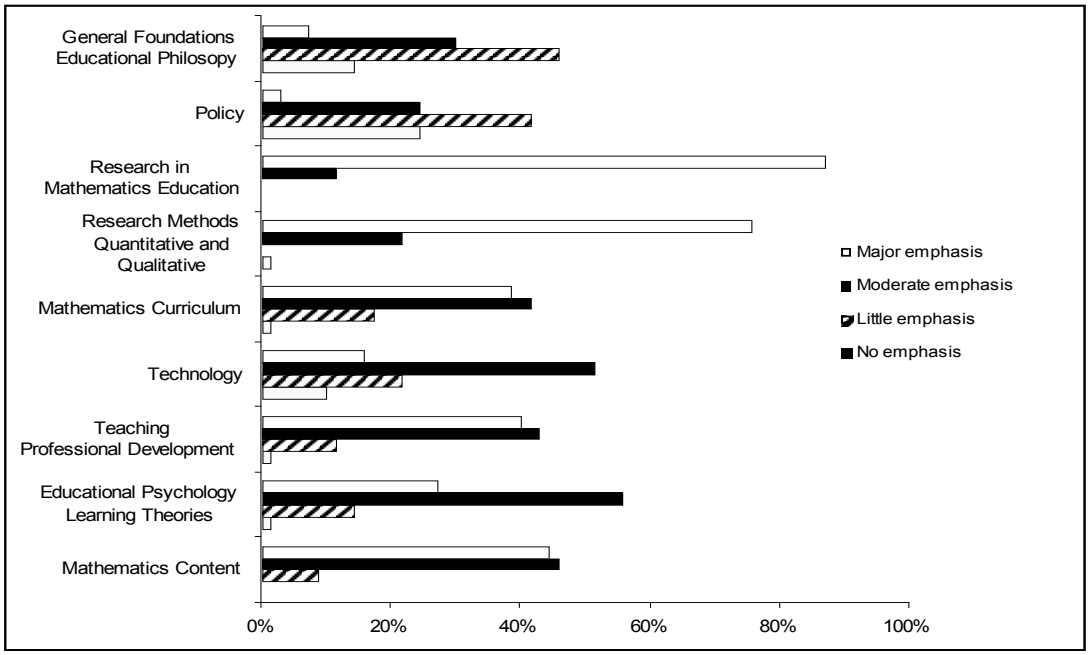

Figure 8. Percent of institutions reporting emphasis given to different content areas (N=70).

Figure 8 shows the two areas with the strongest emphasis (major or moderate) in doctoral programs are Research in Mathematics Education (98%) and Research Methods (Quantitative and Qualitative) (97%), followed by Mathematics Content (90%), Learning Theories (83%), Teaching/Professional Development (83%) and Mathematics Curriculum (80%). In addition, a few institutions identified other program areas, such as Diversity/Multiculturalism, Equity and Cognitive Science as receiving moderate or major emphasis in their doctoral program.

In addition to course work, most institutions require comprehensive examinations (89%) and residency (76%), although how residency is satisfied varies across institutions. Several "beyond course" experiences were reported as required, with internships in research (31%) and college teaching (21%) being the most frequently cited. In addition, 16% of institutions required at least one presentation at professional meetings, and three institutions required a published article as part of their program expectations.

As noted earlier, the emphasis on college mathematics within a doctoral program in mathematics education varies across institutions. Dossey and Lappan (2001) offered proposals to reflect different depths of mathematical knowledge for doctoral students seeking emphasis in elementary, middle and secondary school mathematics education. Figure 9 summarizes the level of mathematics content that would generally be attained as reported by institutions in this survey for elementary and K-16 emphasis.

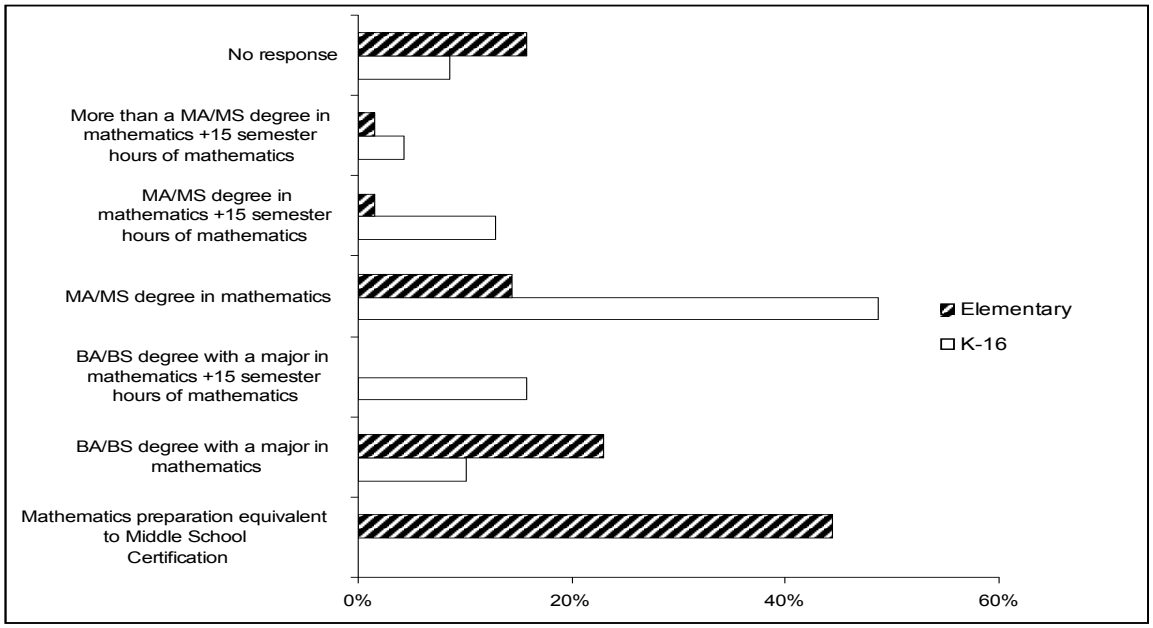

Figure 9. Percent of institutions reporting the level of mathematics course work generally attained by doctoral students focusing on elementary or a broader K-16. (N=70)

Nearly one-half of the doctoral students who have an elementary focus graduate with a mathematics content background similar to a middle school teacher and the others have at least the equivalent of a major in mathematics. Whereas, upon completion of their doctoral program, students with a K-16 focus graduate with a mathematics content background

equivalent to a MA/MS in mathematics. The data in Figure 10 are generally consistent with the 'plus six' criterion offered by Dossey and Lappan (2001), namely that graduates have at least six educational grade levels above their teaching assignment.

Changing nature of doctoral programs

As a result of the 1999 Conference on Doctoral Programs in Mathematics Education, the Association of Mathematics Teacher Educators (AMTE) established a task force to develop guidelines for doctoral programs in mathematics education. The task force produced *Principles to Guide the Design and Implementation of Doctoral Programs in Mathematics Education*. This document was endorsed by the AMTE and the National Council of Teachers of Mathematics (NCTM) in 2002.

In an effort to determine the extent to which this document was known and to examine its impact among institutions with doctoral programs in mathematics education, the following question was asked: "How familiar are you with *Principles to Guide the Design and Implementation of Doctoral Programs in Mathematics Education?"*
Twenty-eight percent of respondents were unaware of the document. On the other hand, 72 percent of these respondents were either Somewhat Familiar (41%) or Very Familiar (31%) with the document. This latter group reported using the AMTE *Principles* to guide the development of a review or reshaping of their doctoral program or in the development of a new program. For example, one respondent said: "It served as a framework for us to develop new courses to provide a broader and deeper preparation of doctoral students." Another indicated, "We used the suggested guidelines for establishing requirements for the Ed.D. in Pedagogy with a Specialization in Mathematics Education." In addition, several respondents commented that they used the recommendations provided in the section 'Institutional Capacity Needed to Support Quality Doctoral Programs' to garner more institutional resources to support their doctoral program in mathematics education.

The 1999 Conference resulted in the publication of *One Field, Many Paths: U. S. Doctoral Programs in Mathematics Education.* This document provided a number of ideas and suggestions regarding doctoral programs. One survey question asked: "How familiar are you with *One Field, Many Paths: U. S. Doctoral Programs in Mathematics Education (2001)?"*

Over three-fourths of the respondents were either Somewhat or Very Familiar with *One Field, Many Paths*. Respondents reported using this document to shape their doctoral program. For example, "We used the information about shortages as a resource to the task force that recently wrote a paper for departmental discussion related to hiring a mathematics educator." Another said "It helped us implement internships and also led to annual progress reviews of our doctoral students that we designed to simulate what our graduates will experience if their pursue a tenure track position in higher education."

These two documents were developed to share with others involved in doctoral programs in mathematics education. The survey results underscore the impact of these documents on the field. The fact that one-quarter of the respondents was not aware of either of these documents suggests there is a continuing need to spread the word about these materials and their

potential for informing and stimulating discussion about doctoral preparation in mathematics education.

Two survey questions were provided to gain information about the status of doctoral programs in mathematics education. One question asked about changes in the last five years, and another asked respondents to speculate on changes for the next five years.

In response to the question "Have the requirements in your doctoral programs changed in the last five years?" institutions were about evenly split. Slightly over half of the institutions (36/70) reported no programmatic changes. Of the other institutions, the common theme was that their doctoral program in mathematics education is "constantly evolving". Large established doctoral programs were represented in each group; whereas smaller and newly established programs dominated the institutions reporting change. The changes reported were diverse, ranging from establishing a new doctoral program (3 institutions) to replacing one doctoral program with another. For example, one institution reported replacing their Ed.D. program with a Ph.D., while another institution reported their Ph.D. program had been shifted from the Department of Mathematics to their College of Education.

While changes in entrance requirements were reported, the most frequently cited changes reflected expanding course offerings in mathematics education, or providing for internship opportunities. There was a trend to expand or refocus course offerings to better serve doctoral students. Institutions reported developing specific courses for doctoral students in mathematics education in a range of areas, including foundations of mathematics education, equity, curriculum, learning, policy, technology, and professional development. Although mathematics content courses provide a common foundation for nearly all doctoral students in mathematics education, no institution reported making any substantial changes in mathematics content courses targeted toward graduate students in mathematics education.

In addition to creating specific courses, research was the area most singled out for change. More emphasis was given to strengthening research preparation. This was reflected in different statements such as:

> "Additional research methods are now required."
> "Increased research methodology requirements, to better prepare students to understand and use a variety of research methods."
> "Requiring a research apprenticeship."
> "We are moving from a program for practitioners to one that promotes high professional engagement in research and scholarship."
> "More emphasis on research, flexibility in core foundation courses, emphasis on presentations and publications."

High quality preparation of doctoral students in mathematics education must go beyond coursework (Blume, 2001; Golde & Walker, 2006; Levine, 2007). There was evidence that a number of institutions have initiated multiple "beyond coursework" experiences for their doctoral students in mathematics education. This idea was clearly captured by one institutional response that stated "We have completely redeveloped our program to

emphasize a graduated series of research apprenticeship experiences that extends beyond formal courses." While this response focused on research apprenticeships, other institutions echoed a similar approach by providing teaching internships (where doctoral students co-teach undergraduate methods courses with regular faculty). Other internships cited included the art of editing, proposal writing, and co-authoring manuscripts for publication. All of these internships reflect an effort to provide opportunities for increased mentoring and closer working relationships with faculty members in mathematics education.

In looking to the future, over one-half of the institutions reported their doctoral program will be changing in the next five years. A central issue for 8 of these institutions was related to the degree designation. Institutions offering both the Ph.D. and Ed.D. were reviewing the nature of these degrees to determine if they are significantly different to justify offering separate degrees. Two institutions that offer the Ed.D. reported they were reshaping their program to offer the Ph.D. in lieu of the Ed.D. Several existing doctoral programs (whether Ph.D. or Ed.D.) were revising their program to better serve students. For example, one urban institution reported developing a doctoral program for part-time students who have a school-centered focus. Several institutions reported a change from a strong emphasis in mathematics content to more rigorous preparation in mathematics education.

The majority of changes described were specific with respect to an institution. However, among the litany of challenges being addressed by more than one institution were better accommodation of international students; strategies for preparing doctoral students who have little/no teaching experience in U.S. schools; reviewing residency requirements; developing graduate courses in mathematics to better serve doctoral students in mathematics education; establishing teams of doctoral students to work closely with individual faculty members; and providing an option of journal articles in lieu of a dissertation. These were offered as issues that are currently being discussed along with the realization that they are complex and their resolution remains a challenge.

Increasing course offerings by adding new required courses for doctorates in mathematics education was reported by many institutions. These course changes were similar to those mentioned earlier by institutions that have been changing their programs over the last 5 years. In addition to the wave of expanding beyond course experiences (such as co-teaching, research, and grant writing), some institutions were specifically expanding requirements to have students take courses in other disciplines, such as cognitive science and learning theories, as well as sociology and urban studies.

Taking these two questions together (i.e., Has your program changed in the last 5 years? Do you anticipate changes in the next 5 years?) it is clear that doctoral programs in mathematics education are changing. Nearly 80% of the institutions reported change has been or will be taking place in their doctoral programs in mathematics education. Given the rapid changes in society and demands for leadership in mathematics education, such ongoing program review and changes are critical to the continued growth and strengthening of doctoral programs in mathematics education.

It is surprising that no institution identified the time required to complete a doctorate in mathematics education as an issue being considered among the many program changes that have been implemented or are being considered for the future. This is in contrast to the discussions reported by Golde & Walker (2006) where concern about shortening the time required to complete a doctorate was a common theme among many different disciplines.

In mathematics education, the majority of doctoral students acquire teaching experience prior to entering doctoral programs. That means these students must make significant financial sacrifices in their income to return as full-time graduate students. Every year spent as a full-time graduate student multiplies this financial sacrifice. Glasgow (2000) reported that doctorates in mathematics education average 18 years between earning their bachelor's and doctoral degrees. This means that generally they are near 40 years of age before they earn a doctorate in mathematics education. This is in comparison to many fields, such as mathematics, where doctorates are usually earned while a person is still in their twenties. For doctoral students in mathematics education, this translates into less time in their career prior to retirement. Given these situations and the shortage of doctorates in mathematics education, it seems reasonable that exploring ways of shortening the time to complete a doctorate in mathematics education should at least be on the radar screen for discussion.

How changes are initiated and implemented are unique to each institution. Learning from others can be a valuable teacher. Along that line, it is said imitation is the greatest form of flattery. Several institutions reported faculty members visiting other campuses with the specific purpose of learning more about their doctoral program in mathematics education. These experiences have been used to revise and strengthen their doctoral programs. One institution reported it made "changes to reflect ideas . . . from other strong doctoral programs in mathematics education." Since every institution is different, there is no single approach to strengthening or revitalizing a doctoral program. Nevertheless, it seems reasonable that faculty at each institution have a responsibility to be vigilant of their doctoral program, the faculty and resources available, and factor in the students being served to ask "Are we doing the best that we can with what we have?"

"Particularly Strong" Doctoral Programs in Mathematics Education

In 2001, the AMTE created a website to allow institutions with doctoral programs in mathematics education to share common information. This resource remains available at www.amte.net. The institutional information is self reported and no effort is made to verify the information or to analyze the data in order to examine different qualities of doctoral programs. Some publications, such as the *U.S. News and World Reports,* provide annual rankings of undergraduate and graduate programs. Although some rankings are based on quantitative data, such as the number of scholarly papers published, often rankings are based on perceptions that have been established. In such cases, the beauty of a doctoral program is in the eye of the beholder.

We report here a slightly different approach. Respondents were asked to identify 'particularly strong' doctoral programs in mathematics education. The assumption in this effort is that faculty members involved in a doctoral program in mathematics education are aware of

different programs around the country. Their familiarity may result from a variety of experiences, ranging from being a graduate of a program, working with colleagues in other programs, and knowing graduates of certain programs. It may also be influenced by the visibility of faculty members from specific institutions during professional meetings and via scholarly publications. Any and all of these factors are likely to influence the perception of a program.

This was the philosophy used in ratings of graduate programs generated by the National Research Council in its first report on the status of research-doctorate programs in the Sciences (including the broad fields of Biological Sciences, Physical Sciences and Mathematics, and Social and Behavioral Sciences), Engineering, and Arts and Humanities in the United States (Jones, Lindzey, and Coggeshall, 1982). The ratings were updated in a second report published in 1995 (Goldberger, Maher, and Flattau, 1995). The process used to form ratings of graduate programs in various fields involved asking faculty members of other programs to rate an institution's program based on two criteria. The criteria were: 1) scholarly quality of program faculty, and (2) effectiveness in educating research scholars/scientists. To facilitate the raters' decisions, a list of faculty for a particular program was provided. The NRC ratings are still used by other organizations, such as the American Mathematical Society, to group graduate programs in particular academic disciplines. There has been no similar effort done with regard to identifying nationally recognized doctoral programs in mathematics education. And given the grain size of doctoral programs in mathematics education, this type of reporting is unlikely by national media.

The current survey collected data from representatives of 70 institutions with doctoral programs in mathematics education, and as mentioned earlier, these institutions account for more than 80% of doctorates in mathematics education. The programs range in size of faculty and the production of doctoral students. Some produce 2-10 doctoral students each year, but the majority graduate 1-2 doctoral students in mathematics education over several years. One respondent from each of these institutions was asked to respond to the following question:

> Identify 6 institutions that you think are particularly strong and that you would currently recommend to a potential doctoral student in mathematics education (other than your own institution).

Seven respondents did not identify any institutions. An examination of the data revealed that all of the respondents honored the request to not make a self-nomination. About half the institutions listed six institutions, and the remaining nominated from one to five institutions. The data in Table 1 were compiled by tallying the number of times an institution was listed, and all institutions identified by at least two respondents are reported. Forty different institutions were nominated by 63 respondents, but only three institutions (University of Georgia, Michigan State University, and University of Michigan) were named by a majority of institutions. The University of Georgia is also the only institution among the top five producers of doctorates in mathematics education to be named by a majority of institutions. In fact a number of the large producers of doctorates, such as Teachers College and Florida State University received only two nominations.

Table 1: Institutions that were identified by at least two institutional representatives as a "particularly strong doctoral program and one you would recommend."

Rank (by number of nominations)	**Institution**	**Number of Nominations**	**Rank** (by number of doctorates awarded)
1	University of Georgia	50	**2**
2	Michigan State	37	**20**
3	University of Michigan	33	**15**
4	University of Missouri	29	**28**
5	University of Wisconsin	20	**14**
6	University of Maryland	18	**9**
7	San Diego State University/UCSD	17	**80**
8	Pennsylvania State University	15	**24**
8	University of California-Berkeley	15	**32**
10	Indiana University	12	**7**
11	Vanderbilt University	10	**19**
12	Stanford University	8	**38**
12	University of Delaware	8	**62**
14	Arizona State University	6	**50**
15	Illinois State University	5	**28**
16	Ohio State University	4	**3**
16	University of Louisville	4	**New Program**
16	University of New Hampshire	4	**54**
19	North Carolina State University	3	**22**
19	Texas A & M University	3	**55**
19	UCLA	3	**73**
19	University of Texas	3	**4**
23	Florida State University	2	**5**
23	Portland State University	2	**98**
23	Teachers College, Columbia University	2	**1**
23	University of Tennessee	2	**39**

It is recognized that as faculty and resources come and go, programs change. This survey provides a current perspective of program visibility from one's peers. Hopefully, these data will be useful as institutions reflect on how their doctoral program in mathematics is perceived by others.

One limitation of this survey is that only one representative from each institution provided information. It is not known whether their selection of institutions was based solely on their own opinion or reflected discussions with other colleagues. Despite whatever limitations are associated with this effort, Table 1 provides a unique view of "particularly strong" doctoral programs in mathematics education.

Summary

The information reported here has been gathered from representatives of 70 institutions in the United States with doctoral programs in mathematics education. It provides current information on faculty and institutional program characteristics.

Both the Ph.D. and Ed.D. degrees are available, but the Ph.D. is offered by over 80% of the institutions, and exclusively by two-thirds of the institutions. Nearly 90% of the doctoral programs in mathematics education reside in the College/School of Education.

The majority of institutions offering doctoral programs in mathematics education have been established for over 30 years, while about 15% of the programs are less than 10 years old. Regardless of the duration of their program, nearly four-fifths of the institutions reported that their doctoral program in mathematics education is undergoing constant review and experiencing frequent changes. One of the most frequently cited changes from the program descriptions provided in the 1999 survey was the initiation of beyond-course experiences (such as co-teaching, research, and grant writing) into many doctoral programs.

Over half of the current full-time faculty members in mathematics education were tenured, and over 80% of them are in Colleges/Schools of Education. In some institutions, all of the mathematics education faculty members are in the mathematics department, yet over one-third of the institutions reported having at least one mathematics educator in the mathematics department.

All institutions were aware of the shortage of doctorates in mathematics education. Consequently, recruiting new faculty and retaining current faculty was recognized as a continuing challenge. During the last five years, four-fifths of the institutions reported losing one or more faculty members to either retirement or being hired by another institution.

As the need for more doctorates in mathematics education increases, the recruitment of doctoral students has become more intense. Word of mouth from prior graduates of doctoral programs was identified as one of the most effective means of recruiting new students. Support (financial, tuition waivers, health insurance) for full-time doctoral students varied among institutions, but the largest variance was in the number of scholarships/fellowships available and their range of financial support.

This survey provides some information on doctoral programs perceived as ‘particularly strong’ by faculty at peer institutions. These results suggest that some of the larger producers of doctorates are perceived as ‘particularly strong’ but other large producers were not frequently nominated. It is a reminder that doctoral programs in mathematics education are constantly changing, and as these changes occur, perceptions of these programs by their peers change.

Our hope is that this survey provides data that will be useful in reflecting on the nature of doctoral programs in mathematics education. It is only a snapshot, and it only reflects information gathered from 70 institutions. Nevertheless, it provides a current set of

benchmarks to use for thoughtful discussion, and ultimately, action as our mathematics education community continues to work toward the never ending task of improving doctoral programs in mathematics education. We are in agreement with Lee Shulman who said:

> The Ph.D. is expected to serve as a steward of her discipline or profession, dedicated to the integrity of its work in the generation, critique, transformation, transmission, and use of its knowledge. (Golde & Walker, 2006, p. 122)

Our hope is that information reported here will facilitate institutional efforts to strengthen their doctoral programs in mathematics education and thereby prepare future stewards of our discipline.

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Appendix A: Institutions (N=70) represented in the survey of doctoral programs in mathematics education in the United States.

Arizona State University
Auburn University
Baylor University
Boston University
Florida State University
George Mason University
Georgia State University
Illinois State University
Indiana University
Michigan State University
Mississippi State University
Montana State University
Montclair State University
New York University
North Carolina State University
Oklahoma State University
Oregon State University
Portland State University
Purdue University
Rutgers University
San Diego State University
Southern Illinois University
Syracuse University
Teachers College, Columbia University
Temple University
Texas A & M University
Texas State University
Texas Tech University
The Ohio State University
The Pennsylvania State University
The University of Iowa
The University of Mississippi
University of California-Los Angeles
University of Alabama
University of Arizona
University of Arkansas-Fayetteville
University of Arkansas-Little Rock
University of Buffalo-SUNY
University of California-Berkeley
University of California-Davis
University of California-Santa Barbara
University of Colorado
University of Delaware
University of Florida
University of Georgia
University of Houston
University of Idaho
University of Illinois
University of Kansas
University of Kentucky
University of Maryland
University of Massachusetts-Amherst
University of Michigan
University of Minnesota
University of Missouri-Columbia
University of Missouri-Kansas City
University of Northern Colorado
University of Oklahoma
University of Pittsburgh
University of Rochester
University of South Carolina
University of South Florida
University of Tennessee
University of Texas
University of Virginia
University of Wisconsin
Vanderbilt University
Virginia Tech University
West Virginia University
Western Michigan University