BOARD OF HIGHER EDUCATION

REQUEST FOR BOARD ACTION

NO.: AAC 09-12

BOARD DATE: April 30, 2009

UNIVERSITY OF MASSACHUSETTS DARTMOUTH
Master of Science in Mathematics Education and Doctor of Philosophy in Mathematics Education

MOVED: The Board of Higher Education hereby approves the application of the **University of Massachusetts Dartmouth** to award the **Master of Science in Mathematics Education** and the **Doctor of Philosophy in Mathematics Education.**

One year after graduating the program's first class, the University shall submit to the Board a status report addressing its success in reaching program goals as stated in this report and in the areas of enrollment, curriculum, faculty, resources, and program effectiveness.

Authority: Massachusetts General Laws Chapter 15A, Section 9(b)

Contact: Dr. Francesca Purcell, Associate Commissioner for Academic and P-16 Policy

BOARD OF HIGHER EDUCATION

April 2009

University of Massachusetts Dartmouth
Doctor of Philosophy in Mathematics Education
Master of Science in Mathematics Education

INTENT AND MISSION

The University of Massachusetts Dartmouth (UMass Dartmouth) filed an expedited application to offer a graduate program leading to the Master of Science and Doctor of Philosophy in Mathematics Education in the School for Education, Public Policy, and Civic Engagement. The proposed program's mission is to foster and improve mathematics education through the training of advanced researchers which aligns with the purposes of the James J. Kaput Center for Research and Innovation in Mathematics Education (Kaput Center), where the proposed program will be housed.

The proposed program in mathematics education intends to provide mathematics educators with the educational infrastructure and advanced specialized training to become researchers of mathematics education, as well as to serve as scholars who will to meet the mathematics education needs of the coming century. Moreover, the proposed program's interdisciplinary perspective intends to provide students with the knowledge and skills to re-construct, appropriate, and develop mathematical knowledge; explore different approaches that emerge from the study of the research literature in the field of mathematics education and related disciplines; and write original research that represents their own contribution to knowledge. During the program of study, students will earn a master of science in mathematics education as preparation for advanced doctoral work and the dissertation. However, students will apply directly to the doctoral program and not to a separate master's program.

In December 2007 a planning committee was established at UMass Dartmouth, and shortly thereafter, Provost Anthony Garro and Associate Vice Chancellor Richard Panofsky granted administrative approval to develop a full proposal for a graduate program in mathematics education. The proposal was reviewed and approved by the Curriculum Committee of the newly established School for Education, Public Policy, and Civic Engagement; the University Curriculum Committee; and the Faculty Senate. A preliminary proposal was submitted to the President's office in September 2008, and authorization for development of a final proposal was given in November 2008. The final proposal was approved by the University Board of Trustees on February 27, 2009.

In accordance with Board of Higher Education guidelines for the expedited review of new programs, a letter of intent for the proposed program was distributed to all public colleges and University presidents and chancellors on December 17, 2008. No comments in response were received.

NEED AND DEMAND

In the last several decades, a convergence of research and a growing national consensus for reform in teaching and learning K-16 mathematics have led to the emergence of mathematics education as a field of inquiry for which faculty are hired. Further, there is an inadequate national infrastructure for doctoral programs in mathematics education. Researcher R. E. Reys reported in 2006 that 90 percent of selected higher education institutions reported hiring at least one mathematics education faculty person during the last five years, and many institutions were

having difficulty filling faculty positions. For example, in 2005-2006, over 40 percent of the institutions were unsuccessful in hiring mathematics education faculty.

The national need for professionals with doctoral training in mathematics education is consistent with findings from UMass Dartmouth's own needs assessments regarding a doctoral program in mathematics education. In February 2008, Kaput Center researchers conducted a needs analysis, surveying over 400 people in schools, universities, and research institutions locally, as well as nationally and internationally. The survey assessed need from potential students, as well as quality in the proposed program from academic advisors, school administrators, senior researchers and university faculty. Overall, results indicated a demand for this graduate program. The survey responses also indicated that the program is innovative, and its emphasis on developing research scholarship is regarded as useful and responsive to the need for more researchers and professors in mathematics education.

The proposed program seeks to integrate its goals with industry research and bring distributed, technological environments and apprenticeships to doctoral training. It also intends to embed research projects in the curriculum in a unique manner and offer students sustained interaction with international scholars and research projects through the Kaput Center. These features intend to set the proposed program apart from others in the region.

The potential competitor programs below are focused on teaching or policy, with math education as a sub-focus, and have different requirements (e.g., advanced mathematics courses) that shape the focus of their programs and their pools of graduate students. In contrast, the proposed program in mathematics education at UMass Dartmouth intends to focus on cutting-edge research theory and methods in mathematics education.

- The School of Education at UMass Amherst offers an Ed.D. in mathematics and science education. This program provides a practical approach, enabling students to use new research findings to improve the learning and teaching of mathematics and science from pre-school to higher education.
- The Graduate School of Education at UMass Lowell offers an Ed.D. in mathematics and science education, which focuses on evaluation and the development of concepts in mathematics and science.
- The School of Education at Boston University offers an Ed.D. in curriculum and teaching, with a focus on preparation of students for K-12 leadership positions or postsecondary teaching positions in junior, community, or technical colleges. This program also prepares students to teach in teacher preparation programs in colleges and universities.
- Lesley University offers a Ph.D. in Educational Studies, which is not specifically in mathematics education research.
- The Department of Education at Tufts University offers a Ph.D. in mathematics, science, technology, and engineering education, which is a broad, interdisciplinary program that admits no more than five full-time students per year focusing on learning and development, cognitive science, and the socio-cultural foundations of education. It is closest to UMass Dartmouth's proposal in design and intentions and is well known to UMass Dartmouth faculty due to long-standing collaborations.

ACADEMIC AND RELATED MATTERS

Admission

UMass Dartmouth intends to admit students to the proposed program in mathematics education based on an analysis of a comprehensive set of measures used to determine their readiness for doctoral studies. These include:

- Bachelor's degree with a minimum GPA of 3.0 (or equivalent) from an accredited program in a field appropriate as preparatory work for doctoral studies in mathematics education. A bachelor's degree in mathematics or a related subject area (e.g., engineering, computer science, etc.), such that the candidate will have completed courses in advanced-level mathematics; or
    - Master's degree in mathematics education or a related educational degree (e.g., Masters of Arts in Teaching), where the program has at least five courses in mathematics integrated with pedagogy; or
    - Exemplary understanding of mathematics as related to teaching and learning as demonstrated and documented through life-time achievements (e.g., professional development, curriculum and software development, etc.).
- Graduate Record Examination scores.
- Statement of interest and intent, indicating research and teaching potential.
- Three letters of recommendation from people who have worked closely with the applicant in an academic or professional setting.

The proposed program is intentionally designed to be inclusive of applicants with many different backgrounds and, as such, will not require the completion of a bachelor's degree in mathematics. UMass Dartmouth program administrators intend to exercise a flexible perspective on admission criteria that involves case-by-case assessment of applicants' academic preparation in fields that serve mathematics education. They expect to admit some students with strong backgrounds in mathematics and other technical sciences, and others with strong preparation in educational theory and the social sciences. The Graduate Coordinator and Graduate Committee may need to recommend additional pre-requisite preparation in mathematics for some applicants to offset perceived deficiencies in the applicant's previous coursework, which will draw from existing mathematics education courses developed for the University's Master of Arts in teaching program. Any identified deficiencies regarding admission requirements will be met prior to entering the advanced doctoral phase of the program.

Enrollment

UMass Dartmouth anticipates admitting an average of nine new students annually for the first four years. The total student body for the proposed program is expected to level off at approximately 26 students with an average of five new graduates each year. Students are expected to be primarily full time, move through the program in cohorts, and finish in four years. The program will seek to support two-thirds through a mix of graduate teaching and research assistantships, work-place internships, and government-sponsored programs. The table below displays UMass Dartmouth's enrollment projection, using an annual attrition rate of 25 percent in the first two years of each student cohort.

	Academic Year (Year of Program Running)				
Year of Entry	AY2008 (0)	AY2009 (1)	AY2010 (2)	AY2011 (3)	AY2012 (4)
Year 1		9	9	9	9
Year 2			7	7	7
Year 3				5	5
Year 4					5
TOTAL	0	9	16	21	26
Graduation					5

Curriculum (Attachment A)

The proposed Ph.D. program in mathematics education falls into three distinct phases: introduction to mathematics education research, preparation phase for advanced doctoral status, and production phase of advanced courses and final dissertation.

Students will be expected to complete 72 credits that include:

- 18 credits of introductory coursework to develop students' knowledge of research tools, methodologies and theories;
- 18 credits of preparatory coursework to refine and focus students' understanding of the research process; and
- 36 hours of doctoral work–12 hours of doctoral coursework and 24 hours of dissertation research, advising to support and guide the production of the final dissertation.

The proposed program in mathematics education at UMass Dartmouth intends to require graduates to achieve a GPA of 3.0 or higher, pass a qualifying examination, and defend the dissertation proposal.

Students will be expected to begin dissertation-related activities in the second year of the program, and this will serve as preparation for their qualifying exams (at the end of year two) and projected formal work on their dissertation in years three and four. Students will be eligible for a master of science in mathematics education at the end of the second year. The Qualifying Examination will include:

1. submission of an 8,000-word paper, based on the student's pilot study completed during years 1 and 2, to the Graduate Committee for evaluation along the lines of the skill sets developed in the student's coursework;
2. submission of a proposal to present research to a national or international conference based upon the student's pilot study completed in years 1 and 2;
3. presentation of the student's pilot study in the Kaput Center; and
4. an (oral, written, or both) examination based on coursework completed in years 1 and 2.

All proposed courses will feature authentic learning experiences in research institutions and projects and an interactive thinking/writing process to develop cutting-edge research and discovery as part of the student's experience. Research scholarship thus pervades the curriculum, uniting theory and practice. Technology is also embedded throughout; wherever

possible, courses will be blended with a variety of delivery methods, including online video seminars, iTunesU/podcasting, and active use of blogs and wikis, as part of the regular mode of sharing and learning content and expressing evolving ideas in and around coursework. A central blog/wiki will be available for students to interact and share their ongoing work outside of classes. Because of the program's central focus on the development of research scholarship, specific attention will be given to the development of research ethics, including appropriate acknowledgement of sources, proper protocols for conducting research on human subjects, the process of institutional IRB approval, and institutional certification for conducting research.

RESOURCES

Faculty

In the first year of operation, the mathematics education faculty in the School of Education, Public Policy, and Civic Engagement is expected to increase from three to four members, and a fifth member is planned for the third or fourth year. The research experience of the present mathematics education faculty crosses many disciplines, including teacher education, design and implementation of innovative technologies, the evolution and use of sign and symbol systems in mathematics (semiotics), discourse analysis, micro-analytic video analysis, early childhood learning, and curriculum design and development across the grades.

The two new positions will call for faculty with a doctorate in mathematics education or a related field, with an established program of research with grant funding in mathematics education research.

Facilities and Technology

UMass Dartmouth administrators propose that the program facilities be located in the Kaput Center at the Fairhaven campus for the first three years of operation. The Kaput Center presently occupies 3,500 square feet for faculty, research project staff, and desk space for four graduate students. There is also a resource room with space for graduate students to work and which includes an extensive K-12 curriculum library and undergraduate materials. SmartBoard technology, video conferencing, telephone conferencing facilities and TV/DVD/video equipment are also available in this space. Program administration does not foresee the need for additional space or relocation expenses during the first cycle of the program, but as the student cohort increases and/or research projects of the Center evolve in size, more space may be needed.

The University library provides services and resources in support of all academic programs, research, and intellectual pursuits of the community. The Kaput Center also has a library and a resource room that supplement the holdings of the main campus library, including many mathematics education journals and periodicals and a wide selection of K-16 mathematics curricula. The Center will continue to add cutting-edge, contemporary, and cross-disciplinary literature that is not always available on the main campus.

Administration

The proposed program in mathematics education will be administered with existing faculty and infrastructure in the STEM Department of the School of Education, Public Policy, and Civic Engagement, in consultation with affiliated faculty in other departments, and within the existing administrative structure of graduate studies at UMass Dartmouth. The Graduate Program Committee, chaired by the Graduate Program Director, will provide direction and oversight for the management of the program, including admissions criteria and individual admission actions, curriculum development, program planning, operating policies and procedures, and program evaluation/quality control. All proposed guidelines and policies will comply with the general

operating policies for academic programs on the UMass Dartmouth campus.

BUDGET (Attachment B)

The University submitted a first-year and multi-year budget for the proposed program that is contained in Attachment B. Based on the current tuition/fee structure at UMass Dartmouth, tuition/fees will be sufficient to support the program. This is based on admitting nine students each year. The main source of costs will be the five full-time faculty members necessary to cover the core instructional and research advising needs for these students. Of these, only the fifth line (to be hired in the third year) represents a new allocation of resources.

PROGRAM EFFECTIVENESS

The University plans to employ three main strategies over the first five years of the program to ensure effective program delivery and to refine its efficiency. The main strategies for effective program delivery are:

***(1) Student E-Portfolios*:** Students will construct e-portfolios of their learning experiences across the course of the program via an online proprietary database developed by Kaput Center faculty and staff to allow podcasts and workflows from multimedia sources. Students will upload assessments of individual courses and end-of-year program evaluations and apply them to a set of expected learning outcomes outlined by the core program faculty. Students will also upload extramural activities, such as papers or presentations that they have developed with or without the support of faculty, as well as other artifacts that they count as evidence of their learning. The resulting reflections and artifacts will be assessed by faculty and other evaluators.

***(2) Faculty Evaluation and Assessment Procedures*:** Course and end-of-year learning outcomes and objectives will be used to establish a survey instrument for students and external evaluators to use as an evaluation to measure of achievement of program outcomes. Students will react to these criteria in their e-portfolios, while faculty, administrators and evaluators will be able to export these as reports from the e-portfolio portal. Faculty will also use assessment procedures for each of the major milestones of the program, such as a preliminary qualifying examination at the end of year 2, a dissertation proposal defense (examined by the program committee at the end of year 3), and a final defense of the dissertation (end of year 4).

***(3) Internal and External Advisory Councils*:** Annually, faculty reviewing the students' e-portfolios and their performance at progression milestones will summarize results for review by the Dean of the School of Education, Public Policy, and Civic Engagement, who will report them to central administrators, such as the Associate Provost for Graduate Studies and the Provost; sample student e-portfolios may be provided. An Executive Advisory Council, which will include members of the Kaput Center Advisory Board, will receive summary reports on a bi-annual basis to assess whether the program is meeting its expected goals and may also view sample student e-portfolios.

EXTERNAL REVIEW AND INSTITUTIONAL RESPONSE

The external review team comprised Dr. Marilyn Carlson, Professor, Department of Mathematics and Statistics and Director of The Center for Research on Education in Science, Math, Engineering, and Technology; and John Olive, Professor, Department of Mathematics and Science Education, The University of Georgia. The reviewers noted that the proposed program will provide students with authentic research experiences and were impressed with the internship

component of the program. The reviewers stated, “The strong faculty team of mathematics educators dedicated to building this program have the research expertise, academic integrity and experiences… …and are highly regarded by their colleagues in the field and have published widely, establishing an admirable research record and reputation for high-quality work.” The reviewers recommended the program strengthen requirements to develop students’ advanced mathematics abilities, strengthen admissions requirements, and include a teaching internship for students without prior teaching experience.

The University amended the admissions requirements, as suggested, and included a teaching internship requirement. The University also explained that applicants with identified deficiencies in admission requirements will be required to enroll in appropriate mathematics focused courses in the University’s Master’s of Arts and Teaching degree program which link mathematical content and pedagogy such that the mathematical content will be sufficiently advanced to help students with deficiencies in their prior mathematical knowledge to understand the subject matter from a relevant perspective to someone entering an educational research program. Moreover, four new courses for the purpose of building advanced mathematical basis for students admitted with deficiencies will be developed.

STAFF ANALYSIS AND RECOMMENDATION

Staff recommendation is for approval of the request of University of Massachusetts Dartmouth to award the Master of Science in Mathematics Education and the Doctor of Philosophy in Mathematics Education.

Upon graduating the first class for this program, the University shall submit to the Board a status report addressing its success in reaching program goals as stated in this report and in the areas of enrollment, curriculum, faculty resources, and program effectiveness.

ATTACHMENT A: Curriculum Outlines

I. Curriculum Outline for Master of Science in Mathematics Education

Major Required (Core) Courses (Total courses required=*9*)		
Course Number	***Course Title***	***Credit Hours***
MAE650	Introduction to Qualitative Methods	3
MAE651	Introduction to Quantitative Methods	3
MAE652	Introduction to Mathematics Education Research	3
MAE653	Theories of Mathematical Learning	3
MAE654	Research Seminar	3
MAE655	Developing Research Skills Part 1	3
MAE680	Authentic Learning (Internship)	3
MAE681	Research Seminar	3
MAE682	Developing Research Skills Part 2	3
	Subtotal # Core Credits Required	27
Concentration Course Choices (Total courses required=3) *(attach list as needed)*		
MAE660	Foundational Issues in Mathematics Education	3
MAE661	Research on Mathematics Teacher Education Part 1	3
MAE662	Research on Mathematics Teacher Education Part 2	3
MAE663	Developing and Implementing Mathematics Curriculum	3
MAE664	Research on Technology in Mathematics Education	3
MAE665	Design Principles for Technology in Mathematics Education	3
MAE666	Frameworks for Research Analysis	3
MAE667	Research in Elementary Grade Mathematics	3
MAE668	Research in Middle and High School Mathematics	3
MAE669	Research in Undergraduate Mathematics Education	3
MAE670	Developing Theory	3
MAE679	Topics in Mathematics Education	3
	Subtotal # Concentration Credits Required	9

Curriculum Summary	
Total number of courses required for the degree	12
Total credit hours required for degree	36

Prerequisite or Other Additional Requirements:

Qualifying exams as outlined in the full proposal. This MS is a credential towards completion of the PhD in Mathematics Education.

II. Graduate Program Curriculum Outline for Doctor of Philosophy in Mathematics Education

Major Required (Core) Courses (Total courses required = *13*)		
Course Number	***Course Title***	***Credit Hours***
MAE650	Introduction to Qualitative Methods	3
MAE651	Introduction to Quantitative Methods	3
MAE652	Introduction to Mathematics Education Research	3
MAE653	Theories of Mathematical Learning	3
MAE654	Research Seminar	3
MAE655	Developing Research Skills Part 1	3
MAE680	Authentic Learning (Internship)	3
MAE681	Research Seminar	3
MAE682	Developing Research Skills Part 2	3
MAE772	Dissertation Research	3
MAE773	Dissertation Research	3
MAE774	Dissertation Research	9
MAE775	Dissertation Research	9
	Subtotal # of Core Credits Required	51
Concentration Course Choices (Total courses required = 7)		
MAE660	Foundational Issues in Mathematics Education	3
MAE661	Research on Mathematics Teacher Education Part 1	3
MAE662	Research on Mathematics Teacher Education Part 2	3
MAE663	Developing and Implementing Mathematics Curriculum	3
MAE664	Research on Technology in Mathematics Education	3
MAE665	Design Principles for Technology in Mathematics Education	3
MAE666	Frameworks for Research Analysis	3
MAE667	Research in Elementary Grade Mathematics	3
MAE668	Research in Middle and High School Mathematics	3
MAE669	Research in Undergraduate Mathematics Education	3
MAE670	Developing Theory	3
MAE679	Topics in Mathematics Education	3
MAE750	Analyzing Participation and Engagement in Mathematics Classrooms	3
MAE751	Contemporary Issues in Elementary Grade Classrooms	3
MAE752	Research on Proof and Reasoning in Mathematics	3
MAE753	Applied Research on Technology in Mathematics Education	3

MAE754	Semiotics and Symbolic Cognition	3
MAE755	Principles of Creativity and Innovation in Mathematics Education	3
MAE756	Advanced Theoretical Development	3
MAE769	Advanced Topics in Mathematics Education	3
	Subtotal # of Concentration Credits Required	21

Curriculum Summary	
Total number of courses required for the degree	20
Total credit hours required for degree	72

Prerequisite or Other Additional Requirements:

Graduate Program Curriculum Outline for Master of Science in Mathematics Education

Major Required (Core) Courses (Total courses required = *9*)		
Course Number	***Course Title***	***Credit Hours***
MAE650	Introduction to Qualitative Methods	3
MAE651	Introduction to Quantitative Methods	3
MAE652	Introduction to Mathematics Education Research	3
MAE653	Theories of Mathematical Learning	3
MAE654	Research Seminar	3
MAE655	Developing Research Skills Pt 1	3
MAE680	Authentic Learning (Internship)	3
MAE681	Research Seminar	3
MAE682	Developing Research Skills Pt. 2	3
	Subtotal # Core Credits Required	27
Concentration Course Choices (Total courses required = 3) *(attach list as needed)*		
MAE660	Foundational Issues in Mathematics Education	3
MAE661	Research on Mathematics Teacher Education Part 1	3
MAE662	Research on Mathematics Teacher Education Part 2	3
MAE663	Developing & Implementing Mathematics Curriculum	3
MAE664	Research on Technology in Mathematics Education	3
MAE665	Design Principles for Technology in Mathematics Education	3
MAE666	Frameworks for Research Analysis	3
MAE667	Research in Elementary Grade Mathematics	3

MAE668	Research in Middle & High School Mathematics	3
MAE669	Research in Undergraduate Mathematics Education	3
MAE670	Developing Theory	3
MAE679	Topics in Mathematics Education	3
	Subtotal # Concentration Credits Required	9

Curriculum Summary	
Total number of courses required for the degree	12
Total credit hours required for degree	36

Prerequisite or Other Additional Requirements:

Qualifying exams as outlined in the full proposal. This MS is a credential towards completion of the PhD in Mathematics Education.

ATTACHMENT B: BUDGET

Campus: University of Massachusetts Dartmouth **Proposed Program: PhD in Mathematics Education**

One Time Costs		***Annual Operating Costs***		
		Description	**Number**	**Cost**
	Faculty	4 current faculty + 1 additional hire in Yr 3	5 from year 3 onwards	$254,853 + $80,000 (from Yr 3 onwards)
	Staff	50% FTE Admin Asst (Yr2 onwards) + Graduate Teaching Assistantships	½ Admin Asst; Grad TAs	$16,500 (Admin Asst Yr 2 onwards); TAs: $24,148 (yr1), $16,560 (yr2), $10,529 (yr3), $18,337 (yr4)
	General Admin Costs	Office supplies and facilities	1	$2,500
X	Instructional Materials (Includes library resources)	Start-up funds	1	$5,000 (Yr 1 only)
	Space	---	---	---
X	Equipment	Start-up funds for faculty	2	$2500 (Yrs 1 & 3)
	Field & Clinical Resources	---	---	---
X	Marketing & Promotional Expenses		1	$3,500 (Yr 1 only)
	Total New Costs:			**$37,648 (yr1), $33,060 (yr2), $93,029 (yr 3), $18,337 (yr 4)**
	CUMULATIVE TOTAL:			**$37,648 (yr1), $68,208 (yr2), $161,237 (yr3), $177,074 (yr4)**