BOARD OF HIGHER EDUCATION

REQUEST FOR COMMITTEE AND BOARD ACTION

COMMITTEE: Academic Affairs   **NO**: AAC 18-29

COMMITTEE DATE: June 12, 2018

BOARD DATE: June 19, 2018

APPLICATION OF THE UNIVERSITY OF MASSACHUSETTS DARTMOUTH TO AWARD THE DOCTOR OF PHILOSOPHY IN STEM EDUCATION

MOVED: The Board of Higher Education hereby approves the application of **University of Massachusetts Dartmouth** to award the **Doctor of Philosophy in STEM 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 the application and in the areas of enrollment, curriculum, faculty resources, and program effectiveness.

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

Contact: Winifred M. Hagan, Ed.D.,
Associate Commissioner for Academic Affairs and Student Success

BOARD OF HIGHER EDUCATION

June 2018

**University of Massachusetts Dartmouth
Doctor of Philosophy in STEM Education**

INTENT AND MISSION

The proposed Ph.D. program in STEM Education is intended to expand the existing Mathematics Education Ph.D. program at the University of Massachusetts Dartmouth (UMD) by adding concentration areas for science education and engineering education. UMD has planned the proposed program to align with its' current Strategic Plan. UMD's established research programs in Engineering, Marine Science and Technology, Bioengineering, Biology, Chemistry, and Physics, are expected to strengthen collaboration between the STEM fields, learning sciences, and education. In addition, UMD reports that, faculty have secured multiple federal funding streams for multi-year research projects in STEM education for the purpose of training doctoral students to develop expertise in STEM education. The proposed program goals include UMD implementation of an innovations designed to develop in-depth knowledge and interdisciplinary skills in STEM education. UMD reports that in planning for the proposed program they found that school districts in the region are in need of increased numbers of teachers in STEM education as well as much more support in general for STEM teachers in districts. Integrated and student-centered experiences are planned to be at the heart of the program, with students designing and conducting small-scale research within districts as they progress toward full-scale dissertation research. The proposed program is also expected to carry forward UMD's Carnegie classification as a doctoral research university.

The fundamental purpose of the proposed program is to develop stewards of the STEM disciplines[1] with a strong sense of responsibility to the fields and to moving the discipline forward. UMD intends that students who graduate from the proposed program will be prepared as researchers and leaders in STEM education fields and to teach in STEM education programs. UMD also intends that graduates will be qualified to pursue employment in research and development companies, secondary and post-secondary education, and other content-focused academic leadership positions in government and non-profit organizations.

UMD intends that students in the proposed program will develop the knowledge and skills to reconstruct, appropriate, and add to the body of knowledge within their content concentration; explore different approaches emerging from research literature in STEM education; conduct original research that contributes to the STEM education knowledge base; communicate comprehension and interpretation in formal, academic writing; integrate STEM education into other areas of education research (e.g. assessment, place-based education, social justice education, interdisciplinary teaching and learning, teacher education, educational theory and policy).

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[1] Walker, Golde, Jones, Bueschel, & Hutchings, (2008). *The formation of scholars: Rethinking doctoral education for the twenty-first century*. Carnegie Foundation for the Advancement of Teaching.

The proposed program has obtained all necessary governance approvals on campus and was approved by the University of Massachusetts Board of Trustees on April 13, 2018 The required letter of intent was circulated on November 11, 2017. No comments were received.

NEED AND DEMAND

National and State Labor Market Outlook

The need for more STEM educators and for improved STEM education pedagogy that maintains student interest has been identified as both a regional and national priority in UMD's estimation, citing the congressional STEM Education Act of 2015[2]. The law specifically supports the development of STEM educators through fellowship programs and it mandates the National Science Foundation to provide a stream of funding aimed at informal science. (UMD has established partnerships with the Lloyd Center for the Environment in Dartmouth; Buttonwood Park Zoo in New Bedford; New Bedford Whaling Museum; The Museum of Science in Boston and others). UMD finds this bipartisan legislation to underscore the national priority of STEM education and research.

Analyzing the need for a Ph.D. in STEM Education, UMD counted current open positions in STEM education nationally and found that in the area described as "Mathematics Education" there were 76 positions advertised in the *Chronicle of Higher Education* between January 1, 2015 and March 28, 2015. A similar search in the Fall 2015 showed an additional 52 Mathematics Education positions posted between September 1 and November 15 between the *Chronicle of Higher Education* and *HigherEd Jobs*. A similar UMD search for "Science Education" found 79 positions posted between January 1 and March 28 of 2015. In the Fall of 2015, an additional 42 "Science Education" positions were found in the *Chronicle of Higher Education* and *in HigherEd Jobs.* "Engineering Education" showed 16 positions though UMD also found that the demand for engineering education is likely to grow nationally as the Next Generation Science Standards[3] make engineering a required part of K-12 science. During July 2014-March 2015, UMD found Wiki showing an Engineering Education list[4] with 76 positions appropriate for Engineering Educators, ranging from postdoctoral students to deans. In reviewing this proposal staff found over 100 listings nationally from this same source in May 2018

UMD reports that according to the Massachusetts Executive Office of Labor and Workforce Development, STEM fields in MA will grow considerably over the next decade. The demand for higher education faculty in math, engineering, biology, chemistry, earth science, environmental science, and physics is expected to grow 10-17% in the next decade. In addition, UMD asserts that the demand for STEM educators at the middle and secondary school level suggests that there will be an ongoing need for STEM educator preparation programs in higher education to develop teachers as well as future STEM professionals. UMD further explicates the MA demand citing the Massachusetts Business Roundtable's summer 2009 publication '*Tapping Massachusetts' Business Potential: The Massachusetts Employers' STEM Agend*a, which included goals to double the number of STEM bachelor's degrees awarded in Massachusetts by 2020, and to double the number of STEM teachers in grades 7-12 by 2020. The proposed

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[2] https://www.congress.gov/bill/114th-congress/house-bill/1020 Retrieved 5/4/2018

[3] https://www.nextgenscience.org/ Retrieved 5/4/2018

[4] http://engineeringeducationlist.pbworks.com/w/page/48108151/Engineering%20Education%20Job%20Postings Retrieved 5/4/2018

Ph.D. in STEM education is designed to develop faculty to fill this expected need for a cadre of teachers in mathematics and science for middle and high school. In addition, the proposed program is designed to conduct needed research on pathways to teacher preparation, which UMD holds as critical to supporting the development of effective teacher preparation programs for STEM education in MA.

UMD found that the South Coast region of Massachusetts is particularly underserved when it comes to educational attainment in STEM. In Fall River and New Bedford, for example, the percentages of students who are rated as proficient in Science and Technology/Engineering by the MCAS exam in grade 10 are 48% and 36% respectively compared to a state average proficiency of 71%. Building a strong research program in STEM education at UMD is intended to more fully engage school systems in the development of new pedagogies, new materials, and new theories of learning designed to meet the needs of students who are currently dropping out of STEM fields or who are not being provided with the "right" opportunities for academic success that would enable careers in STEM fields.

Student Demand

UMD recently conducted a needs analysis related to the STEM Education Ph.D. program with a survey to participants in the M.A.T. program, school partners, and stakeholders who have participated in Kaput Center for Research and Innovation in STEM Education ("the Kaput Center") events over the past several years. There were 62 responses and 30 people (35% of respondents) indicated they would be "Very Interested" or "Somewhat Interested" in a STEM Education Ph.D. program. There were 40 respondents (65%) who indicated that having a STEM Education program would be valuable for the South Coast region. Anecdotally, in the last six years of recruiting students for the current Ph.D. program in mathematics education, UMD's Graduate Program Director and faculty members field 2-3 inquiries each year for students wanting to pursue a Ph.D. in science education. Some of these inquiries come from practicing science teachers currently seeking their advanced professional licenses in UMD's MAT program, while other inquiries result directly from the advertising of the current Ph.D. program. UMD's three research-active science educators and three mathematics educators indicate there is capacity for an expansion to a doctoral program in STEM education. UMD has responded to the need and interest of students with this proposal.

OVERVIEW OF PROPOSED PROGRAM

Interest in creating this program came from numerous inquiries from local school districts, teachers interested in Ph.D. program, as well as the result of the recent survey. A cohort of 10-12 area teachers are eager to apply to the proposed STEM Education Ph.D. program. At the same time, faculty members have been recruited to UMD for the purpose of expanding an existing Ph.D. program to include science education. All three of these faculty members are currently active as principal investigators responsible for research underway at the Kaput Center at UMD. Across the campus and in the region, there is a growing interest in STEM educational endeavors. The College of Engineering is working with local schools to integrate more science and engineering into classrooms, as well as leading a number of other education-related efforts.

UMD also considered the programs identified by the UMass President's office to determine what courses and competencies seem to cut across all STEM programs. It is expected that the proposed program will be housed in the Department of STEM Education & Teacher Development within the School of Education, which is a part of the College of Arts and

Sciences. The Ph.D. Committee at UMD is led by the Graduate Program Director, and is comprised of the Associate Provost for Graduate Studies, the Associate Dean for Graduate Studies and Research, the Dean of the College of Arts & Sciences, and the Chair of the Department of STEM Education and Teacher Development. The Graduate Program Director is also the primary contact for all applicants for the program.

The proposed program is also expected to be fully integrated into the Kaput Center. It offers the space and resources to support program faculty and students in working together in partnerships. The Kaput Center also provides both a physical space and social construct for the exchange of ideas that leads to the development of new knowledge and the sense of stewardship that is a goal of the program. The Kaput Center also brings resources to the program, including recording and computing equipment, journal issues, and an extensive library of books related to STEM education and educational research. The academic endeavors of the Kaput Center introduce Ph.D. students to leaders in STEM education through colloquium and seminar opportunities and provide Ph.D. students with opportunities to engage in critical and creative problem solving through engagement in real educational settings as researchers, curriculum developers, and change agents. The 100+ members of the Kaput Center Advisory Board offer students internship opportunities on research projects. No additional infrastructure is necessary to launch the proposed program.

Duplication

Similar programs offered by public institutions include the Ph.D. in Mathematics, Science, and Learning Technologies in the College of Education at UMass Amherst; the
Ed.D. in STEM Education in the Graduate School of Education at UMass Lowell. In addition, Tufts University offers the Doctor of Philosophy in Mathematics, Science, Technology, and Engineering Education in the Department of Education.

ACADEMIC AND RELATED MATTERS

Admission

It is planned by UMD that students will be admitted to the Ph.D. program based on an analysis of a full application that allows the faculty members to determine an applicant's readiness for doctoral studies. Admission will be determined by the Ph.D. Committee. Prospective students will be expected to meet the following criteria for admittance into the program:
- 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 STEM education. Students will be required to submit transcripts from all post-secondary institutions so that a determination can be made regarding the nature of preparatory course work and the student's successful completion of it.
- Acceptable scores on the Graduate Record Examination.
- Statement of interest indicating research and teaching potential. Applicants should include with this any evidence of such potential (e.g., curriculum vitae, descriptions of research projects on which the student participated and his/her contribution to the project, published or submitted articles, or artifacts of conference presentations).
- Three letters of recommendation from people who have worked closely with the applicant in an academic or professional setting concerning the applicant's abilities and performance relevant to research and teaching potential.

- For international applicants, an acceptable proficiency in English score (e.g., TOEFL score)

Based on the inputs above and individual communications as needed, UMD will seek evidence of a candidate's ability and motivation to succeed in a STEM education research program as well as their potential to contribute to the field. The concentrations that comprise STEM education draw on an eclectic blend of disciplines. Because of the rich interdisciplinary nature of STEM education, the proposed program is intentionally designed to be inclusive of applicants with many backgrounds. UMD holds that this diversity will enrich the experience of all the doctoral students. The Ph.D. Committee will review each application to determine the candidate's readiness and fit for a STEM education course of study. UMD plans that any gaps that may be perceived in an otherwise qualified candidate background will be addressed by the Ph.D. Committee in consultation with the prospective candidate.

Admission with Advanced Standing

Candidates who hold a master's degree in a STEM education field will be considered for UMD's graduate student Advanced Standing that would exempt students from up to 24 credits of first and second year courses. UMD will base this decision upon sufficient evidence of courses or experiences completed prior to applying to the program. Advanced Standing must be approved by the Graduate Program Director, the Department Chair, the Dean of the College of Arts and Sciences, and the Associate Provost for Graduate Studies.

Transfer

Candidates who seek to transfer to UMD after beginning a degree elsewhere may obtain credit subject to approval for transfer by the Graduate Coordinator in consultation with the Graduate Committee. Only courses for which students earned a grade of B or better will be considered for transfer. Transfer credit from research project experiences will be assessed on a per-case basis and, consistent with UMD guidelines, only six (6) credit hours of transfer credit may be applied to the STEM Education Ph.D. program.

Curriculum (Attachment A)

The core program is planned to be a set of 8 courses plus 24 credit hours of dissertation work. Each concentration (Mathematics Education, Science Education, and Engineering Education) will have required concentration courses. The three courses common to all three concentrations include two research seminars in which students undertake their own research projects in year 1 and year 2. All three concentrations include four electives that are concentration specific as well as those that are appropriate across all of the STEM disciplines.

Internships and Field Studies

The Authentic Learning research internship that is planned for the proposed program, will operate as does that internship in the Mathematics Education Ph.D. program. Internships are expected to be aligned with the student's dissertation topic. All authentic learning experiences, whether required or elective, are monitored by a faculty member who is assigned as faculty of record to the intern. That faculty member supervises the student gathering information about the student's goals, timeline, and resources for travel related to studies. The faculty member and

student also discuss potential fits for the internship in terms of faculty with whom, and projects on which, the student might work. Once the faculty member understands the needs of the student and the student's desired placement, the faculty member contacts the researcher to determine whether that researcher is able to accommodate the request. Once a match is identified, the faculty member supports the student and the researcher in refining the internship plan. The faculty member serves as the conduit between the student and mentor. The UMD faculty member is the primary point of contact for any problems or confusion. Each 3-credit internship requires a student to be engaged at least 80 hours spread across three or more weeks. The optional 9-credit internship would require at least 240 hours.

Qualifying Exam and Dissertation

The Qualifying Exam (QE) is structured so that students demonstrate breadth of knowledge as a result of their first two years of coursework, and demonstrate depth of knowledge by conducting a focused research project. The QE is designed to provide students with the fundamental literature-base to support the research skills that prepare them for their actual dissertation work. There are four parts to the QE and all of them must be completed before the beginning of the student's third year (assuming full-time enrollment). First, the student is required to submit a proposal to present at a research conference as first author, or to submit a manuscript to a journal as first author. Second, the student must conduct a small-scale research project and both present it to all faculty in the Ph.D. program and (third) submit an 8,000-word paper reporting the study. The fourth deliverable is a written examination. Students are given 48 hours to complete the examination. They are provided with 5 questions, from which they select 2 to answer. The questions come from the areas of theory, research methodology, learning, teaching, and electives, which are customized to match the electives taken by the students eligible for the exam. The Ph.D. faculty read the responses and convene to evaluate the dissertation-readiness of each candidate.

UMD has developed Dissertation Guidelines across all doctoral programs with additional guidelines in the Department's Ph.D. program handbook as well. Candidates are expected to follow these, along with the standards set forth by both the American Education Research Association and the American Psychological Association. At a departmental level, UMD defines the dissertation committee as including a chair, at least 2 members from the content area in which the student is focusing (e.g., mathematics education, science education, etc.), and at least 3 people in all. The Chair must be a faculty member at UMD, although a co-chair can be included who is not UMass Dartmouth faculty. Consistent with department guidelines for the existing PhD program, requirements for forming a dissertation committee, and conducting and defending a dissertation were provided in detail within the proposal. It is planned that dissertation committees will be chaired by a faculty member from the proposed STEM Education Ph.D. program and reviewed by 3-5 members. Dissertation Chairs are expected to mentor students to meet quality research and presentation and to implement measures to support student completion. The dissertation guidelines are in alignment with graduate guidelines of UMD and include the roles and responsibilities of the Chair and members of the Dissertation Committee, the process and required structure and elements of the dissertation, as well as the procedure for dissertation defense. UMD expects that students will have to complete original research as the culminating product of their program. This dissertation is intended to be completed within 2 to 3 years of successful completion of the QE.

Assistantships

It is expected that approximately 1/3 of the students (10) will be supported on research assistantships, during years 2-4, through grants through the Kaput Center, and in the form of industry-sponsored projects. It is expected that assistantships will cover tuition and fees for the research assistants as well as providing a stipend for their effort. Full-time teaching and research assistants are expected to work 20 hours per week and receive stipend plus full tuition credits. The UMD Graduate Studies Office sets the minimum stipend levels for both research and teaching assistantships. The actual stipend is determined by the Dean's office for Teaching Assistants and by the Principal Investigators for Research Assistants.   UMD continues to review and adjust stipend levels in an effort to make them competitive and comparable to those paid by peer institutions. When a student is awarded a ½ assistantship, they are expected to work 10 hours per week. For this, the student receives ½ of their tuition and ½ of the stipend amount. It is also expected that another 1/3 of the students (10) will be supported as teaching assistants, teaching one course per semester or providing academic support for faculty. Teaching assistants will be assigned to the Master of Arts in Teaching program as instructors of record, to the Mathematics Department to support their general education courses, or as support personnel for the assessment requirements related to the Masters of Arts in Teaching program. Teaching assistantships are planned to run for the academic year while research assistantships can extend to 12-month appointments. All students appointed to an assistantship or provided with a fellowship will sign a letter agreeing not to work on campus outside of the 20 hours allotted by the university.

Program Enrollment Projection

	Year 1	Year 2	Year 3	Year 4
New Full-Time	7	7	7	7
Continuing Full-Time	0	5	10	14
New Part-Time	4	4	4	4
Continuing Part-Time	0	2	3	4
Totals	11	18	24	29

Resources

Budget (Attachment B)

UMD budget reflects that costs are designed to grow all 3 concentrations to capacity over approximately 10 years. Existing resources are expected to cover the mathematics education and science education concentrations with a smaller cohort than the total anticipated size. UMD plans to accept 1-2 Ph.D. candidates per faculty member each year, with 4-6 advisees at various stages of the program for each faculty member. The budget was developed with an assumption that a single engineering educator would be hired for year 4, beginning the engineering education concentration at that time.

The proposed budget is based on current-year tuition and fees with a 5% increase accounted for each year. The standard course load of 18 credits per year is assumed. The number of students (full-time equivalent) added per year is based on estimates of yearly entries to the current Mathematics Education Ph.D. program as well as the capacity of the faculty to provide appropriate levels of dissertation guidance to students. Faculty expenditures were calculated based on 1.8 months of faculty salary per course. UMD does not anticipate the expansion of the Ph.D. program to require additional support staff. Fringe was calculated at 36% for all faculty and staff. Supplies were estimated based on current expenses from the Mathematics Education Ph.D. program with increases to support the needs of concentration is science and engineering. Library cost projections were developed from the current library budget, based on particular journal title requests, and an 8% per year increase in subscription costs. UMD anticipates the primary need will be in the area of journal subscriptions. UMD's plans to increase visibility by advertising in selected professional publications, running one to two ads per year at $1500-$3000 per ad. General Overhead is charged at 8% at UMD.

Assistantships were calculated at about $35,000 per student based on tuition, fees, and stipend. UMD plans that these are positions that will be provided through grants and contracts. The equipment budget includes funds to replace 3 laptop computers each year. UMD maintains a rolling cart of laptops to support Ph.D. coursework. They include software that is not in the regular labs because it is specific to STEM education and these computers are also used to support students who need short-term use of the machines. By using the laptop cart, UMD provides students immediate and constant access to tools like statistical software. The budget line is attributed to ongoing upgrades for the existing lap-top cart.

Faculty and Administration (Attachment C)

There are currently six (6) faculty members at UMD who are expected to teach and advise in the STEM Education Ph.D. program. All six faculty are active researchers and all six teach in the M.A.T. program, thus creating opportunities for research on teacher development.

Facilities, Library and Information Technologies

It is anticipated that additional library resources will be needed as the UMD Library has limited subscriptions to key STEM education journals. Specifically, 5-8 key journal titles will be needed in each of the 3 concentrations. The STEM Education Ph.D. program will have significant technology needs including a rotating upgrade schedule, specialized software such as virtual science labs, programming software, simulations, and licenses.

Affiliations and Partnerships

The Kaput Center oversight includes a 10-person executive board, 106-person international and interdisciplinary advisory board, and elected associates that are long-standing members of research projects at UMD, or adjunct researchers at other institutions or professional organizations. It is expected that the Executive and Advisory Boards will serve as an important resource to the proposed program. In addition, the Kaput Center is sponsored by the Institute of Education Sciences, Lockheed Martin, the National Science Foundation, Texas Instruments and the US Department of Education. The Kaput Center at UMD has signed partnerships agreements with Queensland University of Technology in Australia and with institutions in

Mexico, Brazil and Cyprus to support student exchange programs and to internationalize research innovations developed at the Kaput Center.

PROGRAM EFFECTIVENESS

Goal	Measurable Objective	Strategy for Achievement	Timetable
Program will support the development of students who are prepared to be stewards of the field dedicated to transformative education	100% of the graduates of the STEM Education Ph.D. program will demonstrate an ability to synthesize, argue, and build upon existing knowledge.	This happens gradually through coursework, but is assessed by the Ph.D. committee as a whole in the written qualifying exam.	ongoing
Program will support the development of students who are able to conduct original research in their concentration	100% of STEM Education Ph.D. graduates will have conducted original research for their dissertation study and passed an oral examination focused on that research.	Each student is closely mentored by a member of the Ph.D. committee with expertise in the area of interest and supported/examined by a committee of faculty that may include members from other institutions.	ongoing
Program will support the development of STEM Educators who can clearly communicate about their field and their research	100% of the STEM Education Ph.D. graduates will have one or more peer-reviewed papers or presentations upon graduation.	Part of Qualifying Exam requires this. It is encouraged and fostered in Research Seminar (Capstone) courses.	ongoing
Program will support the development of Ph.D.s capable of working in higher education, research and development, and in policy centers as well as in school districts.	60% or more of our graduates will obtain employment in higher education, a research & development firm, or think tank/policy center. 100% of our graduates will be employed within 1 year of graduation.	- Create coursework that support this goal (e.g., timely, relevant) - Provide guidance on job searching strategies -	ongoing

EXTERNAL REVIEW AND INSTITUTIONAL RESPONSE

The proposed program was reviewed by O.Roger Anderson, Ed.D., Senior Research Scientist in Biology at the Lamont-Doherty Earth Observatory and Professor of Natural Sciences at Columbia University, New York, N.Y. and Wayne Harvey, Ph.D., Vice President of the Education Development Center and Director of Science and Mathematics Programs in Waltham, MA. In addition to a thorough assessment of documentation on the program, the review included a site visit and interviews with administrators, faculty, and students on August 11, 2017.

Among the strengths that reviewers found was notably, that the faculty are well prepared to lead Ph.D. programs with "impressive" academic breadth and quality of vision. The team also remarked that the five faculty members at the assistant-professor level already have published in total over 50 refereed scholarly articles or book chapters listed and made numerous presentations at national meetings. This was viewed as a good beginning in gaining grant funding and seeking external funding sources to support faculty and student research. The reviewers commented that employment opportunities for STEM education go well beyond positions in education institutions, citing informal science education environments, including museums, botanical gardens, zoos and non/for profit organizations. They indicated that the impact of the program was likely to be far reaching, beginning with the influence of faculty and students on the STEM field, the perspectives and knowledge generated by the research community, and the supply of new talent into a number of workforce arenas.   In particular the Authentic Learning Research Internships were viewed as a prominent and innovative offering that has been fully integrated into the graduate experience at UMD. The experts found it provides student access to, and extensive experience with, other academicians and researchers outside of UMD at a variety of academic institutions and other organizations committed to the improvement of the educating professions. The team emphasized that this broadens the intellectual base of cooperating researchers, collaborating with the UMD faculty, and provides another layer of extramural strength in support of Ph.D. student academic and professional development, beyond that provided by the core faculty.

The review team congratulated the faculty on its design and implementation, and recommended that the value of these student-centered experiences should be highlighted in marketing materials for the program. The reviewers recommended a focus on the analysis of big data; that the proposed program develop stronger linkage to public policy programs on campus; provide clearer communication to faculty regarding what is required to be a dissertation advisor (such as a university-wide set of criteria and guidelines), and they recommended that at least one additional faculty member at the level of associate professor or higher, should be appointed in science education.

UMD responded in appreciation of the review team's assessment. UMD is in agreement with the recommendations and has reached out to the Center for Scientific Computing and Visualization Research on campus and underscore its' stated goal of integrating STEM and education policy. UMD identified institutional policy for thesis supervisors and hired an associate professor who will serve as chair of the Department of STEM Education and Teacher Development.

STAFF ANALYSIS AND RECOMMENDATION

Staff thoroughly reviewed all documentation submitted by the **University of Massachusetts Dartmouth** and external reviewers. Staff recommendation is for approval of the proposed **Doctor of Philosophy in STEM Education** program.

ATTACHMENT A: CURRICULUM

Mathematics Education Concentration

Major Required (Core) Courses (Total courses required = 9)		
Course Number	Course Title	Credit Hours
STM 675	Introduction to Qualitative Methods	3
STM 676	Introduction to Quantitative Methods	3
STM 677	Theories of STEM Learning	3
STM 678	Developing Research Skills Part 1	3
STM 679	Developing Research Skills, Part 2	3
STM 680	Frameworks for Research Analysis	3
STM 681	Developing & Implementing STEM Environments	3
STM 697	Authentic Learning (Internship) (3 credit hours required)	3-9
STM 774	Dissertation Research	24
	SubTotal # Core Credits Required	48
Required Concentration Course (Total courses required = 3) *(attach list as needed)*		
STM 601	Introduction to Mathematics Education Research	3
STM 623	Mathematics Education Research Seminar (Capstone 1)	3
STM 624	Mathematics Education Research Seminar (Capstone 2)	3
	SubTotal # Concentration Credits Required	9
Other/Elective Course Choices (Total courses required =5) **(***attach list as needed)*		
STM 682	Development of Theory	3
STM 611	Research on Mathematics Teacher Education	3
STM 612	Research in Elementary Grades Mathematics	3
STM 613	Research in Secondary Grades Mathematics	3
STM 614	Research in Undergraduate Mathematics	3
STM 690	Special Topics in STEM Education	3
STM 696	Directed Study in STEM Education	3
STM 701	Research on Proof and Reasoning in Mathematics	3
STM 702	Contemporary Issues in K-8 Mathematics Classrooms	3
STM 703	Research on Technology in Mathematics Education	3

STM 704	Thinking and Learning in Mathematics Education	3
STM 705	Research on Technology in Mathematics Education	3
STM 776	Leadership, Policy, & Change in STEM Education	3
STM 777	STEM Education Reform in a Political Context	3
STM 780	Design-Based Research in STEM Education	3
STM 781	Analyzing Participation and Motivation in Classrooms	3
STM 785	Social Justice and STEM Education	3
STM 786	Access, Inclusion, and Heterogeneity in STEM Education	3
STM 790	Advanced Special Topics in STEM Education	3
STM 795	Advanced Independent Study in STEM Education	3
STM 796	Advanced Directed Study in STEM Education	3
STM 797	Advanced Authentic Learning (Internship)	3-9
	SubTotal # Elective Credits Required	15

Curriculum Summary	
Total number of courses required for the degree	17 (including 24 hours of dissertation)
Total credit hours required for degree	72
Prerequisite or Other Additional Requirements:	

Graduate Program Curriculum Outline
Science Education Concentration

Major Required (Core) Courses (Total courses required = 9)		
Course Number	Course Title	Credit Hours
STM 675	Introduction to Qualitative Methods	3
STM 676	Introduction to Quantitative Methods	3
STM 677	Theories of STEM Learning	3
STM 678	Developing Research Skills Part 1	3
STM 679	Developing Research Skills, Part 2	3
STM 680	Frameworks for Research Analysis	3
STM 681	Developing & Implementing STEM Environments	3
STM 697	Authentic Learning (Internship) (3 credit hours required)	3-9
STM 774	Dissertation Research	24
	SubTotal # Core Credits Required	48
Required Concentration Course (Total courses required = 3) *(attach list as needed)*		
STM 625	Introduction to Science Education Research	3
STM 643	Science Education Research Seminar (Capstone 1)	3
STM 644	Science Education Research Seminar (Capstone 2)	3
	SubTotal # Concentration Credits Required	9
Other/Elective Course Choices (Total courses required =5) *(attach list as needed)*		
STM 682	Development of Theory	3
STM 626	Nature of Science	3
STM 690	Special Topics in STEM Education	3
STM 695	Independent Study in STEM Education	3
STM 696	Directed Study in STEM Education	3
STM 725	Science Teacher Education	3
STM 726	Science Education and Social Justice	3
STM 727	Science Education in Informal Settings	3
STM 728	Socioscientific Issues Based Education	3
STM 776	Leadership, Policy, & Change in STEM Education	3
STM 777	STEM Education Curriculum Reform in a Political Context	3
STM 780	Design-Based Research in STEM Education	3

STM 781	Analyzing Participation and Motivation in Classrooms	3
STM 785	Social Justice and STEM Education	3
STM 786	Access, Inclusion, and Heterogeneity in STEM Education	3
STM 790	Advanced Special Topics in STEM Education	3
STM 795	Advanced Independent Study in STEM Education	3
STM 796	Advanced Directed Study in STEM Education	3
STM 797	Advanced Authentic Learning (Internship)	3-9
	SubTotal # Elective Credits Required	15

Curriculum Summary	
Total number of courses required for the degree	17 (including 24 hours of dissertation)
Total credit hours required for degree	72
Prerequisite or Other Additional Requirements:	

Graduate Program Curriculum Outline
Engineering Education Concentration

Major Required (Core) Courses (Total courses required = 9)		
Course Number	Course Title	Credit Hours
STM 675	Introduction to Qualitative Methods	3
STM 676	Introduction to Quantitative Methods	3
STM 677	Theories of STEM Learning	3
STM 678	Developing Research Skills Part 1	3
STM 679	Developing Research Skills, Part 2	3
STM 680	Frameworks for Research Analysis	3
STM 681	Developing & Implementing STEM Environments	3
STM 697	Authentic Learning (Internship) (3 credit hours required)	3-9
STM 774	Dissertation Research	24
	SubTotal # Core Credits Required	48
Required Concentration Course (Total courses required = 4) *(attach list as needed)*		
STM 650	Introduction to Engineering Education Research	3
STM 673	Engineering Education Research Seminar (Capstone 1)	3
STM 674	Engineering Education Research Seminar (Capstone 2)	3
STM 651	Engineering Worldviews & Practice	3
	SubTotal # Concentration Credits Required	12
Other/Elective Course Choices (Total courses required =4) *(attach list as needed)*		
STM 750	History and Philosophy of Engineering Education	3
STM 751	Engineering Design: Optimization, Trade-Offs, & Problem Solving	3
STM 776	Leadership, Policy, & Change in STEM Education	3
STM 777	STEM Education Curriculum Reform in a Political Context	3
STM 780	Design-Based Research in STEM Education	3
STM 781	Analyzing Participation and Motivation in Classrooms	3
STM 785	Social Justice and STEM Education	3
STM 786	Access, Inclusion, and Heterogeneity in STEM Education	3
STM 790	Advanced Special Topics in STEM Education	3
STM 795	Advanced Independent Study in STEM Education	3
STM 796	Advanced Directed Study in STEM Education	3
STM 797	Advanced Authentic Learning (Internship)	3-9

	SubTotal # Elective Credits Required	12
Curriculum Summary		
Total number of courses required for the degree	17 (including 24 hours of dissertation)	
Total credit hours required for degree	72	
Prerequisite or Other Additional Requirements:		

ATTACHMENT B: BUDGET

REVENUE ESTIMATES

	Year 1 2018		Year 2 2019		Year 3 2020		Year 4 2021		Year 5 2022	
Full-Time Tuition Rate: In-State	11245.50		11807.78		12398.16		13018.07		13668.98	
Full-Time Tuition Rate: Out-State	20300.94		21315.99		22381.79		23500.88		24675.92	
Mandatory Fees per Student (In-state)	705.84		741.13		778.19		817.10		857.95	
Mandatory Fees per Student (out-state)	705.84		741.13		778.19		817.10		857.95	
FTE # of New Students: In-State	4		3		2		2		2	
FTE # of New Students: Out-State	5		3		3		3		3	
# of In-State FTE Students transferring in from the institution's existing programs		8		0		0		0		0
# of Out-State FTE Students transferring in from the institution's existing programs		6		0		0		0		0

Tuition and Fees	Newly Generated Revenue	Revenue from existing programs	Newly Generated Revenue	Revenue from existing programs	Newly Generated Revenue	Revenue from existing programs	Newly Generated Revenue	Revenue from existing programs	Newly Generated Revenue	Revenue from existing programs
First Year Students										
Tuition										
In-State	$44,982	$89,964	$35,423	$0	$24,796	$0	$26,036	$0	$27,338	$0
Out-of-State	$101,505	$121,806	$63,948	$0	$67,145	$0	$70,503	$0	$74,028	$0
Mandatory Fees	$6,353	$9,882	$4,447	$0	$3,891	$0	$4,085	$0	$4,290	$0

Second Year Students										
Tuition										
In-State			$47,231	$94,462	$37,194	$0	$26,036	$0	$27,338	$0
Out-of-State			$106,580	$127,896	$67,145	$0	$70,503	$0	$74,028	$0
Mandatory Fees			$6,670	$10,376	$4,669	$0	$4,085	$0	$4,290	$0
Third Year Students										
Tuition										
In-State					$49,593	$99,185	$39,054	$0	$27,338	$0
Out-of-State					$111,909	$134,291	$70,503	$0	$74,028	$0
Mandatory Fees					$7,004	$10,895	$4,903	$0	$4,290	$0
Fourth Year Students										
Tuition										
In-State							$52,072	$104,145	$41,007	$0
Out-of-State							$117,504	$141,005	$74,028	$0
Mandatory Fees							$7,354	$11,439	$5,148	$0
Fifth Year Students										
Tuition										
In-State									$54,676	$109,352
Out-of-State									$123,380	$148,056
Mandatory Fees									$7,722	$12,011
Gross Tuition and Fees	$152,839	$221,651	$264,299	$232,734	$373,347	$244,371	$492,639	$256,589	$622,926	$269,419
Grants	$150,000		$200,000		$250,000		$300,000		$500,000	

Contracts	$30,000		$30,000		$50,000		$50,000		$50,000	$0
Campus budget allocation	$20,000		$20,000		$30,000	$0	$40,000	$0	$40,000	$0
Other Revenues (specify in cell 54)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total	$352,839	$221,651	$514,299	$232,734	$703,347	$244,371	$882,639	$256,589	$1,212,926	$269,419

Tuition and fees are based on the regular graduate student course load of 18 credits per year.

EXPENDITURE ESTIMATES

	Year 1 2018		Year 2 2019		Year 3 2020		Year 4 2021		Year 5 2022	
	New Expenditures required for Program	Expenditures from current resources	New Expenditures required for Program	Expenditures from current resources	New Expenditures required for Program	Expenditures from current resources	New Expenditures required for Program	Expenditures from current resources	New Expenditures required for Program	Expenditures from current resources
Personnel Services										
Faculty	$0	$146,884	$0	$151,291	$0	$155,829	$70,000	$160,504	$72,100	$165,319
Administrators	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Support Staff	$0	$21,550	$0	$22,197	$0	$22,862	$0	$23,548	$0	$23,548
Others	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Fringe Benefits 28.86_%	$0	$60,636.24	$0	$62,455.33	$0	$64,328.99	$25,200.00	$66,258.86	$25,956.00	$67,992.30
Total Personnel	**$0**	**$229,070**	**$0**	**$235,942**	**$0**	**$243,021**	**$95,200**	**$250,311**	**$98,056**	**$256,860**
Operating Expenses										
Supplies	$3,000	$5,000	$3,000	$5,000	$3,000	$5,000	$3,500	$8,000	$4,000	$5,000
Library Resources	$1,500	$1,000	$2,000	$1,000	$3,000	$1,000	$5,000	$1,000	$5,000	$1,000
Marketing/Promotional Expenses	$2,000	$500	$2,000	$500	$2,000	$500	$2,000	$500	$2,000	$500
Laboratory Expenses	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
General Administrative Overhead		$1,700		$1,700		$1,700	$200	$1,700	$200	$1,700
Other (specify)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Operating Expenses	**$6,500**	**$8,200**	**$7,000**	**$8,200**	**$8,000**	**$8,200**	**$10,700**	**$11,200**	**$11,200**	**$8,200**

Net Student Assistance										
Assistantships	$105,000		$140,000	$0	$175,000	$0	$175,000	$0	$210,000	$0
Fellowships	$140,000		$140,000	$0	$175,000	$0	$175,000	$0	$210,000	$0
Stipends/Scholarships	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Student Assistance	**$245,000**	**$0**	**$280,000**	**$0**	**$350,000**	**$0**	**$350,000**	**$0**	**$420,000**	**$0**
Capital										
Facilities / Campus recharges	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Equipment	$3,500	$0	$3,500	$0	$3,500	$0	$3,500	$0	$3,500	$0
Other	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Capital	**$3,500**	**$0**	**$3,500**	**$0**	**$3,500**	**$0**	**$3,500**	**$0**	**$3,500**	**$0**
Total Expenditures	**$255,000**	**$237,270**	**$290,500**	**$244,142**	**$361,500**	**$251,221**	**$459,400**	**$261,511**	**$532,756**	**$265,060**

BUDGET SUMMARY OF NEW PROGRAM ONLY

	Year 1 2016	Year 2 2017	Year 3 2018	Year 4 2019	Year 5 2020
Total of newly generated revenue	$352,839	$514,299	$703,347	$882,639	$1,212,926
Total of additional resources required for program	$255,000	$290,500	$361,500	$459,400	$532,756
Excess/ (Deficiency)	$97,839	$223,799	$341,847	$423,239	$680,170

ATTACHMENT C: FACULTY

Name of faculty member (Name, Degree and Field, Title)	Ten-ured Y/N	Courses Taught Put (C) to indicate core course. Put (OL) next to any course currently taught online.	# of sections	Division or College of Employment	Full- or Part- time in Program	Full- or part-time in other department or program (Please specify)	Sites where individual will teach program courses
Güçler, Beste Ph.D., Mathematics Education, Associate Professor	Y	• Intro to Qual (C) • Intro to Math Ed Research (C) • Theories of STEM ED (C) • Frameworks (C) • Capstone 1 & 2 (C) • Authentic Learning (C) • Development of Theory • Research in Undergraduate Math Ed • Research on Proof & Reasoning • Thinking & Learning in Math Ed	(1 each)	College of Arts & Sciences	Part-Time	Part-time in MAT for Mathematics Education	• Main Campus
Kayumova, Shakhnoza Ph.D., Educational Theory and Practice (Science Content Area), Assistant	N	• Intro to Qual (C) • Intro to Quant (C) • Research Skills 1 & 2 (C) • Theories of STEM Ed (C) • Frameworks (C) • Authentic Learning	(1 each)	College of Arts & Sciences	Part-Time	Part-time in the MAT for English Language Learners	• Main Campus

Professor		(C) • Development of Theory • Nature of Science • Science Teacher Education • Science Education & Social Justice • Socioscientific Issues-Based Education • Social Justice & STEM Ed • Access, Inclusion, & Heterogeneity in STEM Ed					
Orrill, Chandra Ph.D., Instructional Systems Technology, Associate Professor	Y	• Intro to Qual (C) • Intro to Math Ed Research (C) • Research Skills 1 & 2 (C) • Capstone 1 & 2(C) • Developing & Implementing STEM Environments (C) • Authentic Learning (C) • Research on Math Teacher Ed • Research in Elem Grades Math • Contemporary Issues in K-8 Math • Research on Technology in Math	(1 each)	College of Arts & Sciences	Part Time	Part-time in MAT for Mathematics Education	• Main Campus

		• Ed • Design of STEM Learning Environments • Leadership, Policy & Change in STEM Ed • STEM Ed Curriculum Reform • Design-Based Research in STEM Ed					
Stroup, Walter, Ed.D., Teaching Curriculum and Learning Environments, Associate Professor	Y	• Special Topics: Research on Technology in Math Ed • Introduction to Quantitative Methods	(1 each)	College of Arts & Sciences	Part-Time	Part-Time in the MAT for Mathematics Education & Science Education	• Main Campus
Terrell, Karen Ph.D., Curriculum & Instruction - Mathematics, Science, and Technology Strand, Full-Time Lecturer	N	• Intro to Qual (C) • Intro to Math Ed Research (C) • Research Skills 1 & 2 (C) • Authentic Learning (C) • Research on Math Teacher Ed • Thinking & Learning in Mathematics Education • Social Justice and STEM Ed • Access, Inclusion, & Heterogeneity in	(1 each)	College of Arts & Sciences	Part-Time	Part-time in MAT for Mathematics Education	• Main Campus

		STEM Ed					
Witzig, Stephen Ph.D., Learning, Teaching, & Curriculum – Science Education, Assistant Professor	N	• Intro to Qual (C) • Intro to Science Ed Research (C) • Research Skills 1 & 2 (C) • Capstone 1 & 2(C) • Developing & Implementing STEM Environments (C) • Authentic Learning (C) • Nature of Science • Science Teacher Education • Science Education in Informal Settings • Socioscientific Issues-Based Education • Design of STEM Learning Environments • Leadership, Policy, & Change in STEM Ed	(1 each)	College of Arts & Sciences	Part-Time	Part-time in the MAT for Science Education	• Main Campus