Masters of Education Degree with a specialization in Elementary Mathematics

Program Proposal

School of Professional and Continuing Studies

Northeastern University

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Program Title: Masters of Education in Elementary Mathematics, Pre – K – 5

Evidence of Need

In its *Guidelines for the Mathematical Preparation of Elementary Teachers, July 2007,* the Massachusetts Department of Education puts forward the challenge to colleges and universities who prepare elementary teachers that "we must prepare teachers and students for a world that is increasingly technological and globally competitive. These new realities demand far higher levels of proficiency in the STEM disciplines: Science, Technology, Engineering and Mathematics. Mathematics is the foundation for accomplishment in all four of these disciplines, and Massachusetts, despite making great strides, still has a long way to go before every student is proficient in math. "

Further, the DOE says that any "course of study should attempt to highlight the breadth and depth of mathematics that teachers at the elementary level must not only be able to do, but understand and explain in many ways to students. The fact that the courses do not extend beyond the mathematics covered by elementary schools should not be construed to mean that the mathematics preparation recommended herein will be easy—quite the contrary. It will require most students to delve far deeper into the underlying structures of mathematics than they have previously explored."

The need to understand and be able to use mathematics in everyday life and in the workplace has never been greater and will continue to increase. Reform of school mathematics has been an important topic within the mathematics education community for many years. As a result, new knowledge, tools, and ways of doing and communicating mathematics continue to emerge and evolve. Recently however, calls for change in the way American students are taught mathematics are once again in the forefront. Major indicators of mathematics educational progress continue to report that American students are not measuring up to their international peers [TIMS Study] and that they seem to lack a *fundamental understanding* of basic mathematics content.

While the Massachusetts DOE Guidelines focus primarily on pre-service education there in far too many instances practicing elementary teachers lack the knowledge, understanding and skills to teach mathematics effectively. Elementary teachers are at the front line of mathematics education. They are responsible for providing students with a firm foundation needed for a fundamental understanding of mathematical principles at all levels. In order to meet this challenge, elementary teachers need a profound understanding of fundamental mathematics.

Today's world demands a mathematically literate citizenry, well prepared for ever-changing technology and growing global competition, and led by a new generation of mathematics teachers. More challenging mathematical content is required at every grade level. Class time should be planned effectively to engage all students. Students must have opportunities to become engaged in mathematics that promotes reasoning and fosters communication between teachers and students and between and among students. Students need to develop and practice skills and procedures for solving a wide range of problems. This Certificate Program is designed to prepare this new generation of elementary mathematics teachers.

Competition

Area colleges and universities offer many types of general education masters programs and general elementary education licensure programs, though none specific for elementary mathematics. For example, Cambridge College has an MED program with licensure and an MED program without licensure in three areas: math methods and content, math content, and a certificate program for high school mathematics teachers. The University of Massachusetts has multiple offerings in their STEM Education Initiatives, but nothing as focused as the certificate program proposed here. Lesley University currently has a Masters of Education in [Elementary] Mathematics.

Program Description

The National Council of Teachers of Mathematics [NCTM] has made their position very clear on what constitutes a *highly qualified mathematics teacher:* **"**Every student has the right to be taught mathematics by a highly qualified teacher—a teacher who knows mathematics well and who can guide students' understanding and learning. A highly qualified teacher understands how students learn mathematics, expects all students to learn mathematics, employs a wide range of teaching strategies, and is committed to lifelong professional learning."

"Mathematics teaching and learning is a cooperative effort by teachers and students to actively engage in purposeful learning experiences that stimulate curiosity, enjoyment, and deep understanding of the mathematical concepts outlined in the Massachusetts Mathematics Curriculum Framework. Teachers and students are knowledgeable about learning objectives, and have ownership of and are accountable for learning outcomes." *Massachusetts DOE Guidelines for the Mathematical Preparation of Elementary Teachers, July 2007.*

The MED in Elementary Mathematics, grades pre-K - 5 proposed here is designed to prepare such highly qualified teachers. Teachers are required to take four core courses and then a sequential series of content courses designed to meet a wide variety of mathematics learning needs.

The program of study is intended to be both inviting and experiential for elementary teachers while offering them interdisciplinary, high level mathematics content in conjunction with best teaching practices. All students wishing to obtain a MED in Elementary Mathematics Education will be required to take the overview course "Creating the Ideal Learning Environment for Elementary Mathematics". This course will present the rationale and research-based foundation for the entire program.

"Most approved programs for teaching licenses at the elementary level will need to expand the number and depth of mathematics courses that are available to their candidates. As in every subject area, candidates will have developed different levels of competence in mathematics prior to enrolling in the program. However, the research is clear that competence across the population in general is lower in mathematics than in reading, writing, and language arts. For those teachers enrolling with typical knowledge and fluency in mathematics, attaining the necessary level of content knowledge will normally require at least three to four college-level, subject-matter courses, i.e., 9–12 semester-hours, taught by mathematics faculty, potentially in partnership with education faculty." *Massachusetts DOE Guidelines for the Mathematical Preparation of Elementary Teachers, July 2007.*

Target Audience

This MED program is designed for elementary classroom teachers, teacher leaders, mathematics coaches and others in grades pre-K – 5 who wish to enhance their understanding of mathematics as it uniquely applies to elementary school curriculum. Participants should have at least two years of classroom experience. Teams of two or three teachers from a school or district is preferred though not required

Program Objectives

The purpose of the MED program is to strengthen the mathematics content knowledge and pedagogy of teachers at the elementary level as called for by the Massachusetts Board of Education. Most elementary teachers have not had sufficient mathematics content-knowledge preparation for their critical role. Our students' mathematics achievement, reported to be ahead of the nation but far below that of their international peers, will not rise until mathematics teaching and learning improves vastly—starting with elementary school.

"Among the population at large, including many elementary teachers, mathematics is widely perceived as a vast hodgepodge of memorized facts and procedures that don't make much sense. The overarching goal of these courses is to lay that misconception to rest, replacing it with the realization that elementary-school mathematics is a coherent and unified set of concepts and principles that is at once powerful, beautiful, and fun. "Massachusetts *DOE Guidelines for the Mathematical Preparation of Elementary Teachers, July 2007.*

The overall objective of this program is to offer a full curriculum designed to provide elementary teachers what they need to become *highly qualified teachers of mathematics*. Mathematics teaching at any level requires that teachers have an extensive knowledge of mathematics on three different fronts: knowledge of the specialized content and curriculum; knowledge of best teaching practices; and, knowledge of how students learn. This certificate program is designed to address all three areas simultaneously. The content and curriculum that is addressed in this proposal matches that specified by NCTM, Massachusetts Department of Education, the Conference Board of the Mathematical Sciences, and by the United States Department of Education Advisory Committee on Improving Teacher Content Knowledge in Mathematics. The content courses consist of college-level mathematics courses that emphasize the mathematical structures essential to the elementary grades including number and operations, algebra, geometry, data analysis, and probability.

This program is designed for in-service elementary teachers as well as mathematics specialists and coordinators, to help them meet the ever-growing demands of today's mathematics classrooms. The program incorporates both mathematics content and pedagogy. Teachers will learn the content through experiences that model the way they should teach in their own classrooms. The program will model not only what should be taught, but how it should be taught.

Each of the six content courses is designed to contain common elements that will be woven into the fabric of the content being introduced. The common elements of each module include the following:

- Teach to the standards

- Create a culture of inquiry.
- Explore how children learn
- Evaluate and use available hands-on equipment, tools, technology and internet resources
- Integrate literacy skills (both reading and writing)
- Present real-world applications of mathematics
- Integrate the use of standard and metric measurement tools and skills
- Integrate engineering and technology tools and skills

All teachers must understand how students learn mathematics. They must know how to plan, conduct, and assess the effectiveness of mathematics lessons and know how and when to make teaching decisions (e.g., listening, modeling, questioning). Teachers of mathematics should understand—and also invest in—the particular culture of their students and the school. They are adept at knowing how to actively engage students of diverse backgrounds and strengths in significant and challenging mathematical tasks that help them understand concepts, learn skills, and solve problems.

A highly qualified mathematics teacher at any level recognizes the need for, and commits to, lifelong professional learning involving mathematics and its instruction. Overall, the mathematical knowledge, informed actions, positive attitudes, and high expectations of highly qualified mathematics teachers lead to mathematics learning, confidence, and the development of a positive attitude toward mathematics on the part of students.

Curriculum

Core Courses

MTHxxxx	Creating the Ideal Learning Environment for Elementary Mathematics	4qh
MTHxxxx	Assessment in the Elementary Mathematics Classroom	3qh
MTHxxxx	Creating a Student-Centered Mathematics Classroom: Meeting the needs of All Students	4qh
MTHxxxx	Integrating Technology into the Mathematics Classroom	3qh

Content Course

MTHxxxx	Count-Ability: Number and Place Value	3qh
MTHxxxx	Puzzling Problems: Arithmetic Operations	3qh
GEOxxxx	Getting into Shapes: Geometry and Measurement	3qh
MTHxxxx	Measure Up! Standard and Metric Measurement	3qh
ALGxxxx	Awesome Algebra: Functions and Algebra	3qh
MTHxxxx	What are the Chances? Data Analysis and Probability	3qh
Total		**17qh**

Course Descriptions

Core Courses

MTHxxxx Creating the Ideal Learning Environment for Elementary Mathematics 4qh

The purpose of this course is to assist participants in becoming confident and effective Inquiry-based mathematics teachers. To accomplish this, participants will *experience* the ideal learning environment that is most conducive for teaching and learning elementary mathematics in today's classrooms. Participants will have the opportunity to explore how children develop foundational mathematical understanding at the very early ages. This course will provide an introductory, hands-on, exploratory experience in number sense, the operations, geometry, measurement, and algebra. The work will be approached from the perspective of the student learner, and participants will delve into the mathematical concepts behind the experiences to gain an understanding of how these early skills are scaffolded at the upper grade levels. Making sense of student thinking, investigating alternative solution strategies, refining lesson planning, sharing instructional strategies, and creating a community of learners will be some of the focus points.

MTHxxxx Assessment in the Elementary Mathematics Classroom 3qh

In this course participants will have the opportunity to explore a range of assessments that can be implemented in the elementary classroom. This will help participants to create a more comprehensive picture of student achievement through data collection as well as more clearly defined student needs which will in turn drive their instruction. Formal assessments (standardized tests) and informal assessments (student observation) in mathematics will be examined, and there will be opportunity to weigh the benefits and limitations of each. Questioning strategies and a protocol for looking at student work will be covered.

MEDxxxx Creating a Student-Centered Mathematics Classroom: Meeting the needs of All Students 4qh

In this course participants will have the opportunity to explore specific instructional strategies that support differentiation in the mathematics classroom. Participants will examine the teacher's current role in the classroom, discuss ways to facilitate student learning through inquiry based activities, and promote student independence. Ensuring equitable access to all members of a diverse learning population will be explored: identification of students in need of services in mathematics, exploring particular mathematical learning disabilities such as dyscalculia, and support for ELL students.

MEDxxxx Integrating Technology into the Mathematics Classroom 3qh

This course seeks to broaden participants' knowledge about, and strengthen the ability to select computer software and websites that can be integrated into the mathematics classroom. The research supporting the use of software and websites in mathematics classrooms at all levels will also be reviewed. Participants will select, review, analyze, and evaluate various software and websites and then design technology-based lesson plans.

Content Courses

MTHxxxx Count-Ability: Number and Place Value 3qh

This course is designed to develop a comprehensive understanding of number systems and how its structure is related to computation and problem solving. It will begin with a look at historical perspective of numbers and number systems. This will lead into the study of place value and the base ten structure of the number system. A great deal of emphasis will be placed upon

understanding the concept of place value since it forms the foundation for understanding other major mathematical concepts (i.e. decimal fractions, scientific notation, standard algorithms, mental math, estimation, and rounding). You will then explore decimals, fractions, percent and mixed numbers and recognize the connections among them. The number line will be used throughout this course as a vehicle for "depicting" positive and negative numbers and fractions.

MTHxxxx Puzzling Problems: Arithmetic Operations 3qh
This course will take an in depth look at the four arithmetic operations: addition, subtraction, multiplication, and division of whole numbers and then revisit the operations in the context of rational numbers. A great deal of emphasis will be placed upon the connections among the operations. The number line will be used for simple arithmetic operations. You will explore the standard and nonstandard algorithms for the four operations and why they work. The properties of arithmetic will be explored. Estimation skills and the skills known collectively as number sense and mental math will also be developed.

GEOxxxx Getting into Shapes: Geometry and Measurement 3qh
This course will focus on the foundations of informal measurement and geometry in one, two, and three dimensions. You will explore how students build an understanding of length, area, volume, angles, and geometric relationships. Visualization, spatial reasoning, and geometric modeling will be stressed You will develop the vocabulary of geometry and explore both definitions and attributes of geometric objects. Transformational geometry, similarity, congruence, and geometric constructions will also be covered. You will calculate the perimeter of polygons, areas of two-dimensional shapes, and volumes of three-dimensional shapes.

MTHxxxx Measure Up! Standard and Metric Measurement 3qh
Measurement in everyday life takes center stage in this course where you will investigate the fundamentals of measurement. Both the standard system of measurement and the metric system will be covered. You will use an assortment of tools to measure length, distances, capacity, volume, weight, mass, time, and temperature. You will convert from one unit of measurement to another within the same measurement system. You will use measurement to design and construct objects and draw scaled drawings. Accuracy and precision of measurements will also be discussed.

ALGxxxx Awesome Algebra: Functions and Algebra 3qh
Algebra, once considered too advanced for the elementary classroom, is now recognized as a gatekeeper subject. This course will demonstrate how to scaffold pre-algebra and algebra skills in the elementary grades. It will also focus on helping you attain depth and understanding of mathematical expressions, formulas, equations, and functions (linear, exponential, polynomials). You will explore the relationship among ratio, proportion, constant rates, and linear functions. In this course you will see how graphs, equations, tables and words can all be used to describe relationships. You will experience the power of variables and how they are used to describe patterns. The graphing calculator will play an important role in these explorations.

MTHxxxx What are the Chances? Data Analysis and Probability 3qh
This course will help you develop a deeper understanding of data analysis. descriptive statistics, and probability, You will begin by the data analysis section by formulating questions, designing

investigations, gathering data, and then organizing and analyzing that data. The descriptive statistic topics covered include measures of central tendency (mean, median, mode), dispersion (range, standard deviation), distributions, and regression. The probability sections will include basic principles and calculation methods of probability.

Total **32qh**

Implementation Schedule: The goal is to launch this proposed MED in Elementary Mathematics program beginning ideally in the summer of 2008 with an intensive course followed by the second core course in the following fall quarter. The remaining core courses and content courses will be scheduled throughout the remaining semesters.

Admissions Criteria
Normally, in order to be admitted to a School of Professional and Continuing Studies (SPCS) MED program, a prospective student must have successfully completed a bachelor's degree from an accredited institution and meet one of the following requirements:

1. Graduated in good standing with a minimum of a 3.00 GPA.
2. Graduated with a 2.5 GPA or better (but less than 3.00) and accumulated significant work experience in the field.
3. Been accepted as a special student and completed two graduate courses with at least a B average and no grade below a B-.

Non-matriculated students with proof of bachelor's degree completion can enroll in up to two courses of graduate study without being fully admitted to a degree. Students seeking to matriculate must meet SPCS admissions criteria.

Admission Process
Prospective MED students must submit official undergraduate transcripts (with translation and evaluation if completed outside of the United States), an up-to-date resume, and a 500-word statement of purpose that describes their interest in the program and the expectations they have for the program and two letters of recommendation at least one from the school principal or other administrator. Additional information and supporting documentation might be requested of the applicant by SPCS.

Progress toward Completion
Courses are scheduled so that students may take one or two courses per quarter and complete the entire program within one year. Students complete the two core courses plus three selections from the content areas, with each course for a total of 17 quarter hours of credit.

Faculty
Faculty will consist of a combination of full-time and adjunct faculty, with an emphasis on instructors with experience in teaching pre k-5 mathematics.

References

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How People Learn: Brain, Mind, Experience and School, National Research Council, National Academy Press, 2000

Knowing and Teaching Elementary Mathematics, Liping Ma, Lawrence Erlbaum Associates, Publishers, 1999

Assessment for Learning: Putting it into Practice, Open University Press, Paul Black et al,2003