

New Graduate Degree – Certificate Program Proposal Form



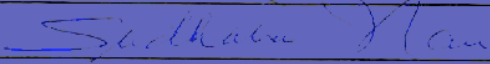
Academic Unit: Mathematics & Science Education (MSED) Date: 11-30-2006

Program Name: Ph.D. in Collegiate Mathematics Education

Program Director(s): Dr. Zaur Berkaliev (MSED)

(Persons named as the Program Director are eligible to receive the New Program Development Incentive from the Graduate College. If someone other than the Program Director should be considered for this incentive, please attach a memo to this effect.)

APPROVAL SIGNATURES REQUIRED:

- (1) Academic Unit Curriculum Committee Chair:  11/30/06
- (2) Academic Unit Head:  11/30/06
- (3) Graduate Dean:  11/30/06
- (4) Graduate Studies Committee Chair: _____
- (5) Main Campus Faculty Council Chair: _____

Attach additional pages on which a detailed discussion regarding the following items is provided.

- 1) Program Overview: Describe the objective of the new program.
- 2) Program Justification:
 - a) Provide a detailed discussion on why the program is needed.
 - b) Provide a detailed description of the relationship of the proposed program to other degree programs offered by IIT and by the academic unit
- 3) Program Resources
 - a) Describe the personnel requirements necessary to offer the program. Include faculty, teaching assistant, and support staff. For faculty, indicate current faculty to be associated with the program, detail any requirements for additional faculty hires, and note the number of part-time faculty needed to support the program. Describe how and when resources will be made available to hire any additional personnel that are required.
 - b) Describe the facilities necessary to offer the program. Describe how and when resources will be made available to obtain any additional facilities that are required.
- 4) Program Description
 - a) Provide the detailed degree requirements for the program.
 - b) Indicate the admission criteria for the program.
 - c) Provide a timeline and schedule for offering the program.

NEW PROGRAM PROPOSAL

ILLINOIS INSTITUTE OF TECHNOLOGY

College: Science and Letters
Departments: Applied Mathematics / Mathematics and Science Education
Date: Oct-04-2006

Approvals Requires

- (1) Academic Unit Head:
 - (2) Dean:
 - (3) Other:
-
-

GENERAL INFORMATION

Program Title: Ph.D. in Collegiate Mathematics Education

Program Scheduling

Fall 2007 Spring __ Summer __

Program Level: Undergraduate __ Graduate X

Total Program Credit Hours: 85

Background:

The last decade has been characterized by the growing concerns among policy makers about the crisis-like state of mathematics education in the United States which has serious implications for US national security. In commenting on the introduction of the "No Child Left Behind" act, President Bush lamented that US students trail students even in Cyprus and South Africa on international math tests. The implications of this for vital US interests had been stated dramatically and unequivocally in the 2001 report of the Commission on National Security for the 21st Century entitled "Roadmap for National Security: Imperative for Change." In calling attention to the need for continued reforms in science and math education this report declared:

"Americans are living off the economic and security benefits of the last three generations' investment in science and education, but now we are consuming capital. Our systems of basic scientific research and [science and math] education are in serious crisis. . ." In the commission's view, "the inadequacies of our system of research and [science and math] education pose a greater threat to U.S. national security over the next quarter century than any potential conventional war that we might imagine." In assessing this alarming situation, the commission report

warns that if the US does not "invest heavily and wisely in rebuilding these two core strengths, America will not be capable of maintaining its global position long into the 21st century." (Full text available at <govinfo.library.unt.edu/nssg/PhaseIIIFR.pdf>.)

This report represents the thinking of a bipartisan commission headed by former Senators Gary Hart and Warren Rudman; its other members were Anne Armstrong (counselor to Presidents Nixon and Ford); Norman Augustine (Chair of the Executive Committee of the Lockheed Martin Corporation and former Under Secretary of the Army); John Dancy (former chief diplomatic correspondent for NBC News); John Galvin (General, US Army [Retired]); Leslie Gelb (President of the Council of Foreign Relations); Newt Gingrich (former Speaker of the US House of Representatives); Lee Hamilton (former ranking Democratic member of the US House of Representatives Committee on International Relations); Lionel Olmer (former Undersecretary of Commerce); Donald Rice (former Secretary of the Air Force and former President and CEO of the RAND Corporation); James Schlesinger (former Secretary of Defense; Secretary of Energy, and former Director of the CIA); Harry Train II (former Commander-in-Chief of the US Atlantic Fleet); and Andrew Young (former US Ambassador to the UN).

The same crisis described by that Commission is referred to in several other documents and publications. In particular, according to *The New York Times* ("Former University President Will Lead U.S. Math Panel," 15 May 2006), "the new panel reflects a growing concern by the Bush administration that the United States risks losing its competitive edge as other nations outpace its performance in math and science. [...] A big part of the problem, regardless of the teaching method used, is the shortage of qualified math teachers."

As a result of these growing concerns, in the spring 2006, the House completed debate and amendments, and finally passed HR 609, the College Access and Opportunity Act of 2005 (Higher Education Act reauthorization). One of the passed amendments is "to provide for increasing the number of teachers qualified to teach advanced and pre-advanced placement courses in science, math and critical foreign languages, and strategies to increase the availability of these courses, particularly for low-income students." (The text of the amendment can be found at <http://www.rules.house.gov/109_2nd/specialrules2nd109/hr609/109_2nd_hr609_mcmoris94.pdf>)

This is a reflection not only of the dearth of qualified math teachers in the US today, but especially the dearth of math education Ph.D.'s. According to a study by *The Chronicle of Higher Education* ("More Jobs than Job Seekers in Mathematics Education," February 19, 2002), most open faculty positions seeking Ph.D.s in mathematics education are going unfilled, and to find a person with a Ph.D. degree in both mathematics and mathematics education is extremely difficult for most institutions. (Full text available at <<http://chronicle.com/jobs/2002/02/2002021901c.htm>>.) Unfortunately, this situation is exacerbated by historically-established disconnect and lack of collaboration between

traditional mathematics departments, on the one hand, and traditional departments of curriculum and instruction, on the other hand.

Currently, IIT is offering a Ph.D. in Applied Mathematics which focuses on advanced mathematical research, and a Ph.D. in Mathematics Education which focuses on K-12 Mathematics Education. However, there is no doctoral program at IIT which emphasizes Collegiate Mathematics Education and which can be offered only through collaborative efforts of the two departments.

Program Description:

This proposal on joint Ph.D. degree in Collegiate Mathematics Education represents a result of collaboration between the Department of Applied Mathematics (AM) and the Department of Mathematics and Science Education (MSED). It addresses, in particular, the above-mentioned concerns about the quality of mathematics teaching in the U.S. and the lack of qualified math instructors having joint Ph.D. degrees in mathematics and mathematics education with strong backgrounds both in the subject matter knowledge and pedagogical content knowledge.

The new doctoral program represents a combination of two types of courses -- on mathematics and on mathematics education -- offered respectively by the AM and MSED departments and based on the existing departmental resources with no additional investments or new faculty hires. Generally, the program is intended for the following two groups of target students:

- Target Group 1: Mainly mathematics graduate students who are interested in teaching careers in community colleges or other post-secondary / higher education institutions and who are interested in research in collegiate mathematics education and, respectively, need to improve and enhance their pedagogical content knowledge and educational research skills.
- Target Group 2: Mainly mathematics education graduate students and other candidates who are interested in collegiate math teaching and in research in collegiate mathematics education and, respectively, need to improve and enhance their subject matter knowledge and mastery of fundamental collegiate mathematics.

The core sequences and electives selected for this joint Ph.D. program are based on the combined needs of these two main target groups of graduate students.

Program Purpose:

1. Attract to IIT new populations of doctoral students by extending and broadening the main target groups of the AM and MSED departments through efficient and innovative combination of the existing departmental resources without additional investments and faculty hires at the start of the new program.

2. Attract to IIT new populations of doctoral students by addressing the above-mentioned urgent and long-term strategic needs of producing more Ph.D.s with strong background both in mathematics and in mathematics education.
3. Provide graduate math majors who enroll in the proposed joint Ph.D. program with up-to-date field experiences and pedagogical content knowledge in mathematics education necessary for their future teaching careers in community colleges and other post-secondary / higher education institutions, as well as for successful research on collegiate mathematics education.
4. Provide graduate math education majors (or those with insufficient collegiate math background) who enroll in the proposed joint Ph.D. program with strong subject matter knowledge of fundamental collegiate mathematics necessary for their future teaching careers in community colleges and other post-secondary / higher education institutions, as well as for successful research on collegiate mathematics education.

Program Benefits:

1. Broadening target groups and attracting new doctoral students both to the departments of Applied Mathematics and Mathematics and Science Education based on their existing resources.
2. No need for additional investments or faculty hires in order to start and implement the proposed joint Ph.D. program.
3. Creating the unique for the Chicago metropolitan area and for the mid-West joint doctoral program addressing the above-mentioned high-priority national needs in improving the quality of mathematics education in the U.S. and producing new Ph.D.s with strong math and math education backgrounds.
4. Establishing a precedent of successful and fruitful collaboration between mathematics and education departments which traditionally often have been disconnected.

MARKETING INFORMATION

Competitive Programs:

According to the Special Interest Group of the Mathematical Association of America on Research in Undergraduate Mathematics Education (SIGMAA RUME), currently there are 51 doctoral programs in Mathematics Education in the U.S. offered at 46 higher education institutions (the complete list available at <http://www.rume.org/phd.html>). Out of these 51 programs, 20 programs are housed in departments of mathematics.

Unlike the proposed herein joint Ph.D. program at IIT, the majority of the above-mentioned 20 programs focus mostly on various aspects of traditional K-12 mathematics education or K-12 teacher preparation. Only 9 out of these 20 programs explicitly offer an option of focusing on research in undergraduate math education (Arizona State University, Central Michigan University, Montana State University, Oregon State University, University of Maryland, University of Montana, University of Northern Colorado, University of Oklahoma, and Western Michigan University), and 2 more universities offer a Doctor of Arts for 2- and 4-year college instructor preparation (Idaho State University and University of Illinois). In many cases, a possible focus on research in undergraduate math education represents only one of the options along with more traditional options of research in K-12 math education offered by the same doctoral programs. One also has to keep in mind here that the above-mentioned optional focus on research in undergraduate mathematics education does not always mean that the corresponding program necessarily stresses broad and concentrated math content preparation for collegiate mathematics teaching per se. However, all of the 9 above-mentioned Ph.D. programs stress and emphasize this option of focusing on collegiate math education as an exceptional value which makes those programs especially attractive for a wide range of mathematics and education majors and teachers.

Finally, only 2 out of the 20 programs (Oregon State University and Syracuse University) clearly state that their Ph.D. degrees are actually joint degrees in collegiate mathematics education offered by both mathematics and education departments (although in some other cases academic advisors may belong to either math or education departments which, however, does not automatically mean that the corresponding degree is joint).

This means that only the last two above-mentioned joint Ph.D. programs may directly compete with the proposed joint Ph.D. program in Collegiate Mathematics Education. Given that overall there are two hundred doctoral programs in mathematics and fifty doctoral programs in mathematics education across the nation, this means there will be no tight competition with the proposed herein doctoral program at the national level.

Finally, there is no equivalent Ph.D. program in the Chicago metropolitan area or in the whole mid-West. Given that there are so many community colleges and other higher education institution in the region, this means that the proposed program should have a favorable market for its implementation and further development.

Market Analysis:

According to the above-mentioned study by *The Chronicle of Higher Education* (“More Jobs than Job Seekers in Mathematics Education,” February 19, 2002), “in 2000-2001, of the 134 job openings in mathematics education (all but one of them was on the tenure track), 66 -- or 49 percent -- went unfilled [because] there simply aren't enough doctoral students in the pipeline to meet the demand.” This study also claims that “[math education] graduates typically have multiple interviews and job offers [and] some departments are so desperate for candidates that they're hiring people who haven't yet finished their degrees.” Given that “the demand for Ph.D.'s in mathematics education has increased, in large part, because of faculty retirements” (ibid.) and given the crisis-like state of mathematics education in the U.S. recently acknowledged by policy makers, it is highly unlikely that the market demand for Ph.D.s in mathematics education has changed significantly since 2002, which means that the proposed joint Ph.D. program in collegiate mathematics education might have highly promising perspectives.

Marketing and Advertising:

The following strategies will be employed for marketing and advertising the program:

- The information and advertisement about the new joint Ph.D. program in Collegiate Mathematics Education will be distributed through the Chicago Public Schools (CPS) Listserv.
- Letters with the information and advertisement about the new joint Ph.D. program will be mailed to junior and community colleges in Illinois and out of state.
- The information and advertisement about the new joint Ph.D. program will be distributed through the National Council of Teachers (NCTM) and Mathematical Association of America (MAA).
- The information and advertisement about the new joint Ph.D. program will be distributed through professional development workshops and other educational activities of the departments of Applied Mathematics and Mathematics and Science Education.

ACADEMIC INFORMATION

Enrollment Estimates:

Currently, the MSED department has 42 Ph.D. students out of whom 8 are full-time students and 34 are part-time students (mostly, in-service high school teachers and community college instructors) enrolled in the department's Mathematics and Science Education doctoral program, as well as 76 M.S. students out of whom 38 are full-time and 38 are part-time students. Besides that, 6 of the current math education doctoral students are community college instructors who might be more interested in pursuing a joint Ph.D. in Collegiate Mathematics Education rather than in K-12 Mathematics Education. Given these numbers and the fact that the pool of 76 M.S. students might be used for recruitment to the new joint Ph.D. program, an initial enrollment estimate for the new program is about 5 full-time and 10-15 part-time doctoral students for the first year and about 15-20 full-time students within the first 3 years of the program (a conservative estimate).

Retention Estimates:

The retention of the new Ph.D. program is expected to be over 80% and is based upon the current retention level in the Department of Mathematics and Science Education, as well as on Norman Lederman's previous experience on similar programs at Oregon State University and Syracuse University.

Course Requirements:

Course requirements for the new joint Ph.D. program are based on the existing courses which are currently offered in the Department of Applied Mathematics and the Department of Mathematics and Science Education. No new courses are to be developed for the implementation of the program, as well as there is no dependence on courses from other academic units.

Course requirements are specifically tailored for the two main target groups mentioned in the "Program Description" section (see above). The core sequences and electives selected for this joint Ph.D. program are based on the combined needs of these two target groups of graduate students.

Course Requirements:

- 85 credit hour requirement (32 credits maximum transfer from master's coursework; 42 maximum transfer of graduate coursework credits; the number of subjects allowed for transfer credit depends on what subject have been recently taken and is decided on a case-by-case basis)
- AM Core Requirements (21 credit hours):

- | | |
|----------|---|
| MATH 500 | Applied Analysis I |
| MATH 553 | Discrete Applied Mathematics I |
| MATH 577 | Computational Mathematics I |
| MATH 515 | Ordinary Differential Equations and Dynamical Systems |
| MATH 532 | Linear Algebra |
| MATH 540 | Probability |
| MATH 476 | Statistics |
- MSED Core Requirements (18 credit hours):

MSED 598	Methods of College Teaching in Mathematics and Science
MSED 599	College Teaching Practicum in Mathematics and Science
MSED 601	Critical Analysis in Quantitative Research
MSED 602	Quantitative Research Design and Practicum
MSED 603	Critical Analysis in Qualitative Research
MSED 604	Qualitative Research Design and Practicum
 - AM Elective Requirements (minimum of 12 credits):

MATH 401	Analysis II
MATH 402	Complex Analysis
MATH 420	Geometry
MATH 5XX	(any 500-level AM courses)
 - MSED Elective Requirements (minimum of 9 credits):

MSED 503	Advanced Strategies: Mathematics
MSED 521	History/Philosophy of Mathematics
MSED 550	Clinical Supervision in Science/Mathematics
MSED 552	Assessment and Evaluation
MSED 555	Mathematics Curriculum
MSED 571	Problem Solving and Nature of Mathematics
 - Qualifying Exam, fulfilled by achieving better than a 3.5/4.0 GPA on the AM core courses and a 3.5/4.0 GPA on the MSED core courses and passing an oral examination within the first five semesters of Ph.D. study (within the first two years for students entering with a Master's degree in Mathematics). The oral exam consists of two parts: the first part covers the AM core courses, and the second part covers the MSED core courses. The MSED oral exam is composed of seven position statements (ranked by the faculty). Position Statement 1: Written defense to support position with empirical research. Position Statements 2, 3, 4: Oral defense.
 - Comprehensive Exam, which consists of an oral examination based on the student's research proposal. The exam aims to ensure that the student has the

background to carry out successful research in his/her chosen area and the proposed research has sufficient scholarly merit.

- Minimum of 25 hours devoted to thesis research (CMT 691)
- Dissertation (thesis), which is expected to contain a distinct and substantial, original and publishable contribution to the field of study
- Defense: an oral examination in defense of the thesis constitutes completion of the degree

Admission Criteria:

Admission to the joint Ph.D. program in collegiate mathematics education requires:

- Master's or Bachelor's Degree in mathematics or applied mathematics. Candidates whose degree is in another related field (for example, computer science, physics, or engineering) and whose background in mathematics is strong are also eligible for admission and are encouraged to apply.
- Quantitative and Verbal score: 1100
Analytical score: 3.0
- TOEFL (minimum score of 600) if from non-English speaking country
- A minimum GPA of 3.0/4.0 is required
- Professional statement of goals/objectives (2 pages)
- Vita
- Three letters of recommendation
- An interview may be required

SAMPLE CURRICULUM / PROGRAM REQUIREMENTS

(as they would appear in the IIT Graduate Programs Bulletin)

Doctor of Philosophy in Collegiate Mathematics Education

85 credit hours beyond the bachelor's degree*
Qualifying exam
Comprehensive exam
Dissertation and Defense

This joint Ph.D. program is offered through the collaboration of the departments of Applied Mathematics (AM) and Mathematics and Science Education (MSED). The objective of the program is to provide advanced education in the teaching and learning of collegiate mathematics through coursework and original research. These advanced studies will enable graduates to teach a wide range of college level mathematics courses, conduct theoretical and practical research on collegiate mathematics teaching and learning, or develop and evaluate college mathematics curriculum.

AM Core Requirements (21 credit hours):

MATH 500	Applied Analysis I
MATH 553	Discrete Applied Mathematics I
MATH 577	Computational Mathematics I
MATH 515	Ordinary Differential Equations and Dynamical Systems
MATH 532	Linear Algebra
MATH 540	Probability
MATH 476	Statistics

MSED Core Requirements (18 credit hours):

MSED 598	Methods of College Teaching in Mathematics and Science
MSED 599	College Teaching Practicum in Mathematics and Science
MSED 601	Critical Analysis in Quantitative Research
MSED 602	Quantitative Research Design and Practicum
MSED 603	Critical Analysis in Qualitative Research
MSED 604	Qualitative Research Design and Practicum

AM Elective Requirements (minimum of 12 credits):

MATH 401	Analysis II
MATH 402	Complex Analysis
MATH 420	Geometry
MATH 5XY	(any 500-level AM courses)

MSED Elective Requirements (minimum of 9 credits):

MSED 503	Advanced Strategies: Mathematics
MSED 521	History/Philosophy of Mathematics
MSED 550	Clinical Supervision in Science/Mathematics
MSED 552	Assessment and Evaluation
MSED 555	Mathematics Curriculum
MSED 571	Problem Solving and Nature of Mathematics

The qualifying exam is fulfilled by achieving better than a 3.5/4.0 G on the AM core courses and a 3.5/4.0 GPA on the MSED core courses and passing an oral examination within the first five semesters of Ph.D. study (within the first two years for students entering with a Master's degree in Mathematics). The oral exam consists of two parts: the first part covers the AM core courses, and the second part covers the MSED core courses. The MSED oral exam is composed of seven position statements (ranked by the faculty). Position Statement 1: Written defense to support position with empirical research. Position Statements 2, 3, 4: Oral defense.

The comprehensive exam consists of an oral examination based on the student's research proposal. The exam aims to ensure that the student has the background to carry out successful research in his/her chosen area and the proposed research has sufficient scholarly merit.

The minimum of 25 hours should be devoted to thesis research (C 691). The dissertation (thesis) is expected to contain a distinct and substantial, original and publishable contribution to the field of stuc An oral examination in defense of the thesis constitutes completion of the degree.

(*) 32 credits maximum transfer from master's coursework; 42 maximum transfer of graduate coursework credits; the number of subjects allowed for transfer credit depends on what subject have been recently taken or decided on a case-by-case basis

Admission Criteria:

Admission to the joint Ph.D. program in collegiate mathematics education requires:

- Master's or Bachelor's Degree in mathematics or applied mathematics. Candidates whose degree is in another related field (for example, computer science, physics, or engineering) and whose background in mathematics is strong are also eligible for admission and are encouraged to apply.
- Quantitative and Verbal score: 1100
Analytical score: 3.0
- TOEFL (minimum score of 600) if from non-English speaking country
- A minimum GPA of 3.0/4.0 is required
- Professional statement of goals/objectives (2 pages)
- Vita
- Three letters of recommendation
- An interview may be required

ECONOMIC ANALYSIS

No initial expenses or investments (including new faculty hires, course development, advertising, staff and office costs) are necessary in order to start and develop the proposed joint Ph.D. program. At the beginning, the program can be implemented exclusively through the existing AM and MSED departmental resources.

Based on a conservative estimate, about 6 new full-time Ph.D. students will join the program each year totaling up to 15-20 students within the first three years which will bring an extra income to the IIT. If the number of students in the new program becomes large enough and provided that the program proves its success, then an additional faculty position would be needed for the AM and MSED departments.

Proposal prepared by:

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