

Rutgers University Ph.D. in Education

Concentration in Mathematics Education

Program Description

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A. Background

The Ph.D. concentration in mathematics education is one of four concentrations leading to the Ph.D. in Education offered by the Graduate School-New Brunswick of Rutgers University. The other three areas of concentration are educational psychology, educational policy, and literacy education. These four concentrations were approved when the Ph.D. in Education was established by the Graduate School in 2000, and the first students were admitted shortly afterwards.

The Graduate School of Education offers a variety of programs leading to the Ed.D., which is a professional degree, including an Ed.D. program in mathematics education.

Potential applicants to the Ph.D. program in Education are encouraged to consider carefully which path best meets their academic and professional needs. Note that the Graduate School-New Brunswick and the Graduate School of Education are two separate units in Rutgers University, though a substantial number of faculty members of the Graduate School of Education belong also to the Graduate Faculty for the Ph.D. in Education.

A list of faculty members of the concentration in Mathematics Education is provided in Appendix 1.

The following text appears on the website of the Graduate School of Education (www.gse.rutgers.edu):

“The mathematics education concentration prepares students to conduct basic research on the learning and teaching of mathematics – how people at all ages learn mathematics and how teachers can facilitate that learning. Among the research topics of faculty and doctoral students are problem solving, mathematical representations, instructional strategies, and affect and attitudes of learners.

The mathematics education concentration also prepares students to articulate between mathematicians and mathematics educators by providing them a strong background in both mathematics and mathematics education. A strong background in mathematics, statistics, or computer science is required for admission; applicants are required to take the Math GRE.

The mathematics education concentration is designed for students who intend to follow an academic career and/or pursue leadership positions in education.

Faculty associated with this concentration are drawn from the Graduate School of Education, the Mathematics, Statistics, Computer Science, and Psychology Departments at Rutgers-New Brunswick, and the Urban Education Department at Rutgers-Newark.

Doctoral students can become involved in the work of the Robert B. Davis Institute for Learning (www.gse.rutgers.edu/rbdil) and the MetroMath Center (www.metromath.org). The Davis Institute, named after the late mathematician, educator, and cognitive scientist Robert B. Davis, combines research and scholarship about learning and teaching with educational practice. MetroMath, the Center for Mathematics in America’s Cities, is a partnership of Rutgers, the University of Pennsylvania, and the City University of New York Graduate Center, and the school districts of New York City, Philadelphia, Newark, and Plainfield. Its two major focuses are multi-disciplinary research focused on improving mathematics education in urban communities, and development of future leaders – both scholars and practitioners – in urban mathematics education.”

B. Education Requirements

Appendix 2, “Program Plan for Ph.D. in Mathematics Education” includes a list of all required courses and provides students with a chart on which they can plan their programs and gain approval for their plans.

All candidates of the Ph.D. in education must complete 72 credits. These are divided into six categories as follows:

1. Proseminar (6 credits). All candidates in all four areas of concentration are required to take this two semester sequence of courses – Proseminar in Educational Theories and Practice (16:300:501) and Proseminar in Educational Research (16:300:503). These two courses are intended to provide a broad general background in education regardless of area of concentration and to permit cross-discipline connections with other students in the Ph.D. program.
2. Methodology (12 credits). All candidates are required to take courses in both qualitative research methods and quantitative research methods, three in one category and one in the other.

Those who wish to focus on qualitative research methods should take the following three qualitative research courses: Qualitative Research Methods in Education I (16:300:509), Qualitative Research Methods in Education II (16:300:513), and Ethnographic Video Analysis (16:300:563 – previously called “Research into the Development of Mathematical Ideas”). They should also take Basic Statistics for Research (01:960:401) or Basic Applied Statistics (01:960:484) in the statistics department or Mathematical Theory of Statistics (01:640:481) in the mathematics department to meet the quantitative research methods requirement. Note: Students who have had courses in statistics are required to take a course that goes beyond other courses they have already taken; course selection should be done in consultation with an advisor.

Those who wish to focus on quantitative research methods should take Qualitative Research Methods in Education I (16:600:509) and three courses in the mathematics or statistics department, typically one introductory course – Basic Statistics for Research (01:960:401) or Basic Applied Statistics (01:960:484) or Mathematical Theory of Statistics (01:640:481) or Theory of Statistics (01:960:595) – and two more advanced courses, typically either Introduction to Experimental Design (01:960:490) or Design of Experiments (16:960:590) and either Regression Methods (01:960:463) or Regression Theory (16:960:663). Note: Students who have had courses in statistics prior to enrolling in the Ph.D. program are required to take courses that go beyond other courses already taken; courses should be selected in consultation with an advisor.

3. Pre-Thesis Research (6 credits). All candidates are required to enroll in two Pre-Thesis Research courses – 16:300:600 and 16:300:601. These are research projects that are supervised by various faculty members and that involve participation in research practicum experiences linked to current faculty research projects. The initial project will be a preparation for the second which is expected to be closely related to (or a pilot for) the dissertation study and to lead to published articles and presentations at conferences. Students must obtain prior approval of the faculty member with whom they want to conduct a research project.
4. Concentration (18 credits). Six courses in mathematics education are required, including Introduction to Mathematics Education (15:254:540), Seminar in Mathematics Education (16:300:661), and Research Practicum (15:254:644). Students with strong backgrounds in mathematics education may be allowed to substitute courses in mathematics for courses in mathematics education.

5. Cognate Courses (6 credits). These are typically courses in mathematics.
6. Research (24 credits). These are the dissertation credits (thesis research). Students may register for dissertation credits after they have completed the Qualifying Examination and are admitted to candidacy for the degree of Doctor of Philosophy.

Although the total number of credits required is 72, some students may need to take additional courses in mathematics in order to meet the requirements in Section C below; their programs will typically involve more than 72 credits.

Students who have already taken courses that are comparable to the required courses are expected to take courses that advance their knowledge beyond where it is. Decisions about such courses are to be reached in collaboration with their advisors and with approval of the program coordinator.

Students need to be aware of whether or not individual courses they take are in the Graduate School since no more than 24 credits (including transfer credits) can be from outside the Graduate School. Since two of the required “concentration” courses (total of 6 credits) are in the Graduate School of Education, only 18 of the students’ remaining credits may be taken outside of the Graduate School. (Courses whose prefix is 16 are in the Graduate School, whereas courses whose prefix is 15 are in the Graduate School of Education.)

C. Mathematics Requirements

Each student in the Ph.D. program in mathematics education will be expected to have an undergraduate major in mathematics (or a closely related field) and complete a sequence of mathematics courses that, taken together with his or her previous preparation, is roughly equivalent in volume and rigor, if not necessarily in level, to the courses required for a master’s degree in mathematics from Rutgers University - New Brunswick.

That is, students will be expected to complete 30 credits (10 courses) of course work in mathematics (including prior post-baccalaureate course work) including:

- At least four graduate courses, including analysis (Math 501) and algebra (Math 551);
- Five graduate or undergraduate courses in addition to Math 501 and Math 551, including at least one from each of the following areas (some courses may fit more than one area):
 - Discrete mathematics (e.g., combinatorics, graph theory)
 - Analysis (e.g., complex analysis, functional analysis)
 - Geometry and topology
 - Algebra, logic, and number theory
 - Applied mathematics (321 (Intro to Applied Math), 336 (Differential Equations in Biology), 338 (Discrete Models in Biology), 339 (Math Models in Social Sciences), 348 (Cryptography), 354 (Linear Optimization), 355 (Game Theory), 357 (Topics in Applied Algebra), or any 01:642:5xx course.
- One course on K-12 mathematics from the perspective of advanced mathematics;
- A concentration including at least three courses in one coherent area, one of which may be an independent study course that culminates in a substantial paper.

Courses used to satisfy the mathematics requirement may also be used to satisfy the cognate requirement in mathematics education and, under circumstances noted previously, part of the concentration requirement in mathematics education. Courses in the mathematical theory of statistics may be used to substitute for one or two of the courses in mathematics.

Entering students will need to determine with an advisor an appropriate set of courses that will, together with courses taken previously, satisfy the above requirements. These courses should be described in the Mathematics Requirement Plan (see Appendix 3).

- Some students who enter the Ph.D. program will already have completed part or all of the requisite courses.
- Some entering students will be required to take a placement test before registering for courses in their first semester at Rutgers (depending on their GRE scores and mathematical backgrounds), and may be required to take additional courses prior to those that will fulfill the above requirements.
- Some students may need to take ten or more courses in mathematics to complete these requirements. If they take six graduate courses in mathematics, they may be eligible to earn a master's degree in mathematics in addition to the Ph.D. in mathematics education; students in this position should consult with the Graduate Director of the Department of Mathematics.

D. Preliminary Examination

The preliminary examination in mathematics will be a take-home examination of which one-third will address each of the following areas:

- Calculus, linear algebra, and differential equations;
- The two required graduate courses (in algebra and analysis);
- Three courses selected by the student (with agreement of the advisor) from the courses that address three of the six areas listed in the second category under "mathematics requirements" above.

Questions will address both concepts and skills, including techniques of problem-solving and proofs. Students are encouraged to take the preliminary examination soon after completing the courses on which they are being examined. Students will have ten days to complete the exam; the passing score is 75%. Under normal circumstances, students will be permitted no more than two opportunities to take the preliminary examination. Students may obtain a copy of the previous preliminary examination from the program coordinator.

E. Qualifying Examination

Prior Qualification

The qualifying examination will be given subsequent to the student's having substantially completed the required course sequence, passed the preliminary examination addressing knowledge in the field of mathematics, and worked on the development, analysis, preliminary investigation, and application of research methodology to a question in his or her area of interest. Normally this includes a research presentation at Rutgers satisfactory to the examining committee, or alternatively the presentation of a research report at a national or international conference.

Written and Oral Examinations

Each part of the qualifying examination (Part I and Part II) consists of a written examination and an oral examination. Thus we have Part I (written), Part I (oral), Part II (written), and Part II (oral).

Each written examination is prepared by the student over a fixed period (normally one to three months), in response to specific instructions from the examining committee. Each oral examination (normally 2 hours) will be scheduled by the examining committee after the student has successfully completed each written examination.

Each part of the examination is prepared and evaluated separately, with satisfactory performance required prior to the next part.

Under normal circumstances, students will be permitted no more than one opportunity to retake each part of the Qualifying Examination.

The written examinations address the following content:

Part I written examination. The student will write a paper that provides both a

(1) coherent description, development, and discussion of a selected mathematical topic or topics extending from the elementary school level through the college undergraduate level [for example, the topics of linear, polynomial, exponential, and logarithmic growth, from both the continuous and discrete perspectives (up to and including differential equations and difference equations)]; and

(2) discussion of the applications of the mathematics to appropriate related domains [for example, in the case of growth models, science and economics].

Part II written examination. The student will write a paper that includes:

(3) critical discussion and comparison of where and how the mathematical topic(s) are introduced at various school levels in standard and in innovative mathematics curricula;

(4) discussion of existing research literature that explicitly addresses the learning and teaching of the designated mathematical topic(s), and/or addresses learning and instruction in other areas of mathematics that might have implications for the designated topic(s);

(5) discussion and analysis of whether and how one or two themes or theoretical approaches in the mathematics education literature can be applied to instruction in the designated mathematical topic(s) [for example, cognitive analysis and schema theory, information processing models, constructivist theory, symbol-systems and systems of representation, theories of problem solving]; and

(6) identification of significant research questions that need to be addressed regarding what, how, and when students should learn about various aspects of the designated mathematical topic(s).

The oral examinations may refer to but are not limited to material in the written examinations. They will also address the following areas: exposition and understanding of mathematical content; curriculum structure and the sequencing of mathematical ideas; theories of learning and mathematical development; growth of mathematical understanding through context-based individual or group experiences; psychology of mathematical problem solving; the design of qualitative or quantitative research studies appropriate to a mathematical domain.

The student is expected to be familiar with published research studies or analyses in these areas, and to be able to substantiate his or her statements with references to the literature.

F. Advising

Advisor: When accepted into the Ph.D. program, the student is assigned as temporary advisor the coordinator of the mathematics education concentration. Soon after arrival at Rutgers, the student should consult with faculty members in the Ph.D. program and, by the middle of his or her first semester, should select one of them (with his or her consent) as advisor to guide the student through the initial years of the Ph.D. program.

This program advisor will not necessarily be the student's thesis advisor subsequently. Indeed, students should get to know the various faculty members of the program so that they can eventually select a thesis advisor who most closely matches their interests and temperaments.

Whenever the student changes advisors, a "Change of Advisor Form" should be completed; see Appendix 4 for a copy of this form.

Advice on courses: Prior to the beginning of his or her first semester in the Ph.D. program, each student will have a “mathematics interview” with a committee of faculty members, the purposes of which are to assess the student’s mathematics background and to provide the student with good advice about the courses he or she should take. As an outcome of this interview and subsequent meetings with the advisor, the student should, in consultation with the advisor, create a preliminary Program Plan for the Ph.D. in Mathematics Education (see Appendix 2). The plan should be signed by the student, the advisor, the coordinator (currently Joseph Rosenstein) and the Director of the Ph.D. Program (currently Clark Chinn). The student should also, in consultation with his or her advisor, determine which courses he or she needs to take in order to fulfill the mathematics requirements of the program described in section C and should complete a preliminary Mathematics Requirements Plan (see Appendix 3). The plan should be signed by the student, the advisor, and the coordinator.

This process should be repeated prior to the beginning of each subsequent semester, including modifications and course grades, until all courses have been completed.

Preliminary examination: One semester prior to the completion of the mathematics requirements, the student should notify the coordinator when he or she anticipates taking the preliminary examination and on which courses he or she elects to be examined. The student will typically take the preliminary examination soon after completing the mathematics requirements. In consultation with the student’s advisor, and with the assistance of the program faculty, the coordinator will make arrangements for the preliminary examination.

Qualifying examination: Students may begin work on the qualifying examination directly after completing the preliminary examination. During the prior semester, the student should consult with faculty members on a suitable topic for the qualifying examination and should select an advisor with whom he or she will be working.

Since it is quite possible that the student’s thesis will be based to some extent on work done in preparation for the qualifying examination, the student may want to select an advisor at this time who will ultimately also serve as his or her thesis advisor, although the student may also delay selecting a thesis advisor until after completing the qualifying examination.

The advisor, in consultation with the student, should recruit two or three additional members for the examining committee; committee members should be considered as potential members of the thesis committee. The advisor, in consultation with the student, should also develop a (tentative) timetable for the four parts of the qualifying examination. The advisor should at that time provide the coordinator and the Director of the Ph.D. Program with a report that provides the members of the committee, the timetable, and the focus of the qualifying examination and that is signed by the student and members of the examining committee. The members of the examining committee and the coordinator should be notified at least two weeks in advance of the date of each oral examination.

Thesis advisor = dissertation supervisor: After completing the qualifying examination, if not sooner, the student should select a thesis advisor (with his or her consent).

G. Dissertation

Dissertation Committee: The thesis advisor = dissertation supervisor shall select a dissertation committee, in consultation with the student and in accordance with the regulations of the Graduate School. The committee shall be chaired by the thesis advisor, and shall include two additional faculty members and an “outside” member, who is appointed by the Program Director in consultation with the student’s advisor. The thesis advisor shall provide the program coordinator and the Director of the Ph.D. Program a report indicating that a committee has been

appointed, and shall keep them apprised of any meetings of the committee and, subsequently, of their results.

Dissertation Proposal and Proposal Defense: The candidate shall develop a proposal for the thesis with the advice of the dissertation supervisor, who, at an appropriate time, shall arrange a meeting of the dissertation committee at which the student will defend his or her dissertation proposal. At least two weeks prior to the thesis proposal defense, and with the approval of the dissertation supervisor, the candidate shall provide the Program Director with an announcement for distribution to the faculty and students of the Ph.D. program in mathematics education that provides an abstract of the dissertation proposal and an invitation to attend the thesis proposal defense. At the close of the session, the dissertation committee will, if it deems it appropriate, formally approve the thesis proposal.

Role and Responsibility of Dissertation Committee: The dissertation committee must be kept informed of the student's progress and must agree to follow the candidate's work and assist in its development. The committee shall also agree to give ample and early warning of any reservations concerning the student's progress and must specify in writing the changes required for acceptance of the dissertation.

Final Examination: A final public examination ("thesis defense") is held under the auspices of the dissertation committee. At least two weeks prior to this event, and with the approval of the dissertation supervisor, the candidate shall provide the Program Director with an announcement for distribution to the faculty and students of the Ph.D. program in mathematics education that provides an abstract of the dissertation and an invitation to attend the thesis defense. The candidate must defend the dissertation and otherwise satisfy the committee and other faculty members in attendance that he or she is qualified to receive the degree of doctor of philosophy. The dissertation must be approved by a minimum of three members of the Dissertation Committee.

Appendix 1: Faculty of the Ph.D. Program in Mathematics Education

Amy Cohen-Corwin, Professor of Mathematics

Eugenia Etkina, Associate Professor of Science Education (Physics)

Richard Falk, Professor of Mathematics

William Firestone, Professor of Educational Policy

Rochel Gelman, Professor of Psychology; Co-Director, Rutgers University Center of Cognitive Science

Gerald Goldin, Professor of Mathematics, Physics, and Education; Director, MetroMath Center; University Director, Science & Math Partnerships

Carolyn Maher, Professor of Mathematics Education; Director, Robert B. Davis Institute for Learning

Naftaly Minsky, Professor of Computer Science

Joseph Naus, Professor of Statistics

Arthur B. Powell, Associate Professor of Mathematics Education, Rutgers-Newark; Associate Director, Robert B. Davis Institute for Learning

Manya Raman, Assistant Professor of Mathematics and Mathematics Education

Fred Roberts, Professor of Mathematics; Director, Center for Discrete Mathematics and Theoretical Computer Science (DIMACS)

Joseph G. Rosenstein, Professor of Mathematics

Michael Saks, Professor of Mathematics

Roberta Schorr, Associate Professor of Mathematics Education, Rutgers-Newark

Keith Weber, Assistant Professor of Mathematics Education

Robert Wilson, Professor of Mathematics

Program Coordinator: Joseph G. Rosenstein

Program Plan for Ph.D. in Mathematics Education

Course #	Course Title	Cred.	Semester	Grade
1. Proseminars				
16:300:501	Proseminar in Educational Theories and Practice	3		
16:300:503	Proseminar in Educational Research	3		
2. Methodology				
16:300:509	Qualitative Research Methods in Education I	3		
01:960:401, 484, or 595 or 01:640:481	*Basic Statistics for Research or *Basic Applied Statistics or *Theory of Statistics or *Mathematical Theory of Statistics	3		
EITHER				
16:300:513 and	Qualitative Research Methods in Education II	3		
16:300:563	Ethnographic Video Analysis	3		
OR				
16:960:490 or 590	*Introduction to Experimental Design (490)	3		
16:960:463 or 663	*Regression Methods or *Regression Theory (prerequisite: 595)	3		
3. PreThesis Research				
16:300:600	Prethesis Research	3		
16:300:601	Prethesis Research	3		
4. Concentration				
1. 15:254:540	Introduction to Mathematics Education	3		
2. 16:300:661	Seminar in Mathematics Education	3		
3. 15:254:644	Research Practicum	3		
4.		3		
5.		3		
6.		3		
5. Cognate courses				
1. 01:640:xxx		3		
2. 01:640:xxx		3		
6. Thesis Research				
16:300:701/2	Research in Education	24		

Student's Name (Print)

Student's Signature

Date

Advisor's Signature

Date

Coordinator's Signature

Date

**Director's Signature

Date

* Although the quantitative methods courses required by the Ph.D. program may be appropriate for students in other Concentrations, those specializing in mathematics education are advised to take more advanced statistical methods courses given by the mathematics or statistics department. Students who have had statistics courses are required to take courses beyond those already taken.

** The signature of the program director here represents that s/he has verified that the Program Plan meets the regulations of the Graduate School and the requirements of the Ph.D. in Education program.

Mathematics Requirements Plan for Ph.D. in Mathematics Education

Post-baccalaureate courses taken at other institutions

Student's Name: _____

Course Title / Where taken	Equivalent Rutgers Course Number and Title	Cred.	Semester	Grade
		3		
		3		
		3		
		3		
		3		
		3		
		3		
Total Credits				

 Advisor Approval Date Coordinator Approval Date

Courses taken or planned at Rutgers

Course #	Course Title	Cred.	Semester	Grade
		3		
		3		
		3		
		3		
		3		
		3		
		3		
		3		
		3		
		3		
		3		
Total Credits				

Checklist of completed courses:

_____ ten courses _____ four graduate courses _____ three-course concentration
 _____ Math 501 _____ Math 551 _____ K-12 math from advanced perspective

Additional courses in each of the five following areas:

_____ Applied Math _____ Discrete Math _____ Analysis
 _____ Geometry and Topology _____ Algebra, Logic, and Number Theory

 Student's signature Date Advisor's signature Date

 Coordinator's signature Date Director's signature Date

Ph.D. in Education – Mathematics Concentration

Change of Advisor Form

Student Name _____

Original Advisor Name _____

Original Advisor Signature _____ Date _____

New Advisor Name _____

New Advisor Signature _____ Date _____

Student Signature: _____ Date _____

Mathematics Education Coordinator Signature:

_____ Date _____

PhD Director Signature:

_____ Date _____