S.88-86

SIMON FRASER UNIVERSITY

MEMORANDUM

TO: Senate

FROM: J.W.G. Ivany
Chair, SCAP

SUBJECT: Graduate Curriculum Revision - Dept. of Math & Statistics

DATE: Nov. 17, 1988

Action undertaken by the Senate Committee on Academic Planning/Senate Graduate Studies Committee gives rise to the following motion:

Motion: that Senate approve and recommend approval to the Board of Governors as set forth in S.88-86 the following curriculum revisions:

New courses:	MATH 603-4	Foundations of Mathematics
	MATH 604-4	Geometry
	MATH 605-4	Mathematical Modeling
Deletion of:	MATH 601-5	Trends and Developments in Mathematics I
	MATH 602-5	Trends and Developments in Mathematics II

Faculty of Education

PROPOSAL

M. Sc. in Secondary School Mathematics Education

This is a proposal for introducing an M. Sc. degree in Mathematics Education into the Faculty of Education. Discussions have taken place with Harvey Gerber of the Mathematics Department and Bernice Kastner of the Faculty of Education. Sandy Dawson has also commented on the structure and content of the program. The Chair of the Mathematics and Statistics department is very supportive.

Rationale

In 1975, the SFU Faculty of Education offered a graduate program in education with "emphasis on secondary school mathematics." It was intended to be an on-campus program with students meeting twice a week for 5 hours a night. Students would take two courses per semester for a total of 7 courses, and would also undertake a special project. The details are attached as Appendix A. A number of candidates applied, but there were too few qualified applicants, and the program was not initiated.

As part of the 1975 program, the Mathematics department created two special courses, Mathematics 601 and Mathematics 602. Each was to deal with recent developments in mathematics. They are still listed in the Calendar under Mathematics Graduate courses, although all references to the Mathematics graduate program have been deleted from the Faculty of Education section of the Calendar.

At the present time, there appears to be renewed interest among secondary mathematics teachers in such a program. Secondary mathematics teachers are facing a revised curriculum that will be fully in place in 1990. This curriculum will contain a renewed emphasis on geometry, a new strand on probability and statistics, and a new unit on calculus. The graduate program will be designed to help teachers develop insights into the nature of mathematics, its place in the school curriculum, research on how secondary students learn mathematics, and current ideas on how best to teach the subject. This is an opportune time for teachers to examine curriculum changes and upgrade their qualifications.

The theme of the graduate program stresses "the human aspects of mathematics." Emphasis will be placed on the role of mathematics in society and the natural development of mathematics as a growing, changing, entity. Developments in the school mathematics curriculum, and in pedagogy, will be related to historical, cultural, and psychological forces operating within society. The goal is to produce teachers who have a broad understanding of mathematics and mathematics education, and who will be qualified to deal with rapid curriculum change in the next several decades. This is different from a traditional program in which teachers progress through a intensive, but narrow, specialization in mathematical topics, followed by a brief exposure to a collection of recommended teaching procedures.

Course Structure of the program

Students will require at least 23 credits and a thesis for a M. Sc. (Education). Equal credits will be taken in the mathematics department and in the faculty of education. Three new courses will be developed by the mathematics department, and two new courses will be developed in the faculty of education. All courses are four credits. Outlines for the five courses are contained in Appendix B.

Mathematics Department

1. Foundations of Mathematics (new course)

"Crises in mathematics, their historical and philosophical background and their resolution." This is a non-technical course in which all necessary mathematics would be taught as part of the course. The intent is to show mathematics in the making rather than as a finished product.

2. Geometry (new course)

"Euclidean and non-Euclidean geometries. Klein's Erlanger programme." A look at the development of geometry to the present time. Emphasis on how geometry was interpreted at various times in history, including the influence of Euclidean geometry on philosophy, and the crisis precipitated by the discovery of non-Euclidean geometry. Modern geometrical treatment including transformations of the plane.

3. Mathematical Modeling (new course)

"Introduction to mathematical modeling using algebraic and geometric techniques, along with techniques using calculus." Designed to give students experience in creating and fitting mathematical models to real

world problems. Based on recommendations of the MAA's committee on the Undergraduate Program in Mathematics. Includes modeling using the computer program Minitab.

All three mathematics courses should have appeal to other students in the Mathematics department, hence the offerings would not be entirely dependent on enrolment in the proposed graduate program.

Education

1. Foundations of Mathematics Education (new course)
"An examination of historical, cultural, and psychological forces shaping the secondary school mathematics curriculum. Current developments in mathematics curriculum and in mathematics education research." The emphasis will be on the historical underpinning of the curriculum and the cyclical nature of reform in mathematics education. The course will have a structure similar to the one on the foundations of mathematics and will focus on critical periods in the development of the school mathematics curriculum.

2. Teaching and Learning Mathematics (new course)
"The theory and practice of mathematics teaching at the secondary level. Emphasis on the nature of the learner and the function of the teacher." Implications for instruction of the ideas of various mathematics educators and schools of thought, for example, Dienes, Gattegno, Skemp, and the constructivist school. Emphasis on teaching geometry reflecting the content of the Geometry course in mathematics. Emphasis on applications and problem solving reflecting the content of the Mathematical Modeling course.

3. One elective
- possibly Education 864-3: Research Methods in Education
Education 816-5: Developing Educational Programs
Education 823-5: C&I in an Individual Teaching Specialty
Education 851-5: Computer-Based Learning

Timetable for Implementation

The program is designed for the students as a cohort. The entire program is a cooperative venture between Mathematics and Education, and each course is designed to complement the other courses. The initial intake will be in the Fall of 1989, with a second intake planned for two years after that time. This schedule may change, subject to demand.

Fall/89 - Mathematics: Foundations of Mathematics
Spring/90 - Education: Foundations of Mathematics Education
Summer/90 - Mathematics: Geometry

Fall/90 - Education: Teaching and Learning Mathematics
Spring/91 - Mathematics: Mathematical Modeling
Summer/91 - Education: Elective

One year to complete a thesis. Members of the Faculty of Education and the Mathematics Department will share responsibility for supervision of students' theses. Students will be encouraged to undertake work in which they can apply the ideas from the courses to curriculum development.

FTE and other implications

Two new courses for Education.

One FTE per year (O'Shea or Dawson)

No additional Library books or resources will be required for the Mathematics courses, as each will have its own textbook. All references listed for the Mathmatics Education courses are available through Faculty members.

Conclusion

The program outlined would be unique in Canada, if not in North America. Most graduate programs in Mathematics Education are housed solely in the Faculty of Education where the emphasis is on pedagogical problems in teaching mathematics. The proposed program is designed to expand the teacher's mathematical knowledge, to encourage teachers to look at historical and philosophical influences on the school mathematics curriculum, and to provide alternative, research-based approaches to teaching. This program follows SFU's tradition of innovation and creativity.

SIMON FRASER UNIVERSITY

New Graduate Course Proposal Form

CALENDAR INFORMATION:

Department: Mathematics and Statistics Course Number: Math 603-4

Title: Foundations of Mathematics

Description: Crises in mathematics, their historical and philosophical background and their resolution.

Credit Hours: 4 Vector: 4-0-0 Prerequisite(s) if any: Acceptance into the Masters Programme in Mathematics Education or permission of the department.**

ENROLLMENT AND SCHEDULING:

Estimated Enrollment: 10 When will the course first be offered: Fall 1989

How often will the course be offered: Every other year

JUSTIFICATION:

This course will be one of three mathematics courses that will comprise the mathematical content of the Masters Degree in Mathematics Education. Note Math 601 will be dropped.

RESOURCES:

Which Faculty member will normally teach the course: Gerber, Berggren

What are the budgetary implications of mounting the course: At least a 4 credit sessional stipend to cover the teaching.

Are there sufficient Library resources (append details): Yes

Appended: a) Outline of the Course
b) An indication of the competence of the Faculty member to give the course.
c) Library resources

Approved: Departmental Graduate Studies Committee: G. Bojadziev Date: 23 Feb. 88

Faculty Graduate Studies Committee: G. Bojadziev Date: 30 March 88

Faculty: CH W J Jones Date: 20 April 88

Senate Graduate Studies Committee: B.R. Clay Date: 1 Sept/88

Senate: Date:

** Graduate students in the Department of Mathematics and Statistics cannot take this course to satisfy their degree requirements.

Math 603-4
Foundations of Mathematics

Proposed text: *TO BE DETERMINED*

Topics

1. **Incommensurability and Eudoxus**
The Greek theory of proportions, Pythagoreans, incommensurability, Eudoxus.

2. **Zeno's Paradoxes and the Calculus**
The beginnings of Greek speculation on infinitesimals, Zeno's paradoxes, the exhaustion method of the Greeks, Newton's infinitesimals, the arithmetization of analysis.

3. **Naive and Formal Set Theory**
Naive set theory, the Russell contradiction, basic relations and operations, finite and infinite sets, the Choice axiom.

4. **Intuitionism vs. Formalism**
Basic philosophy of intuitionism, spreads, species, intuitionistic logic. Hilbert's proof theory, Godel's incompleteness theorem, consistency, formal systems.

5. **Transfinite Arithmetic**
Countable sets, uncountable sets, diagonal procedures and their applications, cardinal numbers and their ordering, the continuum hypothesis, order types, well-ordered sets, ordinals.

Note: The instructor may have to develop notes for this course.

SIMON FRASER UNIVERSITY

New Graduate Course Proposal Form

CALENDAR INFORMATION:

Department: Mathematics and Statistics Course Number: 604-4

Title: Geometry

Description: Euclidean and non-Euclidean Geometries. Klein's Erlangen Programme

Credit Hours: 4 Vector: 4-0-0 Prerequisite(s) if any:

Entrance into the Masters in Math. Education Programme or permission. **

ENROLLMENT AND SCHEDULING:

Estimated Enrollment: 10 When will the course first be offered: Summer 1990

How often will the course be offered: Every other year.

JUSTIFICATION:

This course will be one of three mathematics courses that will comprise the mathematical content of the Masters degree in Mathematics Education.

Note: Math 602 will be dropped.

RESOURCES:

Which Faculty member will normally teach the course: Gerber, Berggren

What are the budgetary implications of mounting the course:

At least a 4 credit sessional stipend to cover the teaching.

Are there sufficient Library resources (append details): yes

Appended: a) Outline of the Course
b) An indication of the competence of the Faculty member to give the course.
c) Library resources

Approved: Departmental Graduate Studies Committee: G Bojadziev Date: 23 Feb 88

Faculty Graduate Studies Committee: G Bojadziev Date: 30 March 88

Faculty: [signature] Date: 20 April 88

Senate Graduate Studies Committee: [signature] Date: 1 Sept/88

Senate: Date:

** Graduate students in the Department of Mathematics and Statistics cannot take this course to satisfy their degree requirements.

Math 604-4
Geometry

Proposed text: *Euclidean and Non-Euclidean Geometries - Development and History* by Marvin Jay Greenberg, W. H. Freeman and Company, Second Edition, 1974

Topics

1. **Euclid's Geometry**
The origins of geometry, the axiomatic method, Euclid's five postulates, attempts to prove the parallel postulate.

2. **Logic**
Theorems and proofs, techniques of proof, incidence geometry, models, isomorphisms of models.

3. **Hilbert's axioms**
Flaws in Euclid, axioms of betweenness, congruence, continuity, and parallelism.

4. **Neutral Geometry**
Geometry without the parallel axiom, alternate interior angle theorem, exterior angle theorem, measure of angles and segments, Saccheri-Legendre theorem, equivalence of parallel postulates, angle sum of a triangle.

5. **History of the Parallel Postulate**

6. **Non-Euclidean Geometry**
Hyperbolic geometry, angle sums, similar triangles, parallels that admit a common perpendicular, limiting parallel rays, classification of parallels.

7. **Independence of the Parallel Postulate**
Consistency of hyperbolic geometry, the Beltrami-Klein model, the Poincare models, perpendicularity in the Beltrami-Klein model, inversion in circles, the projective nature of the Beltrami-Klein model.

8. **Philosophical Implications**

9. Geometric Transformations

Klein's Erlanger Programme, groups, applications to geometric problems, motions and similarity, reflections, rotations, translations, half-turns.

SIMON FRASER UNIVERSITY

New Graduate Course Proposal Form

CALENDAR INFORMATION:

Department: Mathematics and Statistics Course Number: 605-4

Title: Mathematical Modeling

Description: Introduction to Mathematical Modeling using algebraic, geometric techniques along with techniques using calculus.

Credit Hours: 4 Vector: 4-0-0 Prerequisite(s) if any:

Acceptance into the Masters Programme in Mathematic Education, one year of Univ. level calculus**

ENROLLMENT AND SCHEDULING:

Estimated Enrollment: 10 When will the course first be offered: Spring 1991

How often will the course be offered: Every other year

JUSTIFICATION:

This course will be one of three mathematics courses that will comprise the mathematical content of the Masters Degree in Mathematics Education.

RESOURCES:

Which Faculty member will normally teach the course: Faculty

What are the budgetary implications of mounting the course:

At least a 4 credit sessional stipend will be required to cover the teaching.

Are there sufficient Library resources (append details): Yes

Appended: a) Outline of the Course
b) An indication of the competence of the Faculty member to give the course.
c) Library resources

Approved: Departmental Graduate Studies Committee: A. Bajadziev Date: 23 Feb 88

Faculty Graduate Studies Committee: A. Bajadziev Date: 30 March 88

Faculty: C. Jones Date: 20 April 88

Senate Graduate Studies Committee: B.R. Clay Date: 1 Sept 88

Senate: Date:

** This course may not be used for the satisfaction of degree requirements in the Department of Mathematics and Statistics.

Math 605-4
Mathematical Modeling

Proposed text — *First Course in Mathematical Modeling* by Frank R. Giordano and Maurice Weir, Brooks Cole Publishing Company, 1985

Topics:

1. **Graphs of Functions as Models**

2. **The Modeling Process**
Mathematical modeling, examples.

3. **Modeling using Proportionality**
Proportionaltiy and geometrc similarity.

4. **Model Fitting**
Fitting models to data graphically, analytic methods of model fitting, applying the least-squares criterion, examples.

5. **Models requiring Optimization**
Classifying optimization problems, formulation of optimization problems, examples.

6. **Experimental Modeling**
One-term models, interpolation using higher-order polynomials, smoothing using polynomials, cubic spline interpolation.

7. **Dimensional Analysis and Similitude'**
Dimension as products, the process of dimensional analysis, examples.

8. **Simulation Modeling**
Modeling deterministic behavior, area under a curve, developing submodels for probabilistic behavior.

9. **Modeling using the Derivative**
Examples using the derivative, numerical approximation methods.