Transition to a four-course curriculum

Mathematics at SUNY Geneseo

Naturally, these notes are purely speculative and would first require extensive discussion and approval within our department. The following is provided for context on the current state of the mathematics department at Geneseo.

I. Background

The Mathematics Department has three primary responsibilities on campus:

1. To the college through the Numeric & Symbolic Reasoning component of the General Education Core (R/ courses)
2. To departments and programs through specific service courses
3. To undergraduate students majoring in Mathematics

Goal: As we transition to a four-course student semester load, we seek to:

1. contribute to the liberal arts general core
2. provide service courses to other departments and programs as needed
3. preserve the strong major in Mathematics provided at SUNY Geneseo

The department has 24 faculty members of whom 15 hold tenure track positions and 9 hold non-tenure (NT) track positions (Adjunct Lecturers, Visiting Lecturers, and Lecturers). We depend on a large number of non-tenure track faculty partially because of recent retirements that have not been replaced due to budgetary restraints, as well as the constant demand of the college and other departments for our courses. To continue our mission in view of prior and anticipated retirements over the next five years, we will need to attract mathematicians in the areas of Statistics and Secondary Education.

A. Numeric & Symbolic Reasoning Requirement (R/ courses)

The Math Department teaches 50% of the R/ courses campus wide (9 of 18 courses) and a far larger percentage of the students each semester. The majority of these courses have been carefully designed in concert with client disciplines to be of maximal impact on students in their majors and not just a Gen-Ed check-off. As the following diagram illustrates, all but one of the offerings (boxed) each semester serve students with the specific content needed by their department.

R/ courses	Fall		Spring	
Even	**160**		**113**	
	141	213	141	213
	221	237	221	237
	242	262	242	262
Odd	**160**		**104**	
	141	213	141	213
	221	237	221	237
	242	262	242	262

Course and department served:

141	Mathematical Concepts for Elementary Education II	School of Education
213	Applied Calculus	School of Business
221	Calculus I	Biology, Physics, etc.
237	Discrete Mathematics	Computer Science
242	Elements of Probability and Statistics	Biology, Comm. Disorders
262	Applied Statistics	Biology

The remaining courses are aimed broadly at the liberal arts student

104	Mathematical Ideas
113	Finite Mathematics for Society
160	Elements of Chance

Based on enrollment figures from Spring 2010:

- we taught 15 sections for the R/ requirement

- 449 of 476 available seats were filled (94%)

- 414 of 416 seats in NT classroom sections were filled (99.5%)

- 86% of R/ students were taught by NT faculty

B. Service to other departments

Each of the (non-boxed) R/ courses in the above table is offered as a service to another program. Based on enrollment figures from Spring 2010:

- we taught 14 sections as R/ service courses

- 425 of 446 available seats were filled (95%)

- 390 of 391 seats in NT classroom sections were filled (99.7%)

- 86% of service students were taught by NT faculty

In addition to these dual-role courses we have the following service obligations:

- The four-course sequence of Calculus I, II, III and Differential Equations is required by the programs in Biophysics, Geology, Geophysics, Chemistry/3-2 Engineering and Physics.
- The courses Math 228 Calculus II for Biologists, Math 340 Modeling Biological Systems, and Math 383 Biomathematics Seminar are offered in conjunction with the Biology Department for the Biomathematics Minor.
- Math 112 Pre-Calculus is offered for students that are not sufficiently prepared for Calculus I or Applied Calculus.
- Math 237 or Math 239 is a related requirement of the Computer Science Department.
- Math 140/141 are required by the Early Childhood and Childhood program.
- The Liberal Arts Concentration in Mathematics (for Early Childhood and Childhood, Childhood, and Childhood with Special Education) requires MATH 140; 141/R; 221/R; 222; 223 or 233; 335; 242/R, 262, or 360; MATH 239.
- The Liberal Arts Concentration in Urban Studies is serviced by Math 242.
- The Liberal Arts Concentration in Computer Science requires Math 221, while Math 222 and Math 237 are recommended.

The Master of Science in Adolescent Mathematics

The Mathematics Department has taught one course for this program each semester and each summer for over 25 years. Currently, the School of Education and the Department of Mathematics are working jointly to replace our program with a new *Master's of Science in Education: Adolescent Mathematics and Special Education*. This program will be open to applicants who have initial certification in mathematics at the adolescent level. It is designed to accommodate both full-time and part-time students pursuing advanced study in the areas of adolescent mathematics education with special education, with an emphasis on understanding and applying research-based practices. We anticipate our one course per semester and summer commitment to remain the same, but with fewer courses whose content is more structured to relate to a subject area central to the secondary school curriculum.

Remarks

Ideally, each course offered by the Department of Mathematics would be taught by a tenure-track faculty member with a terminal degree in Mathematics. In recent years, however, we have had retirements and faculty lines that have remained vacant. Our response has been to hire local talent to address the General Education and Service components of our mission, while maintaining a vigorous mathematics degree taught by tenure-track faculty. We view this as a cost effective remedy to the ongoing fiscal crisis that is the State of New York. The adjuncts are not superfluous personnel, hired for convenience, but are now fundamental to what we are asked to do by the constituents of the college community. As the data from Spring 2010 indicates, they are worked to capacity. Notice that if the R/ requirement were relaxed, we could only eliminate Math 104, 113 and 160, corresponding to one section per semester, since each of the other R/ courses doubles as a service course to another department. Reduction in adjunct instruction needs to go hand in hand with reductions in the demand for our courses from other departments.

C. The Mathematics Major

At the moment, the Mathematics Major requires 40 hours to complete.

	It requires six basic courses:		
	Math 221, 222, 223	Calculus I, II, III	12
	Math 233	Elementary Linear Algebra	3
	Math 239	Introduction to Mathematical Proof	3
	Math 324	Real Analysis	3
and	Math 348	Oral Presentation	1
	Three courses chosen from a list of six for breadth, and		9
	Two additional 300-level Mathematical electives		6
	Related requirement (CSci 119 or 120)		3

For the Mathematics Major, the Mathematics Department offers a total of 25 courses at the 300 level on a rotating basis, targeted to a diversity of interests and career paths. Broadly, these are Academic Mathematics, Applied & Computational Mathematics, Actuarial Science, Bio-Mathematics, and Secondary Education. Two basic courses are offered each semester, ten courses for breadth are offered once each year with the 13 more specialized courses going once every two years.

From the enrollment figures for Spring 2010:
- we taught 21 sections of upper-division courses leading to the degree in Mathematics

- 15% of the sections (Calculus I & II) were taught by NT faculty

- 477 of 595 available seats were filled (80%)

- after the freshman Calculus sequence, Math 221and Math 222, 100% of the mathematics courses were taught by tenure track faculty

II. Modifications and consequences of a four-course system.

A. Modifications to the Mathematics Major

We have developed two alternative models for the transition to a four-course semester load.

Model 1: 11 course major at 44 hours. (34.4% of 128 for graduation)

Premise: Each course offering will be worth four credits. Each student will take four courses each semester leading to 128 credits for graduation from SUNY Geneseo.

This model, predicated on the observation that the Mathematics Major already provides minimal preparation in the modern competitive climate to teach high school, to enter the computational industrial world or to present a competitive application to graduate school, would retain our current curriculum structure and course distribution. After all, we are charged by President Dahl to "prepare Geneseo to meet the continuing budget crisis strategically by *building on our strengths* and finding ways to carry out *our distinctive mission* better and more effectively."

We have rethought two aspects of our program that originated with the SUNY-wide common-core curriculum changes instituted within the last decade:

(a) We currently meet the Technology Mandate by requiring each student in the major to take a course from the Computer Science Department. There might be a benefit to students by tailoring this experience to the particular skill that is most relevant to each area of student interest:

Applied Mathematics	MatLab, Maple
Academic Mathematics	Latex, Equation Editor
Actuarial Science	MiniTab
Secondary Education	Geometer's Sketchpad, TI-Calculators, Excel

Applied courses such as Math 326, 328, 332, 345, 346, wavelets and 372 would require students to take a computer course in MatLab/Maple as a course prerequisite, not a department related requirement. The other listed suggestions are currently introduced within existent coursework. This change could adversely impact the Computer Science Department by potentially requiring fewer sections of Csci 119 and/or Csci 120.

(b) The Oral Presentation Mandate is currently achieved by students taking one of two courses, Intd 302 or Math 348. For students in the Secondary Education track -- about half of our students -- Intd 302 would continue to involve the presentation of lessons in the high school classroom. On the other hand, since Math 348 is only one credit, we do not envision this developing into an expanded four-

credit course. Perhaps this is one core area that could be relaxed and not apply to all majors, or, perhaps, the extra hour gained in courses currently offered for 3 credits could be used for research and presentation, a good outcome. The presentation requirement could then be satisfied in any of the 300-level courses with a relevant oral presentation added. This would be awkward to impose and may involve redundancy of effort (without substantial gain) for secondary students.

Remark: In reviewing the structure of our major into basic, breadth and elective courses, we realized that the list of six for breadth is an artificial construct that fails to guarantee any breadth in mathematical training. We will suggest to the Curriculum Committee that they review this topic this fall.

As the courses evolve from three to four-hours, there are many pedagogical opportunities that become available to enrich each classroom experience. Any combination of the following could be usefully chosen at the discretion of the instructor:

- Incorporate student presentation opportunities in the classroom,

- Increase training in the use of technology,

- Encourage original undergraduate research,

- Require expository papers incorporating a novel approach to an established subject,

- Investigate more applications,

- Expand the basic content covered,

- Elaborate on the interconnectedness and rigor of topics,

- Expand interdisciplinary investigations (biology, economics, physics, geology, etc.),

- Introduce a service learning component, e.g. statistical analysis or mathematical modeling done for either local industry or civic institutions.

Remark: The tenured faculty is committed to maintaining the diversity of our strong major with the current slate of upper division courses. The integrity of the program would be compromised and our effectiveness diminished if we lose any adjunct faculty. We would hope that the loss of adjunct faculty could be linked directly to either the replacement of retired faculty on lines that already exist or lowered expectations from service departments and perhaps the Numeric & Symbolic Reasoning Requirement.

The following page shows a typical syllabus that includes the entire mathematics major, all of current general education core and electives under Model I. This is perhaps overly restrictive since many freshmen come with AP credit and start with Calculus II or III and most students do not need to complete a year of foreign language at Geneseo.

Mathematics Advising Guide

Freshman Fall

R/**Math 221**
Natural Science
Intd 105
Elective

Freshman Spring

Math 222
Social Science
Non-western
Elective

Sophomore Fall

Math 223
Math 233
Humn I
Elective

Sophomore Spring

Math 326
Math 239
Humn II
Elective

Junior Fall

Math 345
Math 333
Foreign Language
Elective

Junior Spring

Math 324
Foreign Language
Natural Science
Elective

Senior Fall

Math 328
US History
Fine Arts
Elective

Senior Spring

Math 372
Fine Arts
Social Science
Elective

Model 2: The 10 course model, 40 credit hours.

For the sake of discussion here, we will use the premise that we keep the **same number of credit hours for the major**, with that sum including the related requirements. For mathematics, that number is 40 (exactly 1/3 of the current graduation requirement.) We would then require exactly 10 courses in the major, down from 12. (The three required calculus courses are already 4-credits each and we currently require a one-credit course.)

> **Scheme 1:** Continue to require all the currently required courses: Calculus 1, 2 and 3; Elementary Linear Algebra, Introduction to Proof, and Real Analysis. Students would elect four 300-level electives. We might include some parameters, such as one elective must be a proof based course, and/or one elective must have an oral presentation component.
>
> This scheme would increase the number of 200-level credits by 2 credit hours. (The Calculus courses are already 4 hours.) It would decrease the number of electives by one. Students would have a less varied program, perhaps gaining depth at the expense of breadth, not in itself a negative effect. This could have the effect of reducing the breadth of courses offered across the math curriculum because of enrollment issues. This would be detrimental to our program, which has an exceptionally fine array of regularly offered courses along with a slot course for innovative courses which is currently well used. The 2010 graduates who elected to continue in Ph. D. programs utilized this diversity of offering to great advantage, opting to pursue very different math tracks.
>
> **Scheme 2:** Reduce the number of 200 level courses by not requiring Math 239, Introduction to Proofs, and then requiring five 300-level electives (as we currently do). The material in proofs class would be absorbed into other classes, perhaps Math 233, or the material would be distributed into required upper level courses, such as Real Analysis and Abstract Algebra.
> This would retain the breadth of our program and increase its depth.
> If the skills of Math 239 were taught in Math 233, that class would be altered good and not good ways. Also, as a service course, it would have many non-majors, taxing both student and instructor. If the skills of Math 239, were absorbed into upper level courses which are not taken in any particular order, there would be a great redundancy of effort and too much overlap from the student's point of view. We surveyed other schools that use their linear algebra course as an introduction to proofs course -- almost all reported that the course placed too many strains on both the students and the faculty.
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B. Impact on the Secondary Certification Program

> Traditionally, about half of our Mathematics Majors have pursued Secondary Certification and the department has been very successful in establishing placements for these students. We frequently receive inquiries from local school districts seeking our well-prepared graduates. Unfortunately, we cannot ascertain the impact of a four-course semester on the secondary program without

knowing how that program would change while maintaining compliance with the mandates of NCATE accreditation. We need to have parameters set by NCATE, the State Education Department and the Geneseo School of Education to begin to understand the challenges of modifying our courses and fitting our programs together, again.

One potential way to ease the pressures would be to incorporate literacy (currently Educ 215) into Intd 301-302 when they grow into four credits each. Not only does this reduce course-load requirements, but it would give the students a more relevant experience in literacy than they currently are getting (which is the source of significant dissatisfaction among current students).

Aside from the other impacts of adjuncts, we also have adjuncts doing quality work in supervising student teachers. If this task falls back to tenure-track faculty, this will be another source of depletion for courses serving the mathematics major.

C. Impact on the Mathematics Minor

The mathematics minor currently consists of six courses (20-21 credit hours), namely,

> Math 221 Calculus I
> Math 222 Calculus II

and one course each from four of the five options

1. Math 223,
2. Math 233,
3. Math 237 or Math 239 (but not both),
4. Math 242 or Math 262 (but not both),
5. Math 3xx electives.

We envision this changing to three instead of four additional courses from the same list, thus keeping the load to 20 credits. Here there is a definite trade-off between loss of breadth but gain in depth.

D. Impact on faculty workload

First and foremost we are in agreement with the *Re-thinking the Course Load* Taskforce statement:

> "we are unanimous in our agreement that any change in the students' curriculum

should be coordinated with either no change in the teaching workload of faculty, or a decrease in faculty teaching workload."

However, the teaching load must be viewed as one component of the Faculty Workload -- the cumulative effort expended in a given year into the following categories upon which ultimate judgments of tenure, promotion, discretionary pay, etc., are made

    A. Instruction   (50%)
    B. Contributions to the Discipline   (35%)
    C. Professional and Public Service   (15%)

If the goal of SUNY Geneseo is to save money by eliminating adjunct faculty, while maintaining the integrity of the Mathematics program, the teaching load, broadly defined, must increase for the tenure-track faculty. One realistic outcome necessitated by this observation would be an adjustment of the institution's expectation to something such as:

    A. Instruction   (2/3)
    B. Contributions to the Discipline   (1/6)
    C. Professional and Public Service   (1/6)

To keep the current teaching workload about where it is now would require a 3-2 system, which seems unlikely at best. Teaching 3-3 will compromise those extra services which are critical to our successful effort, services such as

- numerous student research opportunities,
- first year seminars,
- independent study in advanced topics or topics not offered,
- subject GRE coaching,
- Competition coaching, etc.
- extended office hours,
- problem sessions,
- time for individual attention.

E. Articulation

For students coming to Geneseo with an Associates degree from a two-year community college, the basic mathematical core must have been covered:

- three semesters of calculus,
- a course in elementary linear algebra, and,
- an introductory course in mathematical proof .

Since our ELA and Proofs courses, Math 233 and Math 239, would be increasing in content and/or intensity, we would ask that students enter Geneseo with the additional mathematical maturity gained by a least one additional 200 level course. This course would not count directly towards our major, but may help close the potential preparation gap. A similar 300-level course may be taken for credit at Geneseo.

This preparation should provide adequate background to complete the requirements for the Mathematics degree from SUNY Geneseo in two more years. We would ask that, despite any credit differences, the major requirement would still be only the additional six 300 level courses, consisting of

- Math 324 Real Analysis
- Three from our list if six for breadth
- Two additional 300-level mathematics electives

Assuming General Education Core from the community college, these students still would have 10 courses available for a minor, electives, etc.

III. Comments

- We found that the mathematics program can be molded into the four-course scenario very well with current core and room for electives. However, any additional constraints such as secondary certification, another minor, double major, etc., make it difficult to work on the local problem without the global perspective of how other majors would change and how the general education program would change.
- Our ability to continue to offer a solid major requires that our limited resources not be diverted to service. Currently, that flexibility is provided by a heavy dependence on adjunct services.
- Since our students will take 32 instead of 40 courses for graduation, there should be an overall increase in the depth of each experience, but there will also be a lessening of overall breadth, which diminishes the liberal arts thrust for the well-prepared Geneseo student.
- Everything changes:
    - Every course will need to be reexamined for content, pre-requisites, etc.,
    - Every major program will need to be redefined

- o Every minor program will need to be redefined
- o Every articulation agreement with every other institution will need to be reviewed
- Faculty teaching load will increase.
  - o If each of us teaches exactly the same number of hours per academic year as we do now, there are 8 additional credit hours to be covered for each student: We will need additional faculty, not fewer.
  - o If we keep the workload at the same number of courses and hence more credit hours, the consequences will be counterproductive. Faculty research will fall off and consequently opportunities for students to participate in research will fall off too. The co-curricular contributions of faculty will diminish. From competition coaching (e.g., Fed Challenge and Putnam) to club sponsorship, there will be no discretionary time or will. We will not attract good new faculty. **It is essential that workload NOT increase.**
- The changeover process
  - o will involve every faculty member for hours and hours without compensation,
  - o will require years of adjustment, witness the recent semester-by-semester changes to the semester schedule worksheet
- Since the intellectual density of the semester will increase, students that would have had a hard time with 5 three-courses will not have it any easier with 4 four-credit courses. Any such student who drops back to 3 courses at some point will need to stay beyond four years to complete their degree.
- Our current curriculum is an intricately designed jigsaw puzzle-like web of interconnections that present a coherent picture. We can only offer the same picture with fewer pieces if each piece handles more of the scene. We have tinkered with our programs for years to the point that we offer very successful programs. We have spent years negotiating our boundaries and streamlining our courses and making our education the best possible for our students.
- The most basic question in redesigning the major is thus, "What is everyone else doing?" So first we need general guidelines that everyone will follow, such as: keep the same number of credits, or keep the same percentage of credits vis a vis the total graduation requirement, and include related requirements in this formula, or not. The formulae won't give us the total picture, but rather a starting point.
- A review of the comments gathered from other schools that have transitioned to a four-course load points to one of three motivations: decreased faculty workload, increased student learning and/or an enhanced revenue stream. Unfortunately the realization of none these goals is clearly supported by the testimony.
- If we want to emulate "our aspirational peers among the great private liberal arts colleges", we should examine their programs to determine the real reasons for their success, and not focus on an arbitrary curriculum structure.