

**Department/Program** Mathematics and Statistics    **Chair/Director** Ruth Haas

**Retreat Dates:** February 17 and 25<sup>th</sup> plus additional subcommittee meetings.

**Departmental/program faculty participating:** Mike Albertson, Pau Atela, Michael Bush, Jim Callahan, David Cohen, Elizabeth Denne, Chris Gole, Ruth Haas, Katherine Halvorsen, Jim Henle, Mary Murphy, Patricia Sipe.

**Outside guest(s)/speaker(s) in attendance:** None.

**Goals for the retreat:**

- Review/reaffirm and update the results of our midterm review (fall 06)
- Discuss how our courses fit with the educational goals of all Smith students via a discussion of the curricular priorities and the capacities identified by the college.
- Discuss how our major serves the educational goals of mathematics majors via mapping the curriculum, discussion of pathways through the major and capstone experiences.

**Process:** In pairs, members of the department did an initial analysis of each of the questions College Hall suggested. They brought working documents to our retreat to frame the discussion. These documents are attached as appendices.

**Outcomes:**

We believe that we serve the Smith Community well; most of our courses are designed to contribute significantly to basic capacities important to every student. We make a particular contribution to reasoning and communication abilities.

We continue to work with other departments to teach the mathematics and statistics required for a variety of majors. We hope to have more opportunity to team-teach in the future, to build in-discipline quantitative components throughout the Smith Curriculum.

Developing quantitative ability requires working on problems and practicing techniques. This need is well documented in math pedagogical literature. It is not usually possible to teach math and statistics courses in big sections. Labs are an efficient way to give students some more hands-on or discipline-specific experience in a larger course.

We are gratified that our majors are interested in mathematics and statistics for a variety of reasons, and hence follow a variety of pathways through the major. Given our desire to continue to increase the number of women and minorities entering the mathematical sciences, it is especially important that we provide multiple access points into the major and continue to be attentive advisors.

The mathematical sciences have broadened considerably in the past 30 years. Where previously there were only a few main branches of mathematics there are now many. We work to bring many of these areas to our students at the 200-level so that majors and nonmajors have the opportunity to sample the rich diversity of mathematics and statistics.

Our courses at the 300-level, which usually focus on one topic, allow students to gain a greater depth of knowledge in that area. We require all majors to take at least one course at the 300-level. Many take more than one.

Our new Center for Women in Mathematics has gained national attention, with articles about the program appearing in several professional journals. It has infused the department with additional excitement about professional level mathematics. Our weekly lunchtime lecture series is attended by many Smith undergraduates, including those thinking of graduate school in the mathematical sciences and others who are not. This past fall over 40 alumnae attended the second Smith Alumnae Mathematician conference (funded by the NSF grant). There were three days of talks and workshops by alumnae and much time for informal discussion and mentoring sessions with current students.

The mathematical sciences continue to expand and encompass multidisciplinary directions. We need to continue to examine and reexamine our course offerings and the structure of the major to enable our students to use the tools of modern mathematics effectively in their chosen professions.

**Plans to achieve outcomes:**

We continue to seek to staff most MTH courses with tenure and tenure track faculty. To continue to serve all Smith students as well to as keep a vibrant major we must provide small sections of all service level courses. Our major must have breadth to serve students interested in statistics, applied mathematics, actuary science, and pure mathematics. Indeed, a well-rounded math major will have some proficiency in all of these areas. Additionally, to continue as a nationwide leader in sending women to graduate school in the mathematical sciences we must provide sufficient depth in key areas.

**How do your plans advance departmental goals as outlined in mid-term or decennial reports?**

The midterm report of Fall 2006 points to our ongoing request for stability in staffing via a replacement of short term hires with tenure lines. This is necessary just to sustain our existing efforts. New initiatives will require additional staffing.

**How does the departmental/program plan to integrate the list of intellectual capacities into the major?**

Reasoning through abstraction is at the heart of learning mathematics. In Appendix 1 we discuss how our courses particularly address the critical capacities of reasoning and communication. Appendix 6 is a mapping of the curriculum.

**Of the specific curricular goals identified by the faculty, which would be furthered within the major?**

We address almost all of these at some points in our curriculum. The most well developed goal in our major is critical and analytical thinking and communication. See Appendix 2 for notes on our discussion.

**Has the department integrated the development of student research abilities in the structure of the major?**

Research in mathematics consists of creating new mathematics. Our students hear professional mathematicians discuss their work in our well-attended weekly seminar. Throughout their time here they also have several opportunities to do research mathematics themselves. We also require expository research projects in almost all of our 300-level courses and many 200-level courses. Appendix 3 has notes on our discussion about research.

**Are the pathways through the major clear for prospective majors? Is the department satisfied with the level of advanced work accomplished by its majors? (It may be useful to review the transcripts of graduating majors, or to examine the course taken patterns of several recent groups of senior majors.)**

There are a variety of pathways thorough the major, depending on the student's interests and abilities. The basic structure of the major is clear, but it is important to tailor a student's program to fit her personal goals. For this review we did a transcript analysis, the results of which are in Appendix 4.

**What are the culminating or capstone experiences for students in your major?**

There are multiple kinds of capstone experiences for our majors. First, the nature of our subject means that every major will have completed at least one sequences of courses that is four levels deep culminating with a 300-level course and at least a second sequence that is three levels deep. For some, taking one 300-level course is a big intellectual achievement. Other students complete several and take graduate courses at UMass during their time here. Some complete research projects and present at conferences. Some participate in our weekly seminar series. For our major to be appropriate for those going to graduate school in several of the mathematical sciences, a capstone experience must be different than for those whose training in mathematics will end upon graduation from Smith. Notes from our discussion about this matter are in Appendix 5.

**Please attach a summary of any proposed changes to be considered by the department and any associated timeline for changes to be submitted to CAP.**

**New Initiatives:**

A) Add research courses.

The department would like to add research courses to its curriculum. One proposal, based on current experience with MTH 301, would offer students the opportunity to work on projects creating new mathematics. Each semester the department would designate one or perhaps several existing courses that would have an accompanying research lab.

A student who is enrolled in the course or has previously completed the course could apply to enroll in the research lab. The instructor of the research lab would offer the students a sequence of open questions. The lab would meet for one two hour session each week, and the students would be expected to work on the project for an additional 6-8 hours each week. The instructor would provide guidance, the occasional good or bad idea (remember we don't know where these questions will lead), and context for the problem. Especially successful projects could result in publication. Every project would offer the students insights into the working culture of doing mathematics.

B) Increase statistics offerings.

Our current statistics courses are at capacity and our two statisticians fully utilized. We would like to offer some of the advanced courses with greater regularity. Additionally, currently several other departments offer statistics courses. We would like to continue to support the discipline-specific statistics needs of students throughout the college.

C) Strengthen our applied offerings and create interdisciplinary courses with other departments.

The use of mathematics in other disciplines has increased considerably in recent years. We would like to be able to offer courses that address such topics as mathematical biology, mathematical ecology, mathematics of finance, operations research, and the mathematics of the environment.

D) Create new interdisciplinary majors in mathematical economics, bio-math (with biology and computer science) and operations research (jointly with Engineering and Economics).

E) Continue to offer innovative mathematics and quantitative skills courses at the 100 level that are suitable to students with diverse backgrounds and interests.

F) Increase the number of courses we offer and the percentage of courses taught by tenure track faculty in the department to allow us to accomplish these new initiatives.

Appendices:

1. Capacities
2. College Curricular Goals
3. Research
4. Transcript Analysis
5. Capstone Experiences
6. Mapping the Curriculum

# Appendix 1: Capacities and Mathematics

From a long list of capacities, we single out two that we consider to be at the core. Even these two are so codependent as to suggest that we see them as facets of a single intellectual capacity. Let's start with the two. They are *reasoning* and *communication*.

## Reasoning

Analytic reasoning This is the deductive logic of mathematical proof. This reasoning is carefully developed in every mathematics course.

Inductive reasoning This is the reasoning that enables a mathematician or a student to generalize from examples. This too is a part of all our courses.

Statistical reasoning This is a subtler and deeper variety of inductive reasoning. This is the reasoning that enables one to describe relationships and phenomena based on data. It further enables one to make precise the level of confidence one should have in such descriptions. This is developed in all our statistics courses (there are eight of them). In addition, our weekly seminar features several statistics talks each semester.

Quantitative reasoning This is a perfect example of the connection between reasoning and communication. The working definition of quantitative reasoning in use at the College is “the ability to read and write numerical descriptions of the world.” This form of reasoning is developed in all but the most theoretical courses. In addition, members of the department collaborate occasionally with colleagues in other departments to increase the quantitative content of their courses—and stand ready to do much more of this.

Mathematical judgement We use this phrase to describe a certain mathematical maturity. Mathematical judgement enables a student to know what aspects of a context are mathematical. It enables her to understand when a phenomenon has a mathematical description, when a question is mathematically interesting, and when a statement can be put in mathematical form. Maturity takes time. Every mathematics course a student takes contributes to it.

## Communication

Reading Mathematicians converse in a patois of English and symbolism. Mathematics is difficult to read not simply because of special terms and grammatical constructions, but because mathematical prose is so concise and exact. Every course in the department exercises a student's ability to read, but most especially the 300-level courses.

Writing This goes with reading and it is emphasized at all levels. Even before students learn to write proofs, they must learn to write with clarity and coherence. Many assignments in 100-level courses require extensive writing. MTH 221, and LOG 100 are formally identified as writing-intensive in the College curriculum.

Formal speaking Mathematical presentation is encouraged of all majors, especially those who have participated in research. Students do formal presentations in most upper-level courses. In addition, speaking is an explicit part of several courses, introductory and advanced.

Informal collaboration Much mathematical research is done collaboratively. Many courses in the department encourage or require group work in order to develop students' ability to exchange ideas.

Listening Listening to mathematical talks takes time to develop. It's not simply the level of concentration required, students must learn to tolerate confusion. In most fields, students are expected to understand what a lecturer says. In mathematics, this is not always the case (we are talking about invited speakers, not classroom teachers). Like infants, students must learn to get what they can from what they hear even if not all the details are clear.

One cannot communicate ideas if one cannot reason about them. That is fairly clear. But the reverse is also the case. As mathematicians, we do not trust our own thoughts until we have written them down with some level of formality. In the same way, we aren't satisfied that our students understand a piece of mathematics unless they can communicate it. Our courses reflect this connection.

## Appendix 2.

### Notes on the discussion of **Curricular Expectations and Requirements**

#### 1. **Develop the ability to think critically and analytically and to convey knowledge and understanding, which require**

- Writing clearly: We address this in all of our courses. Mathematics is a precise symbolic language. Students learn to express mathematical ideas in English and to write statements that translate English into mathematical symbols. We stress clear mathematical writing and logical proofs.
- Speaking articulately: In all upper-level courses and many 100- and 200-level courses, students give in-class presentations.
- Reading closely: We ask students to read their text and other course materials carefully, with the expectation that they will learn mathematics from those sources as well as from the lecture. (This goes along with writing clearly: students must understand the written words in order to translate them into mathematics, and they must understand written mathematics if they are to learn from it.)
- Evaluating and presenting evidence accurately: This expectation is addressed in several courses, most notably in our statistics courses.
- Knowing and using quantitative skills: All of our courses support students in developing these.
- Applying scientific reasoning: Many of our courses use guided discovery techniques. I.e., students build their understanding of the subject by gathering evidence, making conjectures and then proving them either theoretically or with model building. An unusual feature of Smith's math curriculum is that modeling and application are emphasized starting in first calculus courses.
- Engaging with artistic creation and expression: MTH 105 (Discovering Mathematics), MTH 224 (Topics in Geometry), and MTH 227 (Topics in Modern Mathematics) are courses in which artistic creation and expression regularly appears. (Some of the topics taught in these classes have been Mathematical Sculptures and Tilings,)
- Working both independently and collaboratively: Virtually all of our courses emphasize these abilities.

#### 2. **Develop a historical and comparative perspective, which requires**

- Learning foreign languages: Not usually.
- Studying the historical development of societies, cultures, and philosophies: We don't do much of this anymore. Several years ago, we were forced by lack of staffing to stop offering MTH 350, History of Mathematics.
- Understanding multi- and inter-disciplinary approaches: We do some of this in our contextual approach to calculus and continue it in many upper level courses (for example, 204, 222, statistics). We interact with other departments, particularly Computer Science, Engineering, Biology, Psychology, and Economics.

#### 3. **Become an informed global citizen, which requires**

- Engaging with communities beyond Smith: We will be hosting a Math Day for high-school girls in April. We regularly bring students to conferences across the country (recently 10 students visited Dartmouth, 12 went to San Diego). We also regularly host conferences at Smith and encourage our students to attend. This year we had an Alumnae math conference in the fall and will have Discrete Math week this spring, which will bring international experts to campus.
- Learning tolerance and understanding diversity: Faculty are aware of, and understand diverse learning styles. Women and minorities remain highly underrepresented in mathematical disciplines, and take less mathematics at the college level. Bringing more women into mathematics is improving diversity.
- Applying moral reasoning to ethical problems: We help students learn not to be overwhelmed by quantitative information or cowed by unsupported statements, but to assess critically what they read and hear.
- Understanding environmental challenges: We use environmental models in some of our courses (e.g., shrinking polar ice cap, rising global sea levels, increasing world population). This semester the theme of MTH204 is Global Warming.

## Research

### Overview

While original mathematical research at the undergraduate level was a rarity when most of us were students, it has become a trend in the nation. We speculate that the change may have come from an increased use of the computer as the mathematicians' experimental tool and the emergence of new fields with accessible problems, societal changes breaking hierarchical barriers, as well as an increase of funding for undergraduate research.

Research experience provides students a sense of ownership of mathematics and gives them a glimpse into the professional life of a mathematician. This covers everything from solving open problems in mathematics, researching background material to presenting research in papers and at conferences. In addition the research experience for our math undergraduates builds skills that go beyond mathematics: scholarly sifting through diverse information, team playing, thinking outside the box, and communication.

Our department has developed a solid tradition of supporting students' research over the years, and many of our courses contain research like components. Although new this year, our Center for Women in Mathematics has already had a noticeable effect on promoting a culture favorable to students research in our department. The program of the Center includes research experience during the school year and student driven lectures series. This puts our department at the forefront of a national trend in math departments.

But the different aspects of research are also cultivated through many experiences throughout the major: some independent studies or honors theses stress scholarly research of existing mathematical work, while many of our courses require independent papers and projects which in many cases can be seen as mini research project.

We note that, although the math department does not have a formal information literacy program, its web site and the weekly, well attended lectures help point to many sources of information about working in the field of Mathematics & Statistics. We also think that our students are better served by the diversity of research like experience, both curricular and extra curricular, than by a one size fits all research method course.

### Research and the Major

Here are a few ways that students are encouraged to experience research in and outside our department.

**Coursework.** Apart for the explicit case of our research experience MTH 301, the majority of our upper division courses contain research like experiences. In some courses (e.g. 221, 243, 343) the students are asked to "rediscover" the material that they then write and present, with little help from the literature. The majority of our courses above 212 require some independent project resulting in a paper and/or presentation on a subject related to the course. While many of these projects focus on scholarly research of pre-existing material, some include original research components. Finally, many of our independent studies also include scholarly and sometime independent research.

**School semester research.** As part of our Center for Women in Math program, we have created a 2-credit course (MTH 301) consisting of group research on original topics during the semester. A requirement (?) for our Post-bac students, this course is open to all students. MTH 301, running for the first time this year, has an enrollment of 10, working with three faculty. Results will include published papers, written reports, posters at Celebrating Collaboration, talks in seminars and at conferences. This research experience seems to fill in a need for those students who do want to have a research experience but are reluctant to work alone and to invest the time and energy required by an honors thesis. Some students also engage in research as an independent study as a follow up from their summer research experience, providing another kind of flexibility in their plans.

**Honors thesis.** Thesis work in our department runs the gamut between in depth survey work and original research. Reading and writing about a subject in depth, following up the details. New work could include modernizing arguments, streamlining arguments, correcting incorrect proofs. Others are more research oriented and may stem from a REU at Smith or somewhere else.

**Summer Research at Smith.** Students work with faculty in our department on projects funded by outside grants (NSF, NIH), by the Science Center pool or by the department's endowed Borie Fund. These projects have ranged from .... (concrete examples? including Joe and Iliana's projects). These projects sometime turn into honors thesis during the following year.

**Summer research outside of Smith.** Research Experiences for Undergraduates (REUs). It is increasingly popular for students to go to other universities over the summer months to participate in REUs. In 2007, at least 10 of our students participated in such programs. This usually involves between one and four students working on new problems and presenting the work at conferences, as well

### Research Related Activities

**Lunch-time seminar.** Each week students can attend a lunch time talk. Students talk about the research they have done (in REUs), guest speakers talk about their research. Both are beneficial to all students: the former gives the speaking students opportunities to polish their presentation skills; they serve as role models to other students and lowers their psychological threshold for getting involved in research. The latter is important in that students learn some mathematics not seen in the classroom and can see what present day mathematics research can involve.

**Conferences.** Students attend and give talks at math conferences (Mathfest, AMS joint meetings, Hudson Valley C). Smith recently held SMath conference, the speakers were alumna from both the academic and business communities. Many alumna attended who are current graduate students. Attending these conferences give students the opportunity of seeing research in action and building networks in the mathematical community.

### A proposal for further integration of research and coursework

We would like to propose the creation of new - or restructuring of existing - courses into a 3 credit "normal" course work component and a 2 credit research lab attached. Students could take 1 and/or the other, in semi flexible combination (she could take the lab a different year, but after taking the course part). Several of our courses would be suitable for this purpose.

Appendix 4. Some results from a preliminary transcript analysis.

0) We obtained transcripts from all math and stat majors from the classes of 2004 - 2008. There were 16 majors in 2004, 19 majors in 2005, 16 majors in 2006, 21 majors in 2007, and there will be 26 majors in 2008. One might naturally wonder if there is an upward trend in our number of majors. This should become clearer after several more years; however, the new Center for Women in Mathematics may confound the issue.

1) About half of our majors (48/98) completed a double major. Of these, two thirds (32/48) selected math and stat first. There were 21 majors who doubled with economics, 5 with computer science, 3 with education, and no other department with more than two. CS enrollments are beginning to rebound, and we expect that this will result in more of these double majors.

2) About 20% of our majors (19/98) pursued the statistics track. To determine this we counted those who took MTH 346 and neither MTH 233 nor MTH 238 (or their equivalents). Of course some of our majors might have a primary interest in statistics and still take one of these two courses, but we don't know how to identify these students.

3) Two thirds (70/98) of our majors took MTH 225, and two fifths (41/98) took MTH 243. Of our majors who did not complete the statistics track two thirds (53/79) took both MTH 233 and MTH 238.

4) The number of our majors who took 300 level courses were 6 in 325, 18 in 333, 16 in 343, 37 in 346, 6 in 350, 4 in 353, and 11 in 364. We have begun requiring a 300 level course (above 307) for the major. This has not been in effect long enough for the data to be informative.

5) This year there are six of our majors and five postbacs who are planning on graduate school in a mathematical science. The former number is an all time high for us and the latter number represents new enrollments. This suggests that we can expect larger enrollments in our 300 level courses as well as in MTH 233 and MTH 243.

6) Where did our majors begin their calculus study at Smith? About one in every six of our majors (17/98) took MTH 111 in her first semester and MTH 112 in her second. An additional seven students took MTH 111 and MTH 112 later in their career. About 40% of our majors (41/98) began their calculus in MTH 114. Thus a third of our majors (33/98) began their calculus at MTH 212 or above, and nine of our students began their study of analysis above MTH 212. Some of us believe that we should concentrate more on attracting majors from 111. Others believe that we should focus our efforts on attracting majors from 114.

7) About one out of eight of our majors (13/98) took MTH 153 in their first semester. A third (32/98) took it in their second semester. Almost 40% (39/98) took this course in their second year. Five students took this course after their sophomore year, and one in ten students (10/98) took a more advanced course instead.

8) Our majors took an average of 11.3 courses offered by the department. Note this does not count courses that we count for the major either by cross listing or with our 2 for 1 accounting for courses with significant mathematical content offered by other departments.

## Appendix 5.

Capstones/culminating experiences in mathematics.

Culminating experiences occur quite naturally for mathematics students. Our majors are quite a diverse group, and accordingly there are various kinds of capstone experiences.

Mathematics and statistics are intrinsically highly structured disciplines. The study of any topic always requires specific prerequisites. We have recently added even more structure to our major. We began by requiring one course in each of algebra and analysis, with a slight modification for those concentrating in statistics. Next, we reinstated the requirement of a 300 level course. Any student who takes a 300 level course must build a tower of at least four courses, each of which is a prerequisite for the next, in order to successfully complete this 300 level requirement.

One can think of our courses for majors as grouped in levels as follows: These levels are for courses toward the major, omitting the level of non-major offerings.

1. One hundred level required courses – for majors, beginning with 111 and 112 or 114 (the calculus requirement) and 153 (the discrete mathematics requirement). Since every major must take these, they are listed as “calculus and discrete math” in level one below.
2. Two “core” basic courses, Math 211 (221 may be substituted) and 212. Both are required for every major, so these are listed as “core”.
3. Other 200 level courses.
  - a. The courses that fulfill the analysis (225, 243) and algebra (233, 238) requirement.
  - b. For students concentrating in statistics, 247 and 290 replace 233 as a core major requirement.
  - c. Our other 200 level offerings. These include electives and courses required as prerequisites for certain 300 level courses, but not for all majors.
4. Our 300 level offerings. A student must take at least one course numbered between 310 and 390.
5. Special studies, honors program and research experiences. Our weekly seminar (not for credit).

Each of these levels requires courses from the previous one, so a student must move through a sequence of at least four courses, one from each level, to fulfill the 300-level requirement. Every 300 level course caps a tower in this way. Examples of such towers are in the table below.

Towers of courses					
4	333	342	325 or 342	353	346
3	233 or 238	233 or 238 and 243 or 225	243 or 225	254 or 255	246
2	211 and 212				
1	111, 112 and 153				

We emphasize that many pathways in our major require even more structure. The chart above simply shows the minimum that a student must complete to satisfy the requirement of a single 300 level course.

The majority of our majors take more than one 300 level course. Different towers top tracks in different subfields, with different prerequisites. Our offerings need to be rich enough to provide breadth for our strongest students. We need to ensure possibilities for all of our students to design programs to match the necessary prerequisites to the particular 300 level courses offered each year. The fact that 300 level courses and some 200 level prerequisites are offered in alternate years, as well as scheduling constraints can sometimes present obstacles to students. We cooperate with Mount Holyoke for scheduling 300 level courses.

We provide various other advanced opportunities to serve the wide variety of students we teach. The 300 level requirement alone is insufficient for many of them.

- For some of our students completing one of these towers is already a challenging intellectual achievement.
- Some of our students are double majors. Most of these are double majors with economics. They may complete only one 300 level course. But many of those double majors are excellent students for whom the 300 level requirement is not such a challenging requirement *per se*, but they complete extensive work in both disciplines. Often these students integrate their studies of both disciplines in an impressive way, certainly a culminating experience even stronger than completing just one of these towers.
- Students preparing for graduate school in the mathematical sciences should and do take several 300 level courses.
- Some students (usually those who plan to apply to graduate school) take a graduate course at UMass.
- Some students complete research projects either at Smith during the academic year or in summer work here or elsewhere (e.g. REU programs).

- Our students who spend a semester in the Budapest program return well prepared to do advanced work well above our minimal requirements.
- Some students complete honors projects and theses.
- Some go to conferences and present their research.
- Our weekly seminar series attracts an impressive fraction of our majors even though it is neither credit bearing nor required. Its focus is to give an overview of contemporary mathematics rather than to aim for specialization. It serves as an enriching experience for students at all levels. It can be a true capstone for those who speak in the seminar and is a different sort of culminating experience for all advanced students, emphasizing breadth rather than depth, and an opportunity to integrate the different strands of mathematics they have studied. It also contributes to community building, which is particularly important for a mathematician. That is, it is a place for our students to *be* professional mathematicians.

## 6. Mapping the Curriculum

*Note:* “is a focus of” means that the indicated ability, knowledge, etc. is an enunciated goal of the course, is understood by students to be a goal, and that specific teaching methods are used to help students achieve the goal.

<b>Abilities</b>	is a focus of	is a part of
to deal with abstract ideas	all courses	
to solve problems	all courses	
to model situations outside mathematics	102, 107, 111, 112, 114, 153, 204, 212, 227, 353, 364, and all statistics courses	all courses
to write logical proofs	153, 211, 217, 221, 224, 233, 238, 243, 254, 255, 325, 333, 342, 343, LOG 100	225, 246, 301
to write clearly on topics with mathematical content	102, 221, 224, 243, 254, 255	all courses
to make clear oral presentations	221, 243, 301, and all 300-level courses	informally, most courses
to listen, with profit, to difficult mathematical presentations	300 and the Tuesday lunch seminar series	
to think in statistical terms	all statistics courses	
to research known mathematics	most 200-level courses, all 300-level courses, special studies and thesis	courses numbered over 307
to formulate researchable questions	301, summer research projects	
to create new mathematics	301, summer research projects	
to collaborate mathematically	221, 243, 301, and the Math Forum	most classes

<b>Knowledge</b>	is a focus of	is a part of
continuous mathematics	102, 111, 112, 114, 204, 212, 217, 222, 225, 243, 325, 342, 343, 364	211, 221, 246
discrete mathematics	153, 238, 254, 255, 353	211, 221, 246
algebra	102, 211, 221, 233, 238, 333	342
geometry	224, 227	111, 112, 114, 211, 212, 221, 225, 233
topology	227, 342	111, 112, 114, 211, 212, 221, 225
computation	204, 227	111, 112, 114, and all statistics courses
statistics	107, 190, 241, 245, 247, 346 (all statistics courses)	246
multidimensional spaces	211, 212, 221, 225	112, 114
finitude and infinity	217, 221, LOG 100	111, 112, 114, 212, 243

<b>Insights</b>	is a focus of	is a part of
the connectedness of mathematics to the world	102, 111, 112, 114, 204, 353, 364, and all statistics courses	most courses
the interconnectedness of mathematical fields	105, 111, 112, 114, 300, 342	all courses
the breadth and variety of mathematics	the Tuesday lunch seminar series	all courses
the extent to which mathematics remains undiscovered	all 300-level courses	all courses
one's own potential in mathematics	all courses	