

Overview of the Capstone Experience for the Liberal Arts Mathematics Major (MATA)

The goal of the Mathematics Capstone Experience is to develop your mathematical maturity and communication skills by presenting a mathematical project that is a culmination of your studies. Mathematically, you will be working to learn about a mathematical topic at an advanced level with a faculty advisor. Ideally, your topic will bring together two areas of mathematics that you've studied, and we encourage you to seek out such topics, but this is not a requirement. It is your responsibility to find an acceptable topic and an advisor with whom to work. If you cannot find a topic, you can meet with faculty members to discuss possible capstone topics.

To complete the Capstone Experience requirement, you will need to write an expository mathematical paper, usually approximately 8-10 pages, on this topic and give a 20-minute oral presentation on it to an audience of faculty and peers. It is not expected that you will do original mathematical research. Instead, the goal is to demonstrate understanding of a math topic at a level deep enough to enable you to interest others about it in both a written paper and an oral presentation.

You may find the paper and the presentation to be challenging projects. We encourage you to begin your work even before the start of the semester in which you enroll in the Capstone Experience. To help you, we have prepared a list of guidelines and assembled a collection of sample expository papers. The audience for your paper and the presentation should be your peer group, by which we mean a math major graduating from college. Ideally, senior math majors at another college would enjoy reading your paper and would learn from it. This standard will be used to evaluate your work.

Completing the Capstone Experience is a MATA graduation requirement. You will receive a grade for it based upon your written paper and oral presentation. We have prepared guidelines for your paper and presentation that you should read and consult while writing your paper and preparing your presentation. A rubric outlining the criteria to be used to evaluate your paper and presentation is also attached.

If you have any questions about the Capstone Experience, please contact your advisor .

Some MATA Capstone Experience Guidelines

- Your paper should indicate why your topic is mathematically interesting or important. Some history can be included but the paper should be primarily a mathematics paper.
- The examples and proofs you will find in your research will be (usually) correct but not necessarily as clearly explicated as an expository paper for your peer group requires. It is your job to provide written or mathematical clarifications, simplifications, added pictures, and other commentary to make the argument as clear as possible. Your goal is to provide a lucid, enlightening account of your topic.
- Your paper should be as self-contained as possible, yet you do not want to write a textbook on the topic. You should assume that your audience consists of other senior math majors, who are familiar with some but not necessarily all of the concepts you will introduce. Choose the most important concepts to define. If you omit too many definitions, (or arguments, linkages, etc.) your reader will justifiably abandon any attempt to follow your argument.
- Use the language of mathematics correctly. For instance, the words "expression" and "equation" are not equivalent, "definitions" are not "assumptions", "equal" is not "congruent", and so on. Also, explain terms or abbreviations new to the reader, who, remember, has only been with you since your first page.
- Choose standard terms with variety. For instance choose from words or phrases such as "thus, so, therefore, hence, whence, then, it follows that, we see that, we have, etc." when stating the many conclusions that appear in a mathematical argument. Otherwise, you risk putting your reader to sleep with repetition.
- If you draw from different sources, as you probably will, you must unify the notation, sketches, and even the style. The reader should not have to switch for no reason from one set of variables or expressions to another set which symbolize the same ideas. This is sloppy writing, and only obscures your mathematical argument. Translate sources into a single language.
- Theorems, Definitions, Lemmas, Proofs, Constructions, etc. should be indented and set off from the rest of your writing as in the following examples:

Theorem: A pentagon can be constructed with unmarked straightedge and compass.

Proof:

Construction:

Lemma:

Definition: An isometry is a transformation of the plane which preserves the length of segments.

- Mathematical typography can be tedious on standard word processors, so do the best you can. If necessary, write out expressions by hand rather than make a valiant effort with your software, only to produce clumsy approximations.

Capstone Presentation Rubric

Student:

	Grade			
	A	B	C	D
Mathematics (40% of grade)	Completely correct presentation of mathematics at a sufficiently advanced level; excellent use of examples	Generally correct presentation of mathematics at a sufficiently advanced level; adequate use of examples	Mathematics is generally correctly presented, but some parts are incorrect. Some use of examples.	Significant incorrect mathematics presented; few or no examples.
Mathematical Language (10% of grade)	Uses mathematical language correctly and effectively; all terms well-defined	Generally effective use of mathematical language; occasional use of undefined terms	Some problems with the use of mathematical language; some undefined or incorrectly defined terms	Mathematical language incorrectly used or undefined
Talk Organization (15% of grade)	Structure of talk clear and logical; parts connected with highly effective transitions;	Structure of talk generally clear and logical; parts usually connected with adequate transitions;	Structure of talk shows some sense of organization; parts not always clearly connected;	Structure of talk unclear or nonexistent; connections between ideas unclear;
Level and Clarity of Presentation (15% of grade)	Talk presented at a level appropriate for an audience of peer math majors; all parts clearly explained	Most of the talk appropriate peer math majors; generally clear explanations	Some parts of the talk understandable to a portion of the audience	Little of the talk understandable
Presentation of Talk (10% of grade)	Speaks clearly, confidently, not too fast, and with a non-monotone delivery; correct use of time;	Talk generally presented clearly, confidently, not too fast, and with a non-monotone delivery; time managed within reason	Some problems with one of the presentation areas of delivery and time usage.	Significant problems with one or more of the presentation areas of delivery and time usage.
Motivation (10% of grade)	Talk provides strong motivation for the mathematics problem presented	Talk provides adequate motivation for the problem presented	Talk provides some motivation for the problem presented	Talk provides little motivation for the topic of study

Capstone Paper Grading Rubric

Various aspects of the paper are graded below. Note that your paper is first and foremost a paper in mathematics. Therefore 60% of the overall grade for your paper will be based on the mathematics and to a lesser extent the use of mathematical language and citations in the paper. The remaining 40% of your grade will be on the level of presentation and organization of the paper and the motivation for the project offered in the paper.

Student: _____

Your draft's main strength is

Your draft needs improvement in

Categories	Grades			
	A	B	C	D
Mathematics (approximately 50% of final grade)	Completely correct presentation of mathematics at a sufficiently advanced level; appropriate connections with different fields; excellent choice of examples	Generally correct presentation of mathematics at a sufficiently advanced level; appropriate connections with different fields; appropriate choice of examples	Generally correct presentation of mathematics; some connections with different fields; some examples.	Incorrect mathematics presented; few connections to other areas of mathematics or no examples.
Language (approximately 10% of final grade)	Uses mathematical language correctly and effectively; appropriate and correct citations to the math literature	Generally good use of mathematical language and appropriate citations	Many problems with the use of mathematical language and/or citations	Little appropriate use of mathematical language and/or citations
Motivation (approximately 10% of grade)	Paper provides strong motivation for mathematics presented	Paper provides adequate motivation for the mathematics presented	Paper provides some motivation for the mathematics presented	Paper provides little motivation about the mathematics
Level of Presentation (approximately 10% of final grade)	Paper written at a level appropriate for an audience of peer math majors	Paper mostly appropriate for peer math majors; occasional lapses	Some parts of the paper written at a level appropriate for peer math majors	Paper generally written at a level inappropriate for peer math majors
Paper Organization (approximately 20% of final grade)	Structure of paper clear and logical; paragraphs coherent; sections and paragraphs connected with highly effective transitions	Structure of paper generally clear and logical; paragraphs generally coherent; sections and paragraphs usually connected with adequate transitions	Structure of paper shows some sense of organization; paragraphs periodically coherent; some adequate transitions	Structure of paper unclear or nonexistent; paragraphs unstructured; AND/OR connections between ideas lacking

MATA Capstone Experience Proposal

Formal Requirements: Sections of MAT 498: Capstone Experience are considered as “add-ons” to existing 400-level mathematics courses. Students will sign up for MAT 498 in conjunction with a 400-level course MAT course. The course chosen must either have been previously completed or be one in which they will be enrolled concurrently with the Capstone Experience. The Capstone Experience is a Senior year experience.

Course Overview: MAT 498:Capstone Experience has the goal of ensuring that MATA majors have strong mathematical comprehension and communication skills. It focuses specifically on developing a student's ability to read, write, and present a paper on an advanced mathematical topic. Students are required to independently explore an advanced mathematical topic through readings, and then to write and present an expository mathematical paper on that topic.

Over the course of a semester, faculty will work regularly, usually weekly, with students throughout the semester. Faculty will meet with students either individually or in small groups. Students will choose a topic related to the advanced material in an associated 400-level MAT course. Faculty will work closely with them as the students develop their written papers and oral presentations. The written papers will be assessed both by the instructor of the associated 400-level course and a committee of mathematics program faculty. The oral presentations will be made to an audience of student peers and faculty.

Mathematical Topic: A student will be expected to explore an advanced mathematical topic through independent readings. The topic will be based upon the material in the associated 400-level MAT course. When possible, the department encourages the selection of interdisciplinary topics that link more than one mathematical area.

The following are some examples of suitable sample topics for these papers: the study of solutions to a chaotic differential equation (as an add-on to MAT 454); classifying knots or some four dimensional manifolds through polynomial invariants (as an add-on to MAT 405 or 452); an introduction to Lie groups (as an add-on to MAT 4xx); or estimating the percentage of polynomials with the full symmetric group as their Galois group (as an add-on to MAT 451).

Writing Components: The Capstone Experience is a writing-intensive experience that combines the various skills learned throughout the MATA curriculum and synthesizes the knowledge so acquired. It has two distinct writing components.

The most significant part is the requirement for MAT 498 that students write a 10 page expository mathematics paper based upon their mathematical investigations. The paper is expected to be written at a level where it can be profitably read by senior mathematics majors with similar backgrounds, such as those from a peer institution. Students will be given guidelines for how to write a successful mathematics paper, examples of expository mathematics papers, and the rubric to be used for the assessment of these papers. As fluently integrating mathematics with text is a difficult skill to learn, students will be required to write multiple drafts of their paper throughout the semester.

Students will receive faculty feedback on each draft that they will use to improve their papers.

The department's mathematics committee plans to assess the quality of the mathematics papers (and the capstone experience) each semester and to date, this assessment plan has worked well. The first capstone papers were written during the Fall 2006 semester and at its end, a committee of faculty assessed the results. As a result of that meeting, the department made several recommendations to improve the capstone experience, such as to create guidelines on writing a math paper and to distribute examples of model papers. The mathematics committee intends to hold these assessment meetings each semester.

The second writing component of the Capstone will be the regular written homework assignments in the associated 400-level course that the student is enrolled in. Frequent written homework assignments, usually weekly or biweekly, are assigned in these courses and students learn how to write mathematical proofs at a high level. Feedback is then provided by the faculty member in charge of the course. A significant amount of writing and rewriting is done by students in these 400-level courses.

Oral Component: Based upon their mathematical readings and paper, students will be required to give an acceptable oral presentation to an audience of student peers and faculty. The length of the presentations may vary, but at a minimum, a 20-minute presentation will be normally expected.

Administration: Each 400-level MAT course will have an associated section of MAT 498. The professor for each upper-level course will teach the associated MAT 498 course. The MATA major currently averages 10-15 majors per year so a typical Senior year would see approximately four Capstone Experience courses run.

Grades and Credits: Students will receive a letter grade for MAT 498 and the grading criteria used will be made clear to the students at the beginning of the semester. Students will receive 0 course units credit for completion of MAT 498, but a passing grade will be a graduation requirement. MAT 498 will be treated as a group study course for purposes of determining teaching credit for faculty.

(Name of mathematics major: _____)

What evidence is provided by this portfolio of development related to each of the following student learning outcomes?

Student Learning outcomes for all mathematics students:

Each student should progress with respect to these goals in each individual mathematics course, as well as throughout any sequence of mathematics courses that he or she takes. Thus the expectations are increased as the mathematical maturity of the student increases.

- Students should develop the ability to think logically and critically and to analyze information in a mathematical setting.
- Students should develop the ability to reformulate and solve problems in an abstract framework.
- Students should be able to express mathematical results verbally, with both written and oral presentation, working individually and in collaborative groups.
- Students should be able to use appropriate technology, including graphing calculators and mathematical software, both to facilitate understanding of mathematical concepts and to serve as problem-solving and presentation tools.

Additional outcome goals for all mathematics majors:

- Students should participate in and contribute to an academic community of teachers and learners in mathematics.
- Students successfully completing one of the mathematics degree programs should be prepared to enter appropriate employment in business or industry, or to enter a graduate program in mathematics, mathematics education, or related fields.

What evidence is indicated by the portfolio of development related to Seattle University Student Learning Outcomes? (Please see the Seattle University Student Learning Outcomes grid.)