

The Capstone Experience

The University requires a “Capstone Integrating Experience” of all seniors. A student in Mathematics will fulfill this requirement by completing a project which demonstrates his or her ability to independently study some area of mathematics, and to communicate orally and in writing the knowledge so obtained.

1 The Process (A Summary)

Each student will be responsible for choosing a project and a project supervisor. The supervisor must be a member of the faculty, but need not be a member of the Division of Mathematics and Computer Science (MTCS). If the supervisor approves of the project, the student will then propose (in writing) this project to the MTCS division’s Undergraduate Committee. The Undergraduate Committee will then decide whether the project is appropriate (see below).

When the student has completed work on the project and its written report, and when the student’s supervisor approves, he will present the final written report to the MTCS division’s Undergraduate Committee. The committee will then decide whether this report is adequate. If so, the supervisor will make arrangements for the student to present his work. At the completion of this presentation, the he will have then completed his Capstone experience and met the graduation requirement. Hooray!

2 The Nature of the Capstone Project

Many different types of projects will be considered acceptable. All acceptable Capstone projects should meet three criteria:

- (I) The student learns some Mathematics outside the classroom setting.
- (II) The student synthesizes material obtained from different sources.
- (III) The student clearly communicates, orally and in writing, what he or she learned.

A student may not “recycle” a paper he wrote in one math (or non-math) class to fulfill their Capstone requirement because it violates (??) above. If a student wants to choose a topic he studied in, say Advanced Calculus or Linear Algebra, he is expected to extend the topic past the point that it was covered in class.

While researching or working through a Capstone project, a student should amass a collection of resources and references. The MTCS division expects a Capstone project to have at least three references, not all of which are of the same type (*e.g.*, textbooks). These sources should be referenced in their paper.

Very few Capstones will contain knowledge that is new to the mathematical community, but all Capstones should have mathematical content. A Capstone project without mathematical content, or whose mathematical content is veiled from the reader (*e.g.* exists entirely in a C++ program), will be rejected by reviewers.

2.1 Examples and Non-examples

Here are some examples of project that would be considered acceptable:

The student may undertake research in collaboration with a faculty member.

The project may be further study of an area of interest to the student. For example, someone interested in combinatorics could study, and report on, design theory.

The project might be an application, new or old, of mathematics. For example, the student could learn about the application of linear algebra to Markov chains.

The student could base his or her report on an article in *The Mathematical Monthly*.

During the summer, the student participates in a special mathematics program for undergraduates, such as an REU.

Some projects that would not be acceptable might include:

An unadorned computer program would be unacceptable. A nontrivial program, in conjunction with a paper explaining the mathematics involved might be acceptable.

A summary of an article, or a book report, might be inadequate. As stated above, the student should synthesize material from different sources. The project certainly could be based on a single article or book, but at the very least, the material should be placed in an appropriate context.

A report on the history of some mathematics might or might not be acceptable. One of the criteria above is that the student learn some mathematics (not just history). A history that demonstrates the student's mastery of the mathematical issues involved would be good.

Past Capstone projects are available for students to browse. Please do not remove others's Capstone papers from the MTCS division area.

3 The People and their Roles

Each Capstone project requires the coordinated effort of several people. Undoubtedly the most important person in the student. She is carrying out a very important project required by the major. The next most important person is her Capstone supervisor; the person to provide direction to the student when she feels lost, encouragement when she is dragging her

feet, and feedback on the work she produces. Other people who play supporting roles include the Capstone coordinator, a math faculty member who coordinates the student's project and its associated products among the supervisor and two project reviewers. These reviewers usually work in anonymity, but may reveal themselves to supervisor and student if they choose. The reviewers read, critique, and (hopefully) approve both the student's Capstone proposal and the final Capstone paper.

3.1 Capstone Ins-and-Outs

Completing the Capstone project is the student's responsibility. Each student is responsible for ensuring their Capstone project is started and finished on time and that work progresses according to the guidelines set out by the MTCS division. The MTCS division deadlines are listed below.

For Spring or Summer Graduation:

By midterm, Fall Semester	Submit proposal (in writing)
By last day of Fall semester classes	Submit final draft of paper
By the last day of Spring semester classes	Give presentation

For Fall Graduation

By midterm, Spring Semester	Submit proposal (in writing)
By last day of Spring semester classes	Submit final draft of paper
By the last day of Fall semester classes	Give presentation

The first step in the Capstone project is unremarked upon in the above charts. First, a student must find a project. Often finding a project coincides with finding a Capstone supervisor because a supervisor either has ideas ready for her next Capstone student, or because she can help her Capstone student whittle down the Capstone topic choices.

Once a student has a topic and a supervisor, and perhaps after he has done some reading or research, he is ready to write a proposal.

3.1.1 The Capstone Proposal

The Capstone proposal is a short (200-500 word) description of the specific topic a student intends to undertake as their Capstone project. In it the student will demonstrate some knowledge of the subject, and he will lay out the questions he hopes he will be able to answer or the general topic he intends to investigate.

A required part of the proposal is a bibliography of no fewer than three items. In the spirit of (??), these items should represent different types of sources.

Before a student may submit their proposal to their Capstone coordinator, her supervisor must sign their proposal. This indicates to the MTCS division that both student and supervisor agree that the proposal topic is worthy of study.

The student's Capstone coordinator will deliver the student's proposal to the project reviewers, who will then read the project and try to decide if it meets the criteria (??)-(??),

above. If it does, they will pass the proposal and perhaps pass comments on to the student. If a reviewer feels that the proposal does not indicate that criteria (??)-(??) will be met, she may suggest revision to the student that will move the proposed project toward passing. The student must then revise his project and proposal, and he must resubmit his proposal to both reviewers.

3.2 The Capstone Paper

Once the proposal is passed, the student should work on the project to the best of their ability, rationing their time and effort so that he can meet the deadlines as outlined above (page ??). During this time, the Capstone supervisor will primarily provide guidance. He may have helped in the choice of project (*e.g.*, by suggesting articles to look at), and may need to provide encouragement or suggestions at difficult moments. The capstone supervisor and student may choose to meet regularly to discuss the student's progress on the project. The amount of assistance needed will naturally vary between students and Capstone topics, but the project belongs to the student not to the Capstone supervisor. Completing the Capstone project is the student's responsibility.

The culmination of the Capstone project is a written paper and, later, a presentation. The paper must be typeset (*e.g.*, using L^AT_EX or Microsoft Word) and must consistently follow some stylistic convention (*e.g.*, MLA, AMS, or some such). The length of papers may vary.

Once both the Capstone student and supervisor are satisfied that the project and paper are complete, they may submit the paper for review. The Capstone coordinator will deliver a copy of the paper to each of the two reviewers. In about one week, the reviewers will return the paper to the student with comments and a one of the following grades:

- 1 – Pass without revisions
- 2 – Pass with suggested but nonbinding revisions
- 3 – No-Pass, with suggested and binding revisions. Resubmit.
- 4 – Fail.

At this point the student will, if necessary, revise their paper and resubmit it to their Capstone coordinator for another round of reviewing. The revision-resubmission process can continue indefinitely, but rarely goes round more than three times.

Once a reviewer assigns a score of two or lower (see above), we say that the reviewer has passed the Capstone paper. The student no longer needs to submit drafts to that reviewer. When both reviewers have passed the paper, the student is free to schedule a public presentation of their work. (The student should be preparing for the presentation during the review process.)

Publicity for each talk should reach classmates and MTCS division faculty, but it can extend beyond the division. Each Capstone student is responsible for publicizing their talk, but most Capstone supervisors would be willing to help (*e.g.*, making xerox copies of posters).

A Capstone presentation should be 25-50 minutes in length, and should be given in a relatively professional style. The student's talk can be a simple chalk-and-slate based talk, or it can employ overheads or computer slides (*e.g.*, PowerPoint). Writing and performing a good talk is an art, and a student should consult their supervisor on the best way to do this. Going to other peoples's talks is one of the best ways to learn how to give a good talk. Go to other students's Capstone presentations, Colloquius, Visiting Distinguished Scholars's talks, *etc.*

4 Final Notes

Students should seek out a Capstone topic and a Capstone supervisor as early as they can. It is not too early to do this during the second semester of your Junior year.

An outstanding project might also satisfy the one of the MTCS division's requirements for earning graduation honors.

Faculty in other disciplines can serve as supervisors.