The University of Southern Mississippi

Detailed Assessment Report
2010-2011 Computational Sciences (Mathematics) PhD

Mission/Purpose

The program is designed to provide graduates with a knowledge base in computational science, with an emphasis in computational mathematics.

Student Learning Outcomes, with Any Associations and Related Measures, Achievement Targets, Findings, and Action Plans

O 1: Ability to conduct research in the field

Students will have the ability to conduct research in their field of emphasis in applied and computational mathematics.

Related Measures:

M 1: Prospectus presentation

The prospectus presentation provides the graduate candidate the opportunity to present their proposed research for the PhD, fully outlining the goals and objectives of the research. As such, it constitutes a formal research proposal to the student's Graduate Committee, and thus constitutes the first formal measure of the student's progress toward becoming fully qualified in research. The student's Graduate Committee is charged with determining whether the student: 1) is ready for the proposed research based on the student's colloquium presentation of the Prospectus, and based on oral questioning of the student in regard to the proposed work, as well as background questioning in the student's area of mathematical specialization.

Source of Evidence: Presentation, either individual or group

Achievement Target:
We require 20% of all doctoral students to attempt the Prospectus presentation and achieve a pass within one year of entering the program, and 50% to achieve this target within two years, and 90% to achieve this target within 3 years.

Findings (2010-2011) - Achievement Target: Not Met
Among our 4 current doctoral students, only one (25%) has attempted and passed the prospectus presentation within 3 years of entering the program.

Related Action Plans (by Established cycle, then alpha):
For full information, see the *Action Plan Details* section of this report.

Regular communication between graduate coordinator and students/faculty advisers about milestones
Established in Cycle: 2010-2011
For current PhD students, research is already well underway, but the student and adviser have not yet gotten around to preparing...

M 2: Dissertation defense

The defense of the dissertation is the culmination of the student's research work, and presents an opportunity to fully examine the student's ability to be original and creative in their selected

field of specialization within applied and computational mathematics. The student's Graduate Committee provides this assessment based on the review of the dissertation, the students oral summary presentation of the material, and a line of questioning of the student constituting an oral exam which is designed to determine the merits of the student's research.

Source of Evidence: Presentation, either individual or group

Achievement Target:
The baseline effort to complete the PhD in Applied and Computational Mathematics is 3 years after the MS degree. A measure of high achievement is to have 50% of the PhD candidates achieve this target in regard to time to the degree with 90% achieving the PhD within 4 years post MS.

Findings (2010-2011) - Achievement Target: Met
The only PhD student who graduated during the 2010-11 cycle defended the PhD within three years of entering the program.

M 3: Research support

An external measure of the research productivity of the PhD graduate program is reflected in the number of students who are assigned to Research Assistantships funded through external grants or awards.

Source of Evidence: Academic indirect indicator of learning - other

Achievement Target:
20% of the PhD students will be supported by Graduate Research Assistantships or other external scholarships or awards.

Findings (2010-2011) - Achievement Target: Met
Of the four current PhD students, one (25%) is supported by an external scholarship.

M 4: Non-refereed publications

The importance of being engaged in ongoing research, and the ability to participate in this is measured through the student's ability to produce technical papers which outline progress toward a more substantive refereed publication. Thus, student publication in non-refereed venues, e.g., proceedings articles, transactions articles, etc., provide a direct measure of student involvement and progress in research.

Source of Evidence: Academic direct measure of learning - other

Achievement Target:
Three non-refereed papers submitted and accepted for publication before graduation from 33% of the students in the program prior to graduation, two non-refereed papers from 66% of the students before graduation, and one non-refereed publication from 90% of the students before graduation. Papers

Findings (2010-2011) - Achievement Target: Met
Our only graduate during the 2010-11 cycle submitted more than three non-refereed articles prior to graduation.

M 5: Refereed publication

Research quality is ultimately determined by an ability to sustain and achieve peer reviewed publications in the student's field of expertise in applied and computational mathematics.

Source of Evidence: Academic direct measure of learning - other

Achievement Target:
50% of students will submit one publication to a refereed journal before graduation (either joint with their Graduate Advisor or as a single author), and 70% of students will have an accepted refereed publication within their first year after graduation.

Findings (2010-2011) - Achievement Target: Not Reported This Cycle
Beginning in Fall 2011, new students will be encouraged to work toward publication of their research beginning at orientation, and graduate faculty will be advised of this achievement target.

M 6: Post degree research productivity

Graduates of the PhD program who enter academia will continue to develop and expand on their research in their areas of specialization, as well as develop new areas. The most representative measure of success in this is the publication record of the new faculty member, and in mathematics, the refereed, i.e., peer reviewed article, is the most consistent measure of the new faculty member's research productivity.

Source of Evidence: Academic indirect indicator of learning - other

Achievement Target:
Graduates pursuing academic careers (post-doctoral positions or tenure track positions) will have one refereed publication within two years of graduating.

Findings (2010-2011) - Achievement Target: Met
The only student who graduated during the 2010-11 cycle (and the only recent graduate of the program) has multiple refereed journal publications since graduation.

O 2: Ability to teach effectively

Students will have the ability to teach effectively.

Related Measures:

M 7: Student satisfaction with teaching

Classroom teaching represents one of the two primary attainment targets in regard to turning out qualified professionals with the PhD degree (the other being research). While research is usually emphasized, the ability to teach at the college and university level in a classroom setting is an essential part of the education and training process in the Department for all graduate students.

Source of Evidence: Student course evaluations on learning gains made

Achievement Target:
Classroom teaching student evaluations will be commensurate with the Department of Mathematics mean (1-5 scale, with 5 being the highest score). The overall results on these student evaluations for experienced faculty in the Department is a score of 3.0 or higher,

thus a measure of 50% of the PhD Graduate Teaching Assistants (GTAs) earning an average student evaluation score of 3.0, or higher is required.

Findings (2010-2011) - Achievement Target: Met
Of the two GTAs in the program during the 2010-11 cycle, two (100%) earned an average student evaluation score of above 3.0 (3.22 and 3.64, respectively).

M 8: Faculty observation of teaching

Students who are GTAs are required to have one semester of MAT-500. This class is designed to prepare students for teaching, and involves several opportunities for observational assessment of teaching to a lesson plan.

Source of Evidence: Presentation, either individual or group

Achievement Target:
100% of GTAs will receive a faculty assessment of 3 out of 5 on their faculty teaching evaluations in MAT-500. 50% will achieve a rating of 4 out of 5 or higher. The rating scale is 1 to 5 with the highest score being a 5. The scores measures a composite assessing the students presentation skills, ability to cover the material in a timely well paced fashion, and the ability to interact well with student questions.

Findings (2010-2011) - Achievement Target: Not Reported This Cycle
Currently MAT 500 does not include quantitative rating of student-teacher presentations. This will be introduced beginning with the next installment of the course in Spring 2012.

M 9: Diversified teaching experience

Doctoral students must have a diversified teaching experience covering a range of introductory undergraduate courses. This diversity contributed to their capacity to teach various types of students as well as providing a broader measure of their teaching abilities for those interested in careers in academia. This diversity is measured by the number of different teaching preparations a graduate teaching assistant has in each year, and overall while completing their degree requirements. Each student is provided one point for each new preparation.

Source of Evidence: Academic direct measure of learning - other

Achievement Target:
70% of Doctoral Graduate Teaching Assistants teach at least two different classes each year, i.e., achieve at least two points in teaching diversity each year (this excludes those on Research Assistantships).

Findings (2010-2011) - Achievement Target: Not Met
Of the two doctoral graduate teaching assistants currently in the program, one (50%) taught two different courses during the 2010-11 cycle.

Related Action Plans (by Established cycle, then alpha):
For full information, see the *Action Plan Details* section of this report.

Diversity in Teaching Assignments
Established in Cycle: 2010-2011
When assigning graduate teaching assistants to courses each semester, a conscious effort will be made to assign students to cour...

O 3: Mastery of computational mathematics

Students will have mastery of applied and computational mathematics.

Related Measures:

M 10: Mathematics Comprehensive Exam

The Mathematics Comprehensive Exam is designed to assess student attainment in having developed a mastery of fundamental concepts in mathematics, including those in analysis and algebra, essential for further study and research in applied and computational mathematics.

Source of Evidence: Comprehensive/end-of-program subject matter exam

Achievement Target:

80% of students pass the Comprehensive Exam on their first try, 90% pass on the second attempt.

Findings (2010-2011) - Achievement Target: Met

All current PhD students who have taken the comprehensive exam (100%) have passed on their first attempt.

M 11: Software utilization

Students demonstrate proficiency in the use of software associated with a variety of fundamental numerical algorithms covered in MAT-772, Numerical Analysis for Computational Science.

Source of Evidence: Project, either individual or group

Achievement Target:

70% of students will achieve a grade of 4 or above on software utilization and knowledge of algorithms and technology. The rubric used requires assigning a figure of merit of 1 to 5 (highest) to each fundamental algorithm covered in MAT-772 on which the student is required to complete an assignment. A minimum of 3 separate algorithms will be assessed, and the students score is the average of these.

Findings (2010-2011) - Achievement Target: Not Reported This Cycle

This rubric will be introduced in the next instance of MAT 772, in Fall 2011.

O 4: Interdisciplinary knowledge of computational science

Students will have the ability to work in or work with at least one additional field in computational science, e.g., computer science, biology, physics, chemistry.

Related Measures:

M 12: Participation in interdisciplinary coursework

Students will participate in a minimum of two extra-curricular computational science courses.

Source of Evidence: Academic indirect indicator of learning - other

Achievement Target:
90% of students will take two computational science courses outside of the Department of Mathematics.

Findings (2010-2011) - Achievement Target: Not Met
Of current PhD students, none have taken computational science courses outside of the department, except for the required tools courses (COS 701, 702, 703) and seminar course (COS 740).

Related Action Plans (by Established cycle, then alpha):
For full information, see the *Action Plan Details* section of this report.

Adding "application area" requirement
Established in Cycle: 2010-2011
The department is undergoing an overhaul of its graduate curriculum and program requirements. In particular, PhD students will ...

M 13: External interdisciplinary research
Participation in outside or collaborative interdisciplinary research with industry, other universities, or laboratories in areas outside of core mathematics areas.

Source of Evidence: Academic indirect indicator of learning - other

Achievement Target:
20% of students associated with the program will engage in externally affiliated research.

Findings (2010-2011) - Achievement Target: Not Reported This Cycle
Beginning in Fall 2011, students will be encouraged to pursue externally affiliated research, and their advisers will be encouraged to assist them in obtaining such opportunities.

O 5: Oral and written skills in a professional setting
Students will have effective oral and written communication skills before a professional audience.

Related Measures:

M 14: Written performance in tools classes
Students will master the techniques and tools required for professional publication in applied and computational mathematics as measured by the COS-701 Tools Class. This class covers professional publication using Latex, generating figures, plots and data for use in various journal formats.

Source of Evidence: Senior thesis or culminating major project

Achievement Target:
100% of students will be able to utilize Latex to write their dissertation or a professional article using Latex after having taken COS-701 as demonstrated by student's utilizing the Department's Dissertation and publication package, or by having an article accepted for publication done in Latex.

Findings (2010-2011) - Achievement Target: Met
The only PhD student who graduated during the 2010-11 cycle (100%) used Latex and the department's dissertation package for her dissertation, and also used Latex on accepted publications.

M 15: Publication record
Students participate in professional publication at all levels in professional journals.

Source of Evidence: Academic direct measure of learning - other

Achievement Target:
All students generate at least one external accepted publication before graduation.

Findings (2010-2011) - Achievement Target: Met
The only student who graduated during the 2010-11 cycle generated an external accepted publication prior to graduation.

M 16: Participation in conference presentations
Conference presentations provide students the opportunity to learn to speak and communicate effectively in a public setting.

Source of Evidence: Presentation, either individual or group

Achievement Target:
70% of all students participate in an external (regional, state, national or international) conference at least once every two years.

Findings (2010-2011) - Achievement Target: Not Met
Of the five students who have been in the program during the last two years, two (40%) have participated in a conference.

Related Action Plans (by Established cycle, then alpha):
For full information, see the *Action Plan Details* section of this report.

Encouraging students to present their research
Established in Cycle: 2010-2011
Beginning at orientation during their first semester, students will be advised of the importance of being able to present their ...

M 17: Seminars and colloquia
Students provide at least one Departmental or College-wide seminar or colloquium each year after their first year of graduate study. The formal lecture is a difficult venue to master, and having numerous opportunities to engage in the process is necessary.

Source of Evidence: Presentation, either individual or group

Achievement Target:
90% of students provide one Departmental or College-wide seminar or colloquium talk each year after their first year of graduate study.

Findings (2010-2011) - Achievement Target: Not Met
Of the four students currently in the program, all of whom have been in the program for more than one year, one (25%) has presented at an on-campus seminar.

Related Action Plans (by Established cycle, then alpha):
For full information, see the *Action Plan Details* section of this report.

Encouraging students to present their research
Established in Cycle: 2010-2011
Beginning at orientation during their first semester, students will be advised of the importance of being able to present their ...

Action Plan Details for This Cycle (by Established cycle, then alpha)

Assessment
The present assessment instrument needs to be reexamined in light of the fact that the program is now housed in the department.

Established in Cycle: 2005-2006
Implementation Status: Finished
Priority: High
Implementation Description: May 2007
Completion Date: 06/27/2011
Responsible Person/Group: The Graduate Coordinator and the graduate mathematics faculty
Additional Resources Requested: None

Recruitment
There will be two students entering the program in the coming year. In order to create a critical mass of students in the program, the department must mount a recruitment effort. The focus should be worldwide as well as on the graduates from the department`s master`s program.

Established in Cycle: 2005-2006
Implementation Status: Finished
Priority: High
Implementation Description: May 2007
Completion Date: 06/23/2008
Responsible Person/Group: The Graduate Coordinator and the graduate faculty.
Additional Resources Requested: Funds for additional assistantships

Develop coordinated curriculum.
The MS and PhD curricula are in need of updating so as to optimize class scheduling because of the small class sizes, and changing program requirements.

Established in Cycle: 2008-2009
Implementation Status: Planned
Priority: High
Implementation Description: 2011. Currently (Fall 2011) we are attempting to revise our BS program to align it with the MS program so that it serves as a feeder for the MS programs. Concurrent with this effort we are revising the Graduate Program starting in Fall 2011.
Completion Date: 07/02/2012

Responsible Person/Group: Graduate Coordinator and Curriculum Committee Chair.

Adding "application area" requirement

The department is undergoing an overhaul of its graduate curriculum and program requirements. In particular, PhD students will now be required to take at least 6 units of computational science courses outside of the department (and beyond required tools courses and the seminar course). The graduate coordinator has already identified several courses in the physics department and the school of computing that would be suitable for fulfilling this requirement, and do not burden the students with prerequisites. It is anticipated that this requirement will take effect beginning in the 2012-13 academic year, the first year in which it can be included in the Graduate Bulletin, after review of the list of suitable courses by the faculty.

Established in Cycle: 2010-2011
Implementation Status: Planned
Priority: High

Relationships (Measure | Outcome/Objective):
Measure: Participation in interdisciplinary coursework | **Outcome/Objective:** Interdisciplinary knowledge of computational science

Implementation Description: The departmental curriculum committee will review the courses in other departments, particularly PHY, CSC and CSS, and modify its Graduate Bulletin entry to list a requirement of taking a minimum of 6 units chosen from approved courses.
Completion Date: 06/01/2013
Responsible Person/Group: Graduate coordinator (James Lambers), Curriculum committee chair (Sungwook Lee)
Additional Resources Requested: N/A
Budget Amount Requested: $0.00

Create new assessment criteria and document.

The objective was to implement a new assessment process is put in place beginning in AY 2008-2009. Starting with AY 2010-2011 we have established a revised set of outcomes and associated measures and achievement targets.

Established in Cycle: 2010-2011
Implementation Status: Finished
Priority: High
Implementation Description: AY 2010-2011
Completion Date: 06/27/2011
Responsible Person/Group: Department Graduate Coordinator.

Diversity in Teaching Assignments

When assigning graduate teaching assistants to courses each semester, a conscious effort will be made to assign students to courses that they have not previously taught; this was not a criterion in previous semesters.

Established in Cycle: 2010-2011
Implementation Status: Planned
Priority: Medium

Relationships (Measure | Outcome/Objective):

Measure: Diversified teaching experience | **Outcome/Objective:** Ability to teach effectively

Implementation Description: For each graduate teaching assistant, a list will be maintained of all courses that they have taught to date. When assigning courses for each new semester, courses on each student's list will be excluded from consideration unless it makes completion of the teaching assignments impossible.
Responsible Person/Group: Graduate coordinator (James Lambers)
Additional Resources Requested: N/A
Budget Amount Requested: $0.00

Encouraging students to present their research

Beginning at orientation during their first semester, students will be advised of the importance of being able to present their research at seminars and conferences, and will be encouraged to work with their adviser to produce and schedule such presentations as research progresses.

Established in Cycle: 2010-2011
Implementation Status: Planned
Priority: High

Relationships (Measure | Outcome/Objective):

Measure: Participation in conference presentations | **Outcome/Objective:** Oral and written skills in a professional setting
Measure: Seminars and colloquia | **Outcome/Objective:** Oral and written skills in a professional setting

Implementation Description: See description.
Responsible Person/Group: Graduate coordinator (James Lambers)
Additional Resources Requested: N/A
Budget Amount Requested: $0.00

Regular communication between graduate coordinator and students/faculty advisers about milestones

For current PhD students, research is already well underway, but the student and adviser have not yet gotten around to preparing and presenting a prospectus. To remedy this situation in future cycles, the graduate coordinator will impress upon new students that they must complete a prospectus in a timely manner, and regularly remind students and faculty advisers about sticking to degree-related timelines as stated in the Graduate Bulletin.

Established in Cycle: 2010-2011
Implementation Status: Planned
Priority: High

Relationships (Measure | Outcome/Objective):

Measure: Prospectus presentation | **Outcome/Objective:** Ability to conduct research in the field

Implementation Description: The annual graduate student orientation will be augmented with information about degree milestones, and students will be urged to find advisers and select a project within the first year. Each semester, the graduate coordinator will send email reminders to PhD students and their advisers about these milestones, particularly the prospectus.
Responsible Person/Group: Graduate Coordinator (James Lambers)
Additional Resources Requested: N/A

Budget Amount Requested: $0.00

Analysis Answers

What specifically did your assessments show regarding proven strengths or progress you made on outcomes/objectives?

Proven strengths shown by our assessments include: 1. Effectiveness at teacher training. In spite of their lack of experience, Graduate Teaching Assistants consistently earned ratings from student evaluations that are comparable to average ratings earned by faculty. 2. Training in mathematical software. Students completed the MS program with the knowledge of software needed to create mathematical articles and presentations. As we have had only one recent graduate, we do not have sufficient data from this cycle's assessments to determine whether the overall proficiency in research of students in the program can be considered a strength, or an area that needs further attention, even though the data from the one graduate is very promising. As the number of students in the program is about to dramatically increase with 5 new students entering in Fall 2011, future reporting cycles will provide enough data to make this judgment.

What specifically did your assessments show regarding any outcomes/objectives that will require continued attention?

These objectives will require continued attention: 1. Students are taking longer than desired to complete the program. Generally it is intended that students take three years beyond the Master's to complete the PhD, but our current students are on track to need 4-4.5 years, and have waited until their third year to complete the comprehensive exam. That meets the letter of our current requirements, but is not conducive to finishing in a timely manner; this requirement will be changed so that the comprehensive exams must be completed sooner. Students will be strongly encouraged to quickly complete all required coursework for the comprehensive exams, and initiate their dissertation project with an adviser during the first year in the program. 2. Students need more practice disseminating their work through presentations at seminars or conferences, while they are a student, to better prepare them for their careers, especially if they desire a career in academia. Students currently have the foundation for such activity, as they are proficient in necessary software and are productive in terms of the actual research needed for the dissertation, so what remains is to encourage students and their advisers to translate this foundation into output in the form of such presentations. 3. Students need more diversity in their background, including from their coursework and teaching duties. Graduating PhDs who seek academic careers must show a variety in their teaching portfolio to secure faculty positions, so we need to make teaching assignments accordingly. Programs in computational science at other universities tend to require students to take courses in application areas in order to acquaint students with the use of computational techniques in the contexts in which they are applied in the "real world", so a similar requirement will be added to our program. 4. The department needs to secure more external support for students in the PhD program. Although the stated target was met, it was barely met, and the bar was not set very high. In order to continue to meet or exceed it, additional efforts must be made to pursue funding from a variety of sources, so that GTA appointments can be used primarily for MS students as intended.

Annual Reports

Program Summary

The Department of Mathematics had historically run an MS program with about six students in the program at any one time. The introduction in 2005-2006 of the Computational Sciences PhD with an emphasis in Mathematics offered through the College of Science and Technology, but administered through the Department of Mathematics for doctoral students pursuing the PhD in Applied and Computational Mathematics has posed growing pains, and has introduced complexities into the

administration and oversight of the graduate programs managed by the Department. Prior to this the Department participated in the doctoral level Scientific Computing Program which was devolved to the departments of Mathematics, Computer Science and Physics when the Computational Science Program was created. This devolution resulted in the majority of the doctoral students becoming affiliated with the Computer Science program, leaving only one or two students in the initial few years interested in pursuing a PhD in Applied and Computational Mathematics offered by the Department through the Computational Science Program. Thus regaining momentum while restructuring the program due to the loss in credit hour generation at the doctoral level has been difficult (in the new Computational Science Program, doctoral students associated with the emphasis in Computer Science were not required to take any PhD level math courses, unlike the case with the Scientific Computing Program). While this year we now have 10 graduate assistantships to offer, these are split between the MS and the PhD programs. Since the MS program is also a feeder for the PhD, the MS program has proven effective at increasing the number of PhD candidates who are presently enrolled in our program, however this comes at the expense of being able to bring on enough MS candidates for the next cycle (an MS student completes the degree in 2 years, while the PhD is of indeterminate length, although the objective is to have the student finish in about three years after the MS degree). In addition we have had only limited success at getting our PhD students onto externally funded grants. Taken together, the growth of the PhD program (5 new candidates entering in Fall 2011, joining 4 current candidates) comes at the expense of the MS program. Running the MS program with only 5 candidates is the minimum we can have. Overall, the performance of the PhD program has improved, as measured by the number of students involved in the PhD program. We have had our first graduate in 2010, and we anticipate being able to turn out one to two candidates on a yearly basis into the future. We are also managing to find some external funding for some of our PhD students, although the percentages are still unacceptably low in order to maintain long term stability.

Continuous Improvement Initiatives

The PhD program is being reviewed to streamline and improve the curriculum. The initial review process was begun in June, 2011, and it is expected to take about one year to get any proposed curriculum changes through faculty review, College review, and review by Graduate Council at the University level. The improvements are needed to: 1) improve coordination between the MS and PhD programs, 2) strengthen the curriculum of the students doing the PhD degree, and 3) improve the throughput of the program in terms of the time to degree. Specifically, we propose to introduce administrative guidelines to monitor student progress through the degree, and to more strongly encourage and develop mechanisms to increase participation on research through publication and attending conferences as part of the graduate student experience. In part, this latter point is more tenable since we have hired 5 new faculty in the past 5 years, providing us a large base of faculty willing to work with graduate students on research. In order to better prepare students for their careers, particularly in academia, the department will impose new requirements that will enhance the diversity of students' overall experience. Specifically, they will be required to take some courses in computational science outside the department, such as in physics or computer science, so that they will be better prepared to apply their knowledge in new contexts. Furthermore, GTAs will be required to teach multiple courses, so that they can learn how to balance the responsibilities of classroom preparation and advancing their research.

Closing the Loop

The Outcomes, Measures and Attainment Targets listed in many of the previous assessment reports were deemed to be altogether too reliant on surveys (student surveys, alumni surveys). Given the small number of graduates, these proved difficult to utilize. Instead, we have decided to restructure our annual assessment using direct measures of student performance in areas that measure teaching and research effectiveness. In the longer term, these should provide us a better sense of where our strengths and weaknesses lie, as well as to provide the necessary feedback to improve our program.

The additional programmatic changes being considered for the graduate programs also reflect an awareness by the faculty of the need to align and streamline the program to so that its overall productivity is increased.