

SOUTH DAKOTA BOARD OF REGENTS

Academic and Student Affairs

AGENDA ITEM: 6 – U

DATE: March 30 – April 1, 2016

SUBJECT: Program Review Report – SDSM&T

The system has established a process requiring periodic reviews of all programs offered. A primary purpose for these reviews is to continuously improve the quality of all educational programs. Periodic program review involves stakeholders in an analysis of past performance which is used to inform present and future directions and decision-making. The review process is integrated with strategic planning and budgeting, with regional and specialized accreditation processes, and with student-learning outcome assessment. The system's processes require each campus to maintain a schedule that indicates the time frame for the review of every program offered.

For each review, representatives of the program completed a self-study driven either by the system's guidelines or by those of an external accrediting body, if applicable. An external review was engaged to evaluate the program using both the self-study and interviews of constituents. In each case the reviewer prepared a report of findings and the campus then prepared a response.

For each program reviewed, the reviewer's report and institutional response is attached.

South Dakota School of Mines and Technology

- B.S. in Applied and Computational Mathematics (Attachment I)

RECOMMENDED ACTION OF THE EXECUTIVE DIRECTOR

Information only.

PROGRAM REVIEW REPORT TO BOARD OF REGENTS

***Due 30 days following receipt of the External and Internal Reviewers' Report.
This form is available electronically.***

This report is filed with the Board of Regents Office. All units/programs undergoing an accreditation review, nationally recognized review process or institutional program review need complete this form. The Dean or Department Head must approve this report and submit it to Academic Evaluation and Assessment for approval and submission to the Board of Regents.

Institution: South Dakota School of Mines & Technology

Department or School: Department of Mathematics and Computer Science

Program(s) Reviewed: B.S. of Applied and Computational Mathematics

Date of Review: March 4 – March 5, 2015

Please identify the program reviewers and any external accrediting body:

Marie M. Vanisko Mathematics Professor Emerita, Carroll College, Helena, Montana, Program Reviewer for the Mathematical Association of America (MAA)

Items A & B should address the following issues: mission centrality, program quality, cost, program productivity, plans for the future, and assessment of progress.

A. Describe the strengths and weaknesses identified by the reviewers.

The review does validate the central role of our program to the mission of the university. All majors on campus require calculus and many majors require 15 credits or more of mathematics. The applied nature of the mathematics program integrates the curriculum successfully with the other majors on campus and many of the upper level electives are taken by students from other majors. The design of the curriculum is a clear strength and the reviewer was impressed on the amount of mathematics that is included in the major.

The reviewer did identify the quality of the faculty and their passion for teaching as the primary program strength. This is a direct connection to program quality and she has positive comments regarding our assessment activities and our undergraduate research program. She did agree with our concern on the stress of a growing enrollment for the campus has had in the pre-calculus classes and was pleased to learn of the administration's commitment to invest personnel resources to help address this issue. One of the recommendations from the reviewer encouraged further consideration on the use of technology in classroom and the department completely agreed with the point that the vast majority of the classrooms on campus are less than ideal for using technology in a mathematics class. The key issue is the fact that most classrooms do not allow free hand writing display and computer projection display at the same time. The vast majority of computer projection systems are placed in the middle of the front board which prevents faculty from writing equations and diagrams while using math software to conduct the analysis. The department did have a meeting on May 5 to see a demonstration of Smart Board Technology in order to investigate the capabilities of the technology and how it might alleviate the problems present in the current classroom design. The department does have a spirit of innovation and any technology that has a positive impact on student learning is welcome.

Another indicator of program quality is the participation and performance of our students in international academic competitions. The William Lowell Putnam Mathematics Competition is held every December and actively recruits the most talented undergraduate mathematics students in the United States and Canada to participate. The Putnam competition basically involves students taking two tests over the course of six hours on a Saturday. The tests are centered on theoretical mathematics and the majority of the thousands of students taking the test score a 0. The SDSM&T campus regularly competes in this competition and has performed well in this competition, which is evident over the past 16 years the School of Mines has had a team ranked in the top 150 three different times with over 400 teams participating in any given year. It is doubtful that any other college in South Dakota has a similar record. The second international academic competition is the Mathematical Contest in Modeling (MCM), which is a global competition held every February. The MCM has thousands of teams compete with a majority of these teams being from outside the United States. The contest is focused on building a mathematical model to help answer a very broad question, for example, the task from the most recent contest is to formulate a model that can be used to evaluate the eradication of Ebola. The planning and logistics of deploying a vaccine to a large region in order to eradicate a very contagious disease involves many factors: population density, transportation infrastructure, distribution networks for the vaccine, participation of the population to get vaccinated, and many other issues can contribute to the success of a vaccination program. The student teams were asked to develop a mathematical model and then run simulations to analyze their results. The competition concludes with the student teams writing a technical paper that is judged by a large team of judges. The School of Mines regularly participates in the MCM and we have frequently finished in the top half of the teams that participate. The MCM has been a great way for students to apply their analytical skills and multiple teams have converted their work into conference presentations that bring additional recognition to the program and the university.

Program productivity was discussed relative to the courses taught and it was noted the growing enrollment in the service courses was a source of stress in terms of staffing, but also presented an opportunity in terms of recruiting students to the major. The fact the university attracts the best and brightest mathematics students in the region results in a target rich environment for recruiting interest in an applied math degree. The work to recruit double majors and the emphasis on supporting talented students in the classroom was a strategy the reviewer supported and she suggested other strategies for growing the program. The size of the program was one weakness that she shared since the structure of the program forces many of the upper level classes to be offered every other year. A larger program would provide more flexibility and the department continues to actively recruit students to the program. However, the program has remained stable and data indicates slight enrollment growth over the past few years.

Plans for enhancing recruitment and improving placement continue to dominate the activities of the program committee. The mathematics faculty continue to actively recruit talented students within their classes and the department continues to advocate for scholarship support. The department has worked to improve the recruitment brochures given to prospective students and continues to emphasize the co-curricular activities offered on campus to provide characteristics that make the program more distinctive to prospective students.

B. Briefly summarize the review recommendations.

The recommendations from the external reviewer: continue to strengthen recruitment activities; continue to explore ways to incorporate the use of technology in the classes; continue to strengthen the undergraduate research component of the curriculum and consider some designation that honors students that conduct truly original research work.

The review process did allow us an opportunity to evaluate the centrality of the program. The specialized structure of the program does lean heavily in the direction of computing, but it still remains the case that most of the employment opportunities heavily rely on proficiency in computer programming. The program committee continues to carefully considered options in regards to the upper level courses and the balance between theoretical and applied courses is still one of the strong features of the program. The addition of the Data Analysis course is an example of the continued effort to align the degree with industry interests.

The review process also provided evidence that program quality remains high. The placement of graduates is high and the average salary offers are generally higher than the national average for math programs. The size of the program does inhibit frequent offerings of the upper level electives, but the smaller size does allow for every student to participate in an undergraduate research experience. The undergraduate research experience is a very distinctive feature that promotes a great deal of pride amongst faculty and students.

Program cost is very small since the upper level electives are only offered every other year and entail two courses a semester. This requirement is very modest considering the large number of service courses within the department. In addition, the upper level electives are often taken by students outside the major and so the added value of opportunity of these course to all students is a campus benefit that cannot be ignored.

The analysis on program productivity reveals a stable graduation rate and the high placement rate provides evidence that graduates of the program are in demand. The plans to enhance recruitment and retention should help strengthen program productivity and the branding to emphasize the distinctive quality of our program should assist with placement and recruitment.

C. Indicate the present and continuing actions to be taken by the college or department to address the issues raised by the review. What outcomes are anticipated as a result of these actions?

The department has employed a fairly comprehensive strategy when it comes to the recruitment of students to the B.S. in Applied and Computational Mathematics. The department has invested considerable time and resources developing printed materials and web materials to help educate prospective students on the program. In addition, the department has an active Facebook group page and the department is one of the few active users of the EMAS system that is used by the campus admissions department. The department also managed to establish a recruiting scholarship, The Grubby Math Majors Fund, along with an active participating in the Women in Science and Engineering (WISE) program. The math program partnered with the computer science program on a freshmen orientation course, CSC/MATH 110 in order to improve freshmen advising and improve retention in the major. A big challenge is retention since many

students talented in math will easily see a campus career fair full of employers hiring mostly engineering majors. The high priority that students have in regards to placement has attracted them to other majors since the number of employers that come to campus seeking graduates of a math degree is relatively small compared to the engineering majors. The department did create a new course, GES 186 – Job Shadowing, which is directed at first year students. This course is meant to provide students an opportunity to visit professionals in their field of study and learn what professionals do as part of their job. The class involves a research component and plenty of time is dedicated to developing their communication skills. This experience should help students develop their academic plan with their professional goals in mind and also give them a stronger network of contacts they can utilize when it comes time to hunt for a job.

The department continues to seek innovations in the use of technology in the curriculum. The department has established the use of online publisher software, MyMathLab, as part of the course content delivery for the introductory courses of College Algebra, Trigonometry, and Calculus 1. The curriculum guidelines also require the use of a computer algebra system, Maple, as part of Calculus 1 and Calculus 2 with required assessments of students to demonstrate basic skills. The mathematics major has a class that requires Matlab and the two semester sequence of probability and statistics requires the use of R, and open source statistical computing package. The department also encourages the use of video lectures to supplement course materials and several faculty use this technique to cover applications and emphasize examples that feature mastery of algebraic manipulation. The use of technology within the classroom continues to be a challenge since the classrooms are not designed for easy incorporation of the technology as part of a class presentation. The ability to write equations and diagrams is fundamental to discussions in mathematics, but such activity is not possible in a fixed computer projection environment that features PowerPoint or projection of active desktop sessions using Maple. Advances in technology should make these obstacles smaller, but it still requires training and funding to properly deploy technology at a campus scale.

The undergraduate research component of the curriculum is clearly the capstone of the program and a source of pride for students and faculty alike. The ability of every student to complete a two semester project with individual help from a faculty member is a clear strength of the program. It must be noted that not all undergraduates are capable of conducting original research and so it is frequently the case the research projects often take the form of applying known theory in new situations rather than developing new theory. The external reviewer did recognize that it is rare for students to successfully conduct original research and she suggested students that did complete a research project that features original research to be given some type of special recognition. The reviewer thought some type of honors program would be the appropriate path to recognizing outstanding performance in undergraduate research. The department is reviewing options, but the discussions that were held in considering the reviewer recommendations produced several ideas related to incorporating more elements into the undergraduate research experience that will serve to strengthen communication skills and also foster more scholarly work in the first semester of the research program.

The B.S. in Applied and Computational Mathematics continues to be a high quality program that has a focus on skills that are in high demand in academia, industry, and government. The biggest challenge is forming the connections with employers that can utilize the skills of graduates that

have two semesters of computer programming, two semesters of probability and statistics, along with 55 credits in mathematics. The applied upper level required mathematics courses include: Mathematical Modeling, Partial Differential Equations, and Data Analysis. An economy that depends on data driven decision making and also the ability to handle the unexpected risk that can occur requires a professional workforce that has the skills encapsulated in the B.S. for Applied and Computational Mathematics. The review process has affirmed that our goals and objectives for the program are correct and the reviewer validated our assessment of the current status of the program. We are very much committed to continuing our work on this great program.

Submitted by: Kyle Riley Kyle Riley
Department Head

Reviewed by: [Signature] DEMITRIS KOURIS
Provost and Vice President for Academic Affairs

Approved by: [Signature] Kate Alley
Director of Academic Evaluation and Assessment

South Dakota School of Mines & Technology

Prepared by Marie Vanisko, External Evaluator

I. Introduction/Overview

I was invited to conduct a review for the mathematics program at South Dakota School of Mines and Technology in March 2015. Before traveling to the university, I was provided with many documents concerning the SDSM&T and the Mathematics Department itself. These documents included information on all courses taught and course requirements, along with lists of faculty teaching those courses and faculty resumés. There was a detailed explanation of the use of technology in courses and a description of the efforts made to improve the curriculum, including the program self study report. By reviewing these materials in advance and getting additional insights from Kyle Riley, the department chair, I was able to conduct the on-sight review in two days. Kyle did an excellent job of arranging my schedule so that I had the opportunity to have productive discussions with all members of the department, usually in teams of two, as well as with selected administrators and students. In all, this was a very rewarding experience and I am pleased to file this report as an external evaluator.

II. Program Evaluation

A. Mission Centrality

The mission of the mathematics program aligns itself with the mission of the university. The focus is to provide students with a firm understanding of mathematics. The Department's course content reflects a clear understanding of topics that must be covered to satisfy pre-requisites for later courses, both in mathematics and related disciplines. It is clear that serious ongoing discussion occurs among the faculty to make certain that objectives are being met.

B. Program Productivity

The Department has three categories of course offerings, not mutually exclusive"

1. College Algebra and Trigonometry:

These classes are offered to meet the needs of entering students who are not prepared to enroll in calculus. Faculty members who teach these classes are very concerned about how they can best prepare the students in these sometimes large sections. It is a challenge they take seriously

2. Calculus, Differential Equations, and other courses required by other departments:

These courses are structured to best meet the needs of the numerous engineering and science programs that require selected course for their majors. When it became clear that topics in linear algebra, although needed for some required courses, were not among the required courses, faculty members found a way to include necessary topics in the structure of other required courses.

3. Courses offered primarily for the mathematics major:

The courses required by the Department and the upper division electives provide the students with an excellent background for graduate school in mathematics or

for combining their mathematics with another discipline for either securing employment immediately after graduation or pursuing study in another graduate program.

C. Plans for the Future

One major focus is to address the needs of the students in the trigonometry courses. These sections are often large and the dropout and failure rate are higher than desired. The Department is considering adding recitation sessions and finding a way to make sure that the sessions are well attended by those who most need them. The Department has just learned that they will have an additional position to help meet these demands, as well as to make the sections smaller.

Faculty members are also considering ways in which they might attract more students to the major. This could be done specifically by encouraging good students to get a double major, by helping them understand the advantages of adding mathematics to their field of study. More majors would mean that upper division courses could be offered annually instead of bi-annually.

D. Assessment of Progress

The Department is reviewing the methods used for assessing student achievement. Gateway exams are used by some, especially in calculus, to validate students' understanding of important topics as they progress through a course. These procedures can play an important role in program reviews by outside accrediting agencies such as ABET.

III. Overall Assessment of Program

A. Strengths

I see the biggest strength of the Department as the outstanding faculty members. They have strong and diverse credentials and are dedicated to doing the very best job they can for all their students. I was especially impressed with their enthusiasm and respect for one another. The four students with whom I met were very pleased with the education they are receiving and the manner in which they are treated. In addition, the Department is very well regarded by the Administration, who realizes the importance of mathematics as playing a central role in supporting other disciplines.

B. Limitations

In its offerings that are required as support courses for numerous disciplines, the Department can make suggestions for changes in requirements, but cannot demand that those changes be made. However, for example, in the case of topics in linear algebra, the faculty members have found ways to incorporate essential topics in the required courses.

Another limitation, due to the small number of mathematics majors, is the need to offer many upper division courses only on alternate years. This creates problems with regard to pre-requisite knowledge that an instructor cannot assume a student has had. It can also make it difficult for students trying to complete all their requirements in a timely manner.

IV. Recommendations

My recommendations fall into three categories: recruitment, technology, course content.

A. Recruitment of New Majors

I suggest that information be gathered with regard to current upper class students and former students who are combining their mathematics with other disciplines and working or interning in fields that demonstrate the advantage of their mathematical background. Having a few vignettes of such students on the website could make new students aware of exciting new possibilities for mathematics majors. In selected classes, the inclusion of particular examples could get students in related majors thinking about how a more thorough understanding of mathematics could enhance their career choices.

B. Use of Technology in Courses

I suggest that faculty members, both individually and in groups, consider ways in which technology could be used to truly enhance the mathematical presentation of a variety of topics, with the goal of giving students a deeper understanding of important mathematical principles. If professors do not demonstrate that they value technology, students will not value it. One physical change that could assist the integration of technology would be the re-positioning of the screens in rooms, so that the boards and screens could be used simultaneously. When a room is newly painted, you might consider the type of paint that turns walls into white boards.

C. Course Content

I think that it is a good idea to allow students to select the topics for their research projects, under the guidance of an advisor. It can give them the opportunity to delve deeper into topics that interest them. My one suggestion would be that you find a way to distinguish between the projects that are primarily a review of the literature from those that are more thesis quality. If there were an honors designation, that would be a way to make that distinction.

I suggest that you continue your joint analyses of courses to determine if there should be changes in topics covered, as well as changes in presentation, for example, in the use of technology or the addition of recitation sessions.

V. Persons Interviewed

Department Members:

Kyle Riley (Chair), Martha Garlick, Peter Grieve, Debra Bienert, Julie Dahl, Travis Kowalski, Roger Johnson, Matt Leonard, Michelle Richard, Karen Braman, Don Teets, Brent Deschamp, and Patrick Fleming

Administrative Personnel:

Heather Wilson (President), Richard Sinden (Provost), Carol Racanelli (Admissions), and Darrell Sawyer (Career Center)

Students:

Noah Brubaker, Kjerstin Cosand, Matthew Dyke, and Shaina Colombe

South Dakota School of Mines & Technology

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Marie M Vanisko, Mathematics Professor Emerita, Carroll College, Helena, Montana

Program Reviewer for the Mathematical Association of America (MAA)

Items A & B should address the following issues: mission centrality, program quality, cost, program productivity, plans for the future, and assessment of progress.

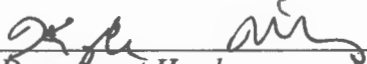
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B. Briefly summarize the review recommendations.

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Submitted by:

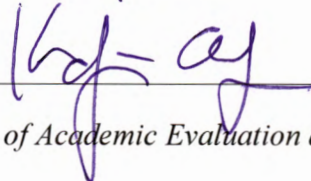
Date 11/18/15



Department Head

Approved by:

Date 11/18/15



Director of Academic Evaluation and Assessment