

South Dakota School of Mines & Technology

Math Pilot Project update for July 2017

In April 2016 the South Dakota Legislature and Governor Dennis Daugaard approved \$250,000 to support the math readiness skills of incoming freshman to the South Dakota School of Mines & Technology (SDSM&T). The effort was spearheaded by then SDSM&T President Dr. Heather Wilson in cooperation with members the Department of Mathematics and Computer Science. Mathematics is crucial to the success of students at SDSM&T. Since the university does not offer remedial math courses, the focus of the math pilot was on all entry level mathematics courses – College Algebra, Trigonometry, Calculus 1, and Calculus 2. An earlier summer 2015 pilot program for incoming freshmen – called ‘MathSpark,’ which included the use of online self-study review materials and faculty mentorship, had shown some success in terms of improved pass rates of these freshman in their entry level mathematics classes as compared to the previous year’s (2014) incoming freshman class.

The 2016-2017 math pilot was comprised of five main components:

- an online summer program;
- additional instructor support;
- the adoption of gateway exams in the introductory courses;
- the addition of recitations courses to accompany the lecture courses; and
- funding for a team to provide data driven analysis of the program.

The initial 2015 pilot was a limited online summer program with a strong focus on developing online materials combined with additional faculty mentors to assist students with completing the online materials. The initial summer program involved targeted mentoring for a relatively small number of students and the entire program was limited to incoming freshmen; a pool of less than 500 students. The expansion of the summer program in 2016 resulted in a robust communication plan to engage more students via email, phone, social media, and texting. The expanded mentoring program also opened up to all returning and transfer students, growing the audience pool to around 800 students. The online materials and support were all provided to the students for free, and the same materials are used to help prepare students over winter break.

95% of students surveyed in Fall 2016 would recommend the use of the summer program to incoming students.

The additional instructor support made it possible for all introductory mathematics courses to have section sizes of less than 40 students each. This is in sharp contrast to previous semesters where College Algebra and Trigonometry would have 60 students or more per section. The smaller class sizes enabled the deployment of active learning exercises and provided for more individualized instruction. Table 1 shows the percentage of students that achieved a C or better in the 2014 through 2016 academic years compared to historical success rates. One clear challenge area is the classes that are heavily populated with students repeating the class. In the spring semester, College Algebra and Calculus 1 were heavily populated with students repeating the course; traditionally

success rates for students repeating these courses are lower than the general population. We continue to devise strategies to engage these students and encourage them to utilize the resources that are provided: instructor office hours, supplemental instructions, free campus tutoring, forming study groups, and the new recitation sections.

Table 1: Success Rates for Freshman Cohorts for Academic Years 2014 - 2016

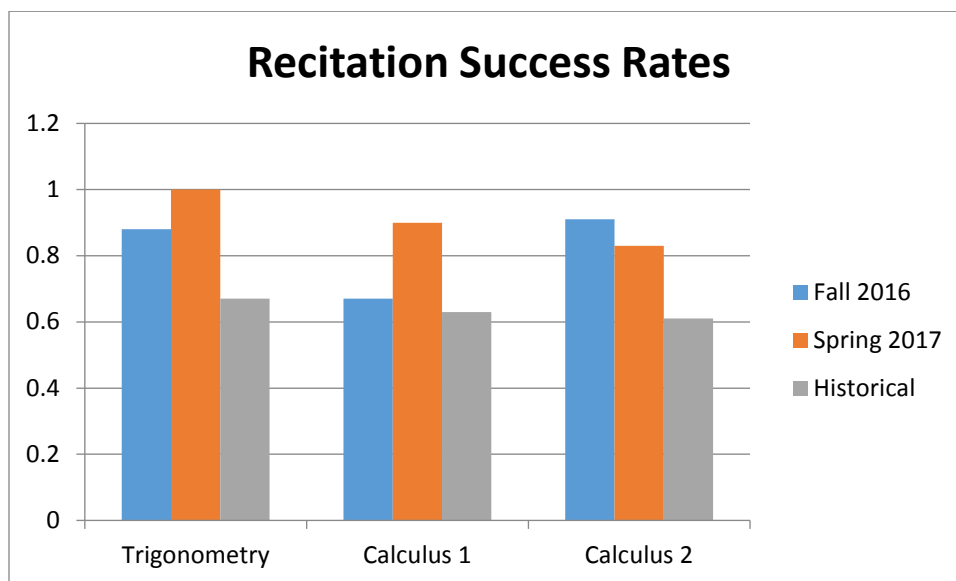
| Course | 2014 Freshman Cohort | 2015 Freshman Cohort | 2016 Freshman Cohort | Historic Overall Success Rates - all students - Fall 2010 to Spring 2016 |
|------------------------|----------------------------|----------------------------|----------------------------|--|
| College Algebra | 65% | 71% | 75% | 66% |
| Trig | 71% | 77% | 67% | 67% |
| Calc I | 68% | 81% | 76% | 63% |
| Calc II | 77% | 79% | 84% | 61% |

One innovation produced via the math pilot was the advent of gateway exams across all sections of Trigonometry, Calculus 1, and Calculus 2. Gateway exams focus on student mastery of fundamental skills. Students may retake the gateway exams until the desired level of mastery is reached. The electronic system used to produce these exams was created internally with specific focus placed on randomized questions so the tests are sufficiently rigorous. Additional investments were made in supplemental instruction and tutoring to provide adequate support in reviewing materials and achieving the desired level of mastery to students failing a gateway exam.

The increased personnel also allowed for the development and delivery of new recitations that accompanied Trigonometry, Calculus 1, and Calculus 2. The recitations focused on the development of the necessary skills to succeed in the accompanying lecture course. The recitation sections were small (20 students or less in a section) and were taught by regular faculty. The recitations were designed to offer a more active learning format where students work in groups to cover mathematical content, develop mastery in basic skills, and provide extra coverage on conceptual understanding to improve success in the accompanying lecture. Each recitation also included coverage of study skills, time management, and information regarding the affective components to learning. The recitations involved graded assignments and required active participation in the meetings. To offer a clear incentive to students to participate in the recitations, we offered a small amount of extra credit (around one percent award in the lecture) to students that successfully complete the recitation requirements. The recitations were offered at zero credit and were voluntary enrollment open to all students. Early communications were conducted with key student populations to encourage enrollment in the recitations. Overall, the students that successfully completed the recitation did far better in the accompanying lecture section. Figure 1 presents the results for students successfully completing recitations in the fall 2016 and spring 2017 semesters. Student feedback was highly favorable with 74% indicating they felt the work in

recitation improved their performance in the corresponding lecture, and 86% of the students surveyed would recommend the class to their peers.

Figure 1: Percentage pass rates of C or better for students successfully completing recitation requirements for Fall 2016 and Spring 2017 compared with the overall historical average success rate over 2010-2016.



In the two mathematics courses that saw a decline in pass rates from 2015 to 2016 – Trigonometry and Calculus I – it is possible a change in the placement process for these courses may have impacted the pass rates. In the fall semester we adopted the placement process common to the state system. In previous semesters the cut score on the placement exam to enroll in Trigonometry was higher than the rest of the South Dakota BOR system. This change in placement could certainly be a contributing reason, then, to lower pass rates in Trigonometry Fall 2016. Turning to Calculus I, the “Accuplacer” placement tool is now used across the state system rather than the “COMPASS” exam. Also, as a local change to just SDSM&T, Trigonometry is now a prerequisite rather than a corequisite for Calculus I. It is a bit unclear how these two changes may have affected grades and the pass rate in Calculus I. It is important to note that even though these pass rates were not as high as the 2015 cohort, all pass rates are at or above the historic average in all mathematics courses.

The analysis team was comprised of two faculty members and one graduate assistant. The team developed reporting tools that would 1) make it easier to evaluate student success rates in subsequent semesters, and 2) compared the students’ current performance against their performance from earlier years. Another component of the analysis was to determine characteristics that correlate with student success via completion of a degree from SDSM&T. It was found that the high school grade point average (GPA) was one of the few identifiers the correlated well with student success. The association of low high school GPA with lower student success in mathematics does provide a mechanism to help identify potential students for recitations

and for supplemental instruction. Additionally, student success in their first math class has a demonstrated influence in their eventual completion of a degree from our university. Students that need to repeat a course are of particular concern since their success rates are generally lower and their failure in a subsequent attempt is highly correlated with eventual withdraw from the university. Given the success of the students in recitation it is clear more needs to be done to get students that repeat a class into a recitation. The recitations for Calculus 1 and Calculus 2 have generally been in demand and appear to be providing the positive influence we have intended, as evident in Figure 1. The recitation for Trigonometry has had difficulty drawing student enrollment. Students in Trigonometry often feel they do not need to participate in the recitation since they typically have had experience with the content prior to arriving on campus. We plan to redesign the recitations for Trigonometry to allow enrollment later in the semester and offer assistance to students after the first exam. All recitations are designed to put a student in the best position to succeed in their class, but it is clear the Trigonometry students do not have adequate awareness of the pending risk of failure in the course at the start of the class.

The table below demonstrates the very labor intensive methodology taken with the math pilot. The majority of funding received in FY17 was used to hire additional faculty, graduate students, and additional student tutors to assist in reducing class sizes, making recitation sections possible, and administering our gateway exams. We applied a very hands on approach to mentoring, which we believe to be the most effective method available. As stated earlier, the recitation portion of the pilot proved to be very effective when utilized by the students. The operating expenditures were used to develop our gateway exams and data analysis of the pilot.

| Total Math Pilot Expenditures FY17 | |
|-------------------------------------|------------------|
| Faculty | \$167,709 |
| Graduate Assistants | \$17,000 |
| Civil Service | \$848 |
| Student Labor | \$13,819 |
| Benefits | \$36,877 |
| Total Personal Services | \$236,253 |
| | |
| Travel | \$6,023 |
| Supplies | \$1,238 |
| Computer Hardware/Software | \$4,276 |
| Total Operating Expenditures | \$11,537 |
| | |
| Grand Total | \$247,790 |

The past year has been very informative and we have already been hard at work expanding the effort for next year. The summer program has resulted in a stronger communication plan and we experienced fewer technical glitches than in the previous two years. Revisions are being implemented in several areas: revised design in the recitations, revised implementation of

supplemental instruction, improvements to the gateway exam system, and revisions within some of the course designs. This work has also fostered stronger collaborations with the Tutoring Center, established strong connections with the Student Success Center, and provided a focused area of communication with academic advisors. We are eager to deploy our new tools and work to continue our work in fostering student success.