Meeting (and exceeding) student goals in mathematics and statistics

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Dept. of Chemistry, Dept. of Psychology, Dept. of Sociology We’ve been communicating with other departments also.

Challenge
Reframing Challenge

Abstract/Summary
With more than two-thirds of PSU students pursuing a B.S. degree, recent studies have shown that success in mathematics and statistics courses is linked to retention and degree completion. A significant and successful reframing of these courses will have a huge positive impact on these students. We propose a technology–supported redesign of the content and delivery architecture that will recognize prior knowledge and allow students to proceed more quickly and effectively through mathematics and statistics requirements. Our proposal includes cohort development, peer mentoring, student–centered curricula, technology–based guided learning, and community outreach. Our redesign will be driven by both assessment of student needs and assessment of student performance.

Introduction
An innovative mathematics and statistics program supporting student success is essential to building capacity to support academic excellence for all students, particularly the success of students traditionally underrepresented in higher education. More than 80% of PSU’s graduates enroll in mathematics and statistics courses during their PSU experience. The students in mathematics and statistics “service courses” often struggle, impacting retention and time to degree completion. The DFW rates (students who receive a grade of D, F, or Withdraw) are high in these courses; for example, 38% of students received a D, F, or W in a fall term large-lecture STAT 243 class in 2012. We also find that many of the students who pass these courses are still not adequately prepared for downstream courses (in mathematics and in other disciplines).

We propose a redesign of our service courses in the mathematics and statistics program that:

- is supported by research on the effective use of technology and human resources to improve student learning,
- is informed by assessment of student needs,
- advances mathematics and statistics knowledge required for degrees in a variety of majors,
- expands our community outreach,
- includes cohort development, peer mentoring, student-centered curricula, and technology-based guided learning.

Recent redesign efforts
The Fariborz Maseeh Department of Mathematics and Statistics has already made big steps forward in improving student learning in lower division courses:

- Performance-based online placement into lower division courses has been mandatory since Winter quarter of 2012, using ALEKS (Assessment and LEarning in Knowledge Spaces).
- Students have been using the learning component of ALEKS to place into higher math classes and thereby satisfy mathematics requirements more quickly.
- Precalculus, calculus, and statistics courses in the flipped format (see below) and eTutoring from the Learning Center were piloted this quarter with great success.

With support from the Center for Online Learning, a group of faculty and instructors (listed above) in the Fariborz Maseeh Department of Mathematics and Statistics have been developing and piloting “flipped” courses in precalculus, calculus, and statistics, as well as online courses in calculus and statistics. “Flipped” refers to the strategy of providing online lectures and online homework systems, allowing face-to-face time to be used for developing deeper understanding in an in-class and/or computer-assisted cooperative learning format. The sections of flipped courses piloted Summer 2012 and Fall 2012 resulted in significantly more student success than traditional sections. Based on studies of student success in mathematics and statistics here at PSU and at other institutions of higher education, we propose to expand these redesign efforts: pilot, assess, make improvements based on assessment, and expand implementation of multiple learning strategies in mathematics and statistics.

We plan to work in collaboration with departments whose majors depend on these courses, adjusting our program to meet their needs.

One of our goals is to reframe service course offerings in a way that recognizes prior knowledge and allows students to proceed more quickly through mathematics and statistics requirements. Our reframing plan will be designed to be more attractive to students who have been avoiding taking mathematics and statistics courses, and we plan to use technology to more effectively use the limited human resources available.

Impact/Significance
We propose to expand the redesign that we recently initiated. In particular, we plan to address student needs in pre-college math and in quantitative literacy, as well as student needs within degree programs. Our underlying principle is: Students learn math by doing math, not by listening to someone talk about doing math.

More than 80% of PSU’s graduates enroll in mathematics and statistics courses during their PSU experience. The service courses in mathematics and statistics are required courses in many majors; consequently, time to degree completion is often dependent on completion of one or more of these courses as early as possible in a student’s university experience. Unfortunately, many of our students have gaps in their math knowledge and delay taking the math courses required for their degree. Sometimes this results in failure to graduate and sometimes students finish with an interdisciplinary degree instead of a degree in their chosen major. Even when students pass these courses, some are still not adequately prepared for downstream courses.

Prerequisite and placement enforcement has already improved DFW rates (see chart above). The learning component of ALEKS can be even better utilized to further reap the student benefits seen thus far.

In our recent pilot of flipped courses, we have already experienced success: the DFW rate for the flipped STAT 243 course was only 13% with an average grade of 80%, as opposed to 38% with an average grade of 74% in a regular large section taught by the same instructor.

Looking nationwide at redesign efforts in mathematics at NCAT (National Center for Academic Transformation) partner institutions, we see:

- Students successfully completing a developmental math course increased by 51% on average (ranging from 10–135%) while reducing the cost of instruction by 30% on average (ranging from 12–52%).
- Students successfully completing a college-level math course increased by 25% on average (ranging from 7–63%) while
reducing the cost of instruction by 37% on average (ranging from 15–77%).

At PSU, almost 50% of students who take the ALEKS placement test initially place into remedial mathematics (MTH 70, 95, or lower). Students who choose to use the learning module in ALEKS to refresh on these topics tend to increase their score by 15% (an entire course) on their reassessment. This allows us to retain these students without sending them away to a community college to complete coursework that is likely previously-learned. Although this resource is available to all PSU students, many have difficulty finding the time to use it alongside their other full-time obligations. If we can incorporate this powerful technology into a course that can contribute to a student’s full-time status, we can better assist these students to move into college level courses more quickly and effectively.

A redesign of our service courses in mathematics and statistics will also boost ongoing community outreach programs (Challenge and LINK and classes at correctional facilities) which are helping students get an early start as well as recruiting students to PSU.

Many of these courses are currently taught by graduate students and adjuncts, most of whom are dedicated but inexperienced. Providing more structure and direction for these instructors will be an essential component of our redesign, creating more consistency among these courses and our students’ continuing knowledge.

We expect implementation of our proposal to result in significant improvements in:

- Success rates
- Retention
- Graduation rates
- Time to degree completion
- Completion of chosen degree
- Course content that better serves student needs (particularly quantitative literacy for non-STEM students)
- Education for our graduate students in best practices and alternative models of pedagogy
- Early learning and recruitment via community outreach

Approach and Strategy

Recognizing that student interaction is essential to student success, we plan to develop cohorts and to make use of other strategies that bring students together (e.g. Brian Forrester’s BuddyUp proposal). A foundational component of our proposal is assessment of student needs and assessment of student performance.

Our approach includes:

- Student-centered curricula:
  - Identifying student needs in mathematics and statistics:
    -- The mathematics and statistics content supporting their majors
    -- Mathematics and statistics content supporting responsible citizenship
    -- Support needs: cohort development, peer mentoring, eTutoring, etc.
  - Assessment of student performance
  - Developing and implementing curricula that meet student needs
  - Developing and implementing architecture of delivery of curricula that promotes student success and uses human resources efficiently
  - Addressing math anxiety

- Expanding the feedback loop so that assessment drives subsequent re-redesign
- Using research on the effective use of technology and human resources to improve student learning, particularly technology-based guided learning
- Expanding our community outreach

We will continue to integrate open source resources (e.g. Kahn Academy) into our courses. If any existing MOOCs (Massive Open Online Courses) are compatible with our course goals, we could integrate them into our program where appropriate. Similarly, course exchange programs could be integrated into our program.

The current course offerings we propose to reframe are those with high student enrollments:

- MTH 70, 95 (pre-college)
- MTH 105 (quantitative literacy)
- MTH 111, 112 (pre-calculus)
- MTH 251, 252 (differential and integral calculus)
- STAT 243, 244 (introduction to statistics).

The specific delivery formats that we propose to utilize are:
- eTutoring: Online tutoring is in the pilot stage at PSU now, with a plan to offer it to all students starting Fall of 2013.
- Emporium format: In a large room filled with computers and roving instructors, students use interactive software to learn math skills. See [http://www.kent.edu/mathemporium/index.cfm](http://www.kent.edu/mathemporium/index.cfm) for information on the emporium format successfully implemented at Kent State University.
- Modules: We plan to offer quantitative literacy courses in technology-supported self-paced 1-credit modules.
- Flipped class formats: In our pilot "flipped courses," students watch videos instead of face-to-face lecture and use interactive software to learn math skills. Class time is reserved for cooperative learning activities, often using math learning software in a computer lab, thereby increasing understanding and addressing misperceptions early on. The flipped model transforms classrooms from a focus on the delivery of information to interaction and comprehension of that information.

For a "big-picture" viewpoint of changes in higher education, including descriptions of emporium and flipped models, see: [http://www.educause.edu/ero/article/challenge-and-change](http://www.educause.edu/ero/article/challenge-and-change)

Our proposal targets the three student needs:
- Preparation for college-level mathematics and statistics courses
- Quantitative literacy
- Proficiency in mathematics and statistics required for majors in other departments

In all cases, students in these learning paths will be supported by forming cohorts, peer mentoring, and eTutoring. At all levels, the ALEKS learning system will be available to identify knowledge gaps, to support students in filling in those gaps, and to facilitate students to move more quickly through mathematics and statistics requirements.

Our team is looking forward to expanding our current efforts to improve student success in mathematics and statistics, thereby improving retention and time to degree completion.

### Milestones

<table>
<thead>
<tr>
<th>Goal</th>
<th>Prior to Fall 2013: collecting information + course design</th>
<th>2013–2014 Academic year: implementation + assessment</th>
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<tbody>
<tr>
<td>Prep for Univ-level math</td>
<td>--design: emporium-style courses assessments of student proficiencies</td>
<td>--implement courses, supported by the ALEKS online learning system --assess proficiency and attitudes of these students</td>
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<tr>
<td>Quant. Lit. Non-STEM majors</td>
<td>--student focus groups to identify factors motivating non-STEM students to enroll in mathematics classes earlier in their university experience and implement a strategy to attract these students --design: courses emphasizing quantitative literacy assessments of student proficiencies</td>
<td>--pilot these course(s) --analyze enrollment demographics --assess proficiency and attitudes of these students</td>
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<tr>
<td>Prep for STEM majors</td>
<td>--review assessments of online and flipped courses that were piloted during the 2012-2013 academic year: online: statistics (STAT 243, 244), calculus (MTH 251, 252) flipped: statistics (STAT 243, 244), precalculus (MTH 111, 112), calculus (MTH 251, 252) --continue our conversations with other departments to identify needs of their</td>
<td>--implement the modified courses --assess student proficiency --modify courses as indicated --conduct workshops to inform faculty and GTA's of the course designs</td>
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students
--modify these courses based on assessments and information collected
--plan further assessment of these courses

Summer 2014:
--analyze data about student proficiency and student attitudes and modify course designs based on that analysis
-- based on data collected, modify our strategy to encourage non-STEM students to enroll in mathematics courses early in their university experience

Benefits
Our short-term benefits are:

1. To improve student success in mathematics and statistics via technology-supported learning and efficient use of human resources
2. Course content that better serves student needs
3. Teaching experience for our graduate students in alternative models of pedagogy
4. Teaching assistant opportunities for STEM students (see below)

Our long-term benefits are:
1. Continuation of the above benefits
2. Improvement of retention, graduation rates, time to degree completion, and completion of chosen degree via success in mathematics and statistics early in students’ university experience
3. Technology-based teaching strategies for faculty and GTA’s so that we can use human resources more efficiently

The courses we propose to create and/or redesign had a total enrollment of over 30,000 student credit hours during the 2012 calendar year. Based on historical trends, these enrollments will grow with growth in the student population at PSU.

We propose to hire 2–3 undergraduate teaching assistants and 1–2 GTA’s to assist with our emporium-style classes. This shifts funds previously allocated to adjuncts to financial support for students, as well as providing those students with valuable teaching experience.

By using prepared and vetted course strategies and materials, as well as online homework systems, our 31 GTA’s and the 14 faculty who teach these courses will cut class preparation time significantly, allowing more time for their studies.

Consequences

1. Continuing DFW rates of 13% to 36% in the courses we propose to redesign.
2. Continuation of poor retention, graduation rates, time to degree completion, and completion of chosen degree because of:
   --inefficient use of student study time in developing proficiencies in mathematics and statistics that allow them to enroll in college-level courses
   --non-STEM students delaying their enrollment in mathematics courses
   --inadequate proficiency in the mathematics and statistics required for success in their majors
3. Inefficient use of financial and human resources

Needs Assessment
Meeting and Excellent Student Goals: Mathematics and Science

Course design group in the Fall 2012. Department of Mathematics and Statistics

Rethink presentation from joyceohalloran

Tags
- 21st Century Student
- Accelerated College Program
- Assessment/ePortfolio
- College Access
- Cost of Degree
- Degree Completion
- Developmental Ed
- Financial Literacy
- High-Quality Learning
- MOOCs/Open Access
- New Models
- Online Education
- Process Change
- Proficiency Based Curriculum
- Student Success
- Undergraduate
- Underrepresented Students
- Workforce Development

Comments

Robert Mercer — January 3, 2013 – 1:12pm

the Department of Mathematics has done so much in recent years—reviewing curriculum, mandatory online placement, etc....—that is already showing positive results for students. I think this proposal would be another big positive step in improving student success in math courses and in courses across the University that build on strong math skills.
go to news