American Mathematical Society
Committee on Education Meeting
October 24-26, 2013
Washington DC

Summary

This year's Committee on Education (COE) meeting began with a dinner on Thursday evening where an overview of the upcoming meeting was presented. The focus of the meeting was on online tools in undergraduate mathematics education and their current and potential impact on colleges and universities. The meeting itself consisted of presentations and discussions over a day and a half. Attendees included a large number of chairs of departments of mathematics from across the country. Tara Holm, Chair of COE, introduced the speakers and facilitated the meeting:

The Lion in the Path

Hunter Rawlings (Association of American Universities - AAU) spoke to the group about an AAU initiative aimed at improving teaching and learning in science, technology, engineering and mathematics (STEM) fields. He cited recent studies that have shown that students learn best when they are actively engaged rather than simply a part of a lecture course.

The overall objective of AAU's Undergraduate STEM Education Initiative is to influence the culture of STEM departments at AAU universities to support and encourage faculty to utilize evidence based teaching practices that will engage their students. This five year project has a number of facets including a web-based interactive tool for faculty/administrators, the development of a set of measures/metrics to aid institutions in the evaluation of their use of evidence-based teaching practices, and the creation of a STEM Network to provide a forum to facilitate communication among member universities.

Thirty-eight of sixty-two member institutions sent in proposals to be part of this initiative, and eight project sites have been established thus far. The AAU also works within coalitions and in other collaborative ways to improve undergraduate STEM education.

Clicks and Mortar? Online learning in the context of traditional universities and colleges

Rebecca Griffiths (Ithaka S+R) began by reviewing statistical information related to failure and withdrawal rates in post-secondary mathematics courses and other challenges faced by math departments today. She went on to talk about how online learning technology can provide opportunities to address these challenges, including: 1) enabling students to actively engage in problem solving rather than passively listening to lectures; 2) allowing students to learn at their own pace utilizing practice problem solving and instant feedback; 3) providing more flexibility; 4) enabling at least equivalent student outcomes with lower cost per student; 5) facilitating collaboration; and 6) providing learning data to improve instruction.

Study results comparing online, hybrid and face-to-face teaching vary widely. However, what seems to be constant across studies is that certain subgroups of students tend to fare worse in online-only environments. So while hybrid formats can be good for all students and potentially save money in the long run, online-only formats work well for some students but not for others.

What remains largely unknown is the efficacy of Massive Open Online Courses (MOOCs) and whether technology will actually reduce costs across programs/institutions or produce better learning outcomes.

The Evolution of MOOCs in Mathematics

Robert Ghrist (University of Pennsylvania) gave attendees a very broad introduction to the calculus MOOC (massive open online course) that he has been running for the past year. He spoke about the design and the curriculum of the course, outlining course chapters and showing examples of the course videos. The homework sets are open and collaborative. It is a complete second semester calculus course. The course is free and the majority of people who signed up are either those in industry who want to get a refresher or college students looking for a different perspective.

Ghrist emphasized that MOOCs are not just a delivery platform but rather a tool to provide a different approach to teaching and learning, and his course is an example of the degree of innovation possible with MOOCs. Although there are only a handful of MOOCs that have been developed in mathematics, there is much optimism for the potential returns.

Learning about proofs by evaluating them

Keith Devlin (Stanford University) began his presentation with a brief history of MOOCs. He described the typical components including video lectures, in-lecture quizzes (machine-graded), on-screen or downloadable written materials, peer-evaluated work assignments and collaborative group work.

Devlin developed a MOOC at Stanford University based on a course he teaches in the traditional way. He shared the concept and design of his "Introduction to Mathematical Thinking" course and presented examples of its format. He also talked about some of the key challenges in MOOCs including the importance of community building, group interaction, peer evaluation, accreditation and appropriate metrics.

Enhancing Mathematics Education Through Technology – Myth or Reality

William "Brit" Kirwan (University of Maryland System) spoke about what makes good pedagogy and the changes that are occurring in the ways education is delivered to students. Advances in cognitive science and technological innovation are paving the way toward more interactive classrooms. He did not suggest that traditional learning be cast aside but rather enhanced with the strategic use of technology.

The University of Maryland System is experimenting with course re-design. They are using a technology enhanced design in some 40 courses across the system, combining online and in-person education. The University of Maryland, Baltimore County is especially engaged in this project and is getting very good results.

Kirwan acknowledged the challenges involved in getting faculty engaged in these efforts, but the evidence of advanced teaching and learning outcomes as a result of these course transformations supports their embrace.

Renovating Introductory Probability and Statistics at MIT:
Changing the pedagogy, syllabus and technology all at once

Jeremy Orloff (Massachusetts Institute of Technology) discussed how MIT used a two-year Davis Foundation grant to bring active learning to their mathematics department. They did not create a MOOC but rather used some new technologies to renovate an introductory class in probability and statistics. He discussed in detail the changes they made both inside and outside of class, including the space and setup of the classroom.

The grant required them to study their changes to the course. Besides realizing the tremendous amount of work and subject expertise required to re-design the course, they found that the format has its limitations but that there is evidence that student achievement increased. MIT is planning to revise the class and run it again next spring.

Online learning in Liberal Arts Environment: Creating a Digital Community

Tina Garrett (St. Olaf College) presented some background information on liberal arts institutions and spoke about the challenges of applying online learning to a liberal arts education effectively. She discussed an Associated Colleges of the Midwest (ACM) initiative to bring online technologies to courses at liberal arts colleges. The pilot program sought to create an online calculus course that all 14 ACM colleges could offer to increase access and flexibility, develop new technologies and techniques and reduce costs.

Garrett and Chad Topaz (Macalester College) developed and taught the summer course, "Calculus: A Modeling Approach." Garrett described the course design and showed examples of the course page, screencasts, checkpoint quizzes, exam questions and the online forum. She also talked about the faculty experience and student feedback.

Although the project had some positive outcomes, there are no plans yet to offer the course during the regular school year.

Mathematical Preparation of the Future Workforce

William "Bus" Jaco (Oklahoma State University) presented information on the INGenIOuS (Investing in the Next Generation through Innovative and Outstanding Strategies) Project, which seeks to develop strategies for training the next generation of mathematical sciences workforce. The project is funded by the National Science Foundation (NSF) through grants to the Mathematical Association of America (MAA) and the American Statistical Association (ASA) and participation by the American Mathematical Society (AMS) and the Society for Industrial and Applied Mathematics (SIAM).

The effort was comprised of six key themes, each focused on a unique topic: recruitment and retention; technology and MOOCs; internships; job placement; measurement and evaluation; documentation and dissemination. A product of the project is six white papers on each of these topics and the culmination was a three-day workshop held in July 2013.

Jaco shared statistics about the increasing importance of the mathematical sciences in the workplace and the challenges facing mathematics educators to fully prepare our future workforce. The project report, due out soon, will have implications for the training of the mathematical sciences workforce and should help inform future investments by funding agencies.

General Discussion

The meeting was organized purposefully to allow discussion time on topics of general concern and interest which resulted in participation by those attending in conversations related to some general aspects of teaching and curriculum development, innovations, delivery methods and departmental issues.

Submitted by Anita Benjamin
American Mathematical Society
November 13, 2013