Teaching and Learning Laboratory

The Teaching and Learning Laboratory (TLL) was founded in 1997 as a resource for faculty, administrators, and students who share a desire to improve teaching and learning at MIT. Its mission is to collaborate with members of the MIT community to promote excellence and innovation in teaching and learning throughout the Institute and to contribute to MIT's standing as a leader in science and engineering education.

This report details TLL achievements in three areas: research and assessment, contributions to educational innovation at MIT and to the teaching and learning enterprise, and participation in national and international activities in STEM (Science, Technology, Engineering, and Math) higher education.

The Teaching and Learning Laboratory continued to study how students learn using digital online resources. In a paper published in *Educational Researcher*, one of the top journals in the field of education, we argued that massive open online courses (MOOCs) make it necessary for educational researchers to rethink variables historically used to measure educational quality. We conducted further analyses of data collected from 6.002x Circuits and Electronics and produced additional papers and presentations detailing our findings.

We submitted a final report detailing the spring 2013 Office of Digital Learning experiments in blended learning. These experiments were undertaken in 7.012 Introductory Biology, 8.02 Physics II (in Experimental Study Group and Concourse), 14.73 The Challenge of World Poverty, and 2.01 Elements of Structures. A fifth subject, 18.05 Introduction to Probability and Statistics, was also studied with funding provided by the Davis Foundation (through professor Haynes Miller).

TLL had a record enrollment in the Graduate Student Teaching Certificate Program (TCP), with 213 students completing the program. We have seen significant interest from postdocs in TCP, and have bolstered the training we provide regarding the design and use of educational technology.

Of the 46 videos we created on pivotal concepts and critical skills in STEM undergraduate education with Singapore University of Technology and Design funding, 44 have been posted on OpenCourseWare. They have received almost 89,000 hits, with the top three videos being those focusing on communication, problem solving, and conditional probability.

We completed 20 assessment studies for members of the MIT community, representing approximately a 50% increase over the last reporting period. These studies included department-based initiatives (e.g., the modular curriculum in Course 2), courses (e.g., 5.111 and 3.091 as it was taught fall 2013), and programs (e.g., M+ Vision).

Accomplishments in Research and Assessment

TLL's work in research and assessment has focused on online learning in MOOCs and blended learning on campus, although we continue to assess residentially based courses and programs as well.

In August 2013, we submitted the final report to the Office of Digital Learning on the assessment of five subjects taught in spring 2013 that experimented with blended learning. These courses incorporated, to a greater or lesser degree, material that had been developed for the MOOC version of the course. The study collected data on the experience of the course instructional staff and students, how students used digital resources, the use of those resources in content-related collaborations, and the perceptions of the instructional staff and students of (if used) a flipped classroom.

Also, we have continued to work with the data from MIT's first MOOC, 6.002x Circuits and Electronics and have analyzed the clickstream data (approximately 230 million interactions) to understand use of resources and their correlation with achievement. We have used this data to develop a more in-depth picture of how students in different geographical areas and countries interacted with 6.002x. Another stream of research has focused on the approximately 100,000 discussion forum posts. We have undertaken a content analysis of a random sample of these posts, looking at both the content of the post and the role of the poster. We are working with collaborators in CSAIL to experiment with machine coding given the large number of posts.

A list of TLL staff papers and presentations and a table detailing our assessment studies are provided later in this report.

Accomplishments in Teaching and Learning

TLL provides expertise in teaching and learning that complements the MIT faculty's domain expertise. Our signature program is the Graduate Student Teaching Certificate Program, which graduated over 200 students in AY2014. It is noteworthythat we had to turn away almost 70 students who wished to enroll in the summer program. We are working to increase the number of instructors who teach in the program, which has been the limiting factor in accommodating demand. TLL assistant director Leann Dobranski has been instrumental in providing support as we grow TCP and in offering strategic directions for its continued expansion.

We have incorporated material on educational technology and opportunities for students to experiment with various tools that they might use in a course they would teach. In fact, we are employing educational technology to improve learning through the development of an app we have named Vinculum (the mathematical symbol to signify terms that are to be considered together or, more broadly, a bond signifying unity). Vinculum allows instructors and students to map a constellation of topics, ideas, or concepts and show the relationships between and among them. It is designed to address a persistent problem in education—that students often see topics in a course of study as disconnected. It also provides a tool allowing instructors to present similar ideas in multiple contexts, a pedagogical practice that strengthens retention and transfer of learning.

Finally, Dr. Janet Rankin, TLL senior associate director for teaching and learning, consulted with more than 35 faculty members and graduate students on their teaching, including observing classes and meeting with instructors to provide feedback. We are working with two Course 3 faculty members, Michael Cima (on an assessment of 3.091) and Craig Carter (on course design and assessment of 3.016). We have provided additional workshops and consultations on teaching and learning to the Undergraduate Research Opportunities Program (UROP) graduate supervisors in the Office of Undergraduate Advising and Academic Programming (UAAP), the Lemelson-MIT Program, and the Saturday Engineering Enrichment and Discovery (SEED) Academy program.

MIT Initiatives

TLL director Lori Breslow served on a working group for the Institute-wide Task Force on the Future of MIT Education.

National and International Efforts in STEM Higher Education

TLL staff members contributed to initiatives to advance STEM education nationally and internationally. These efforts included:

- Participation in the EdIT Workshop, President's Council of Advisors on Science and Technology, Washington, DC, August 2013
- Participation in a meeting for congressional senior staff/educational committees sponsored by the Postsecondary National Policy Institute (New American Foundation), Washington, DC, May 2014
- Participation in an MIT-Haiti initiative (supported by the National Science Foundation) to translate active learning materials into Kreyòl and assess their impact
- Membership in the Olin College President's Council and the MIT Museum Advisory Board
- Meetings with visitors from 18 countries

Research Activities

TLL staff designed and implemented program evaluations for Interphase EDGE (Office of Minority Education), the Undergraduate Research Opportunities Program (UAAP), and freshman advising (UAAP). The office developed and implemented the AdviSOR survey for the Office of Undergraduate Advising and Academic Programming.

Publications and Conference Papers

Jennifer DeBoer, Andrew Ho, Glenda Stump, and Lori Breslow. "Changing 'Course': Reconceptualizing Educational Variables for Massive Open Online Courses." *Educational Researcher*, 2014, 43(2), 274–284.

Glenda Stump, Jennifer DeBoer, Jonathan Whittinghill, and Lori Breslow. "Development of a Framework to Classify MOOC Discussion Forum Posts: Methodology and Challenges." *EducationXPress*, 2014.

Jennifer DeBoer, Glenda Stump, Daniel Seaton, Andrew Ho, David Pritchard, and Lori Breslow. "Bringing Student Background Online: MOOC User Demographics, Site Usage, and Online Learning" in Sidney D'Mello, Rafael Calvo, and Andres Olney (Eds.), *Proceedings of the 6th International Conference on Educational Data Mining.* Memphis, TN: International Data Mining Society, 2013.

Keynotes, Invited Talks, Presentations, and Posters

Lori Breslow, Jennifer DeBoer, Glenda Stump, and Andrew Ho. "Investigating Learning in the Worldwide Virtual Classroom." Poster prepared for Advancing Technology-Enabled Education, Washington, DC, July 2013.

Lori Breslow. "With MOOCs, We Can Leverage New Pedagogies." Invited commentary for the World Innovation Summit for Education, Doha, Qatar, October 2013.

Lori Breslow. "What Students Bring to the Table: How Student Background Impacts Learning." Presentation at Harvard Medical School Education Grand Rounds, Cambridge, MA, October 2013.

Lori Breslow. Remarks for the 100th Anniversary of the Harvard School of Public Health, Cambridge, MA, October 2013.

Lori Breslow. "What We Have Learned From the Study of 6.002x." Briefing for MIT Investment Management Company, Cambridge, MA, October 2013.

Lori Breslow. "How MOOC Data Can Help to Understand Learning." Presentation at the MOOC Research Conference, Arlington, TX, December 2013.

Lori Breslow. "How the Principles and Philosophy of Progressive Education Are Evident in Higher Education." Presentation at the New School for Social Research, New York, NY, January 2014.

Jennifer DeBoer. "TLL: MIT's Teaching, Consulting, Assessment, and Education Research Group." Presentation at Tsinghua University, Beijing, China, July 2013.

Jennifer DeBoer. "Diversity, Data, and Student Development: Learning From Research on the First MITx Course." Keynote for the Innovations in Engineering Education Conference, Medellin, Colombia, August 2013.

Jennifer DeBoer. "Diversity, Data, and Student Development: Learning From Research on the First MITx Course." Keynote for the World Engineering Education Forum, Cartagena, Colombia, September 2013.

Jennifer DeBoer. "Global Attributes and Competencies: An Initiative to Identify and Assess Key Characteristics of the World's Future Engineers." Presentation at the Colloquium on International Engineering Education, Lexington, KY, November 2013.

Jennifer DeBoer. "Diversity, Data, and Student Development: Learning From Research on the First MITx Course." Presentation at the International Symposium of Sorbonne Universités: Trends in Innovative Education, Paris, France, December 2013.

Jennifer DeBoer, Glenda Stump, and Lori Breslow. "National Differences in an International Classroom." Presentation at the 4th Annual Learning Analytics and Knowledge Conference, Indianapolis, IN, March 2014.

Jennifer DeBoer and Lori Breslow. "Tracking Progress: Predictors of Students' Weekly Achievement during a Circuits and Electronics MOOC." Poster presented at the 1st Annual Learning@Scale conference, Atlanta, GA, March 2014.

Jennifer DeBoer. "Reconceptualizing Teaching and Learning in a New Educational Context." Keynote for the Institute of Electrical and Electronics Engineers (IEEE) Educational Control System Analysis and Design Program, Istanbul, Turkey, April 2014.

Jennifer DeBoer and Lori Breslow. "Virtual Classrooms in a Real-World Context." Presentation at the MOOCs4D International Invitational Conference, Philadelphia, PA, April 2014.

Jennifer DeBoer. "National Differences in an International Classroom." Presentation at xTalks: Digital Discourse, Cambridge, MA, April 2014.

Jennifer DeBoer. "Global Attributes and Competencies: An Initiative to Identify and Assess Key Characteristics of the World's Future Engineers." Presentation at the American Society for Engineering Education Annual Conference, Indianapolis, IN, June 2014.

Darshita Shah, Jennifer French, Janet Rankin, and Lori Breslow. "Using Video to Tie Engineering Themes to Foundational Concepts." Invited plenary presentation at the American Society for Engineering Education Annual Conference, Indianapolis, IN, June 2014.

Glenda Stump, Jennifer DeBoer, Jonathan Whittinghill, and Lori Breslow. "Development of a Framework to Classify MOOC Discussion Forum Posts: Methodology and Challenges." Poster presented at the Neural Information Processing Systems Annual Conference, Lake Tahoe, NV, December 2013.

Teaching and Learning Laboratory Assessment Studies

Subject/Study	Scope of Investigation	Client	Status/Findings	Researcher
Mechanical Engineering (MechE) modular curriculum	Study comparing achievement based on trajectories chosen by Course 2A and Course 2 students	MechE (A. Hosoi)	Report submitted	G. Stump
Blended learning experiments	2.01, 7.012, 8.02, 18.05, 14.73	Office of Digital Learning (ODL)	Report submitted	G. Stump J. DeBoer F. Carter-Johnson
"Thrivatude" study	Exploration of what contributes to student wellbeing at MIT	Dean for Undergraduate Education	Report Submitted	F. Carter-Johnson G. Stump
Course 2.002	Distance learning experiment	K. Kamrin	Report submitted	G. Stump P. Reis
Course 5.111 curriculum innovations	Study of impact of lecture videos on student motivation and diversity awareness	C. Drennan	Report submitted	R. Mitchell
Graduate student teaching assistant "boot camp"	Retrospective study of five-year impact of TA boot camp.	C. Drennan	Analysis continuing	R. Mitchell
Course 18.05	Assessment of blended learning	H. Miller	Report submitted; publications being planned	G. Stump
Course 20.020	Spring 2012 course	N. Kuldell	Report submitted	R. Mitchell
Madrid-MIT M+ Vision Program	Assessment of experience of an international fellowship program in medical imaging	M. Gray	Report submitted; additional report submitted to Spanish government	R. Mitchell
iQuISE	Evaluation of graduate education in an interdisciplinary program	K. Berggren	Report on '09 cohort submitted	R. Mitchell

Teaching

Lori Breslow: 15.279 Management Communication for Undergraduates, spring 2014, and Communication/Writing, Interphase EDGE, summer 2013

Janet Rankin: 5.95J Teaching College-Level Science and Engineering, fall 2013

Funding

We received $80,000 in funding from external sources for assessment (these funds were from grants awarded to faculty for initiatives that had an assessment component), $7,000 from projects funded by the d'Arbeloff Fund for Excellence in Education, and $7,500 from the MIT Office of the Vice President for Research to staff an additional section of the TCP summer program.

Personnel

Dr. Glenda Stump, associate director for educational research, has accepted a position as a research assistant professor at Arizona State University's Learning Sciences Institute.

Dr. Jennifer DeBoer has accepted a position as an assistant professor in the Department of Engineering Education Research at Purdue University.

We wish to acknowledge the support of Daniel Nocivelli, administrative assistant, in all of the initiatives described above.

Lori Breslow
Director