Strategic Assessment at the Massachusetts Institute of Technology

Lori Breslow, Massachusetts Institute of Technology

Abstract

In 1999, MIT Provost Robert A. Brown formed the MIT Council on Educational Technology (MITCET) to guide the development of changes to the educational infrastructure at the Institute, as well as to oversee the creation of new educational initiatives. In the same year, two grants — one from Alex d'Arbeloff, chairman of the MIT Corporation, and his wife, Brit d'Arbeloff, and one from the Microsoft Coroporation — allowed MIT to embark on a series of innovations in education, many of which employ educational technology. The Teaching and Learning Laboratory was asked to coordinate the assessment of these initiatives. In order to maximize resources, TLL staff, along with faculty and administrators, created both an operational and intellectual strategy. This paper describes those strategies and gives several examples of how they have been implemented to date.

A UNITED ENGINEERING FOUNDATION CONFERENCE
Davos, Switzerland 11-16 August 2002
http://www.coe.gatech.edu/eTEE

I. Background

The Massachusetts Institute of Technology is undergoing an educational renaissance. For the past several years, the Institute has been examining its educational practices in a systematic way and creating innovations designed to enhance the MIT educational experience. These changes were originally fueled by the work of three groups: the Task Force on Student Life and Learning, which issued a report in September 1998; and two committees that focused on the impact of educational technology on MIT, the Ad Hoc Committee on Education via Advanced Technologies (report issued July 1995) and the MIT Educational Technology Council (report issued July 1997). In response particularly to the last two reports, as well as to the groundswell of activity that was occurring around educational technology worldwide, Provost Robert A. Brown formed the MIT Council on Educational Technology (<http://web.mit.edu/cet>) in 1999 to guide the development of changes to the educational technology infrastructure at MIT, as well as to oversee the creation of new educational initiatives.

This work was given an important boost by two grants the Institute received in 1999. The first, a gift from Alex d'Arbeloff, the chairman of the MIT Corporation, and his wife, Brit d'Arbeloff, created the d'Arbeloff Fund for Excellence in Education. The second grant from the Microsoft Corporation funded iCampus (<http://mit.edu/icampus>), a five-year, $25 million research alliance whose purpose is to strengthen higher education through the use of information technology.

Today there are over thirty projects underway that are being funded by either iCampus or d'Arbeloff grants. Together, they represent a rich array of educational experiments. Faculty members, administrators, students, and staff are working to incorporate new educational technologies into the classroom; structure new kinds of relationships between students and faculty, among students, and between students and alumni; employ a wider range of pedagogical methods; and develop new tools to evaluate the efficacy of these efforts. As Sally Atwood [1] wrote in an article entitled, "The Innovation Bubble," for the May 2002 alumni edition of *Technology Review*, "It has been 30 years since MIT last saw such a groundswell of educational innovation, and it's beginning to transform the classroom experience."

II. Challenges to the Assessment Effort

Of course, the Institute has assessed its educational efforts throughout its history, but now it wanted to study these new initiatives in a more systematic way. The Teaching and Learning Laboratory (TLL) was asked to be on the frontline of the assessment effort. (For more information on TLL, please see our web page at <http://web.mit.edu/tll>. A part of the Office of the Dean for Undergraduate Education, TLL provides a comprehensive range of services to help faculty, students, and administrators improve teaching and learning at the Institute.) Although assessment is not solely our responsibility (more on this below), we handle a majority of projects, as well as coordinate efforts campus-wide and serve as a clearinghouse for resources.

As to be expected, we began this work faced with a set of obstacles not the least of which were the attitudes towards and stereotypes about assessment and evaluation that are typically present in an academic institution. After all, assessment can be a dirty word to some faculty, for it implies someone—

the department head, a school dean, a visiting committee—is looking over their shoulder to evaluate the quality of their work**.** Our first challenge was to get the community to think of assessment not as an adversarial process, a call to judgment, or a time sink. So at every opportunity, we repeated the same message as our mantra: assessment is the first cousin to the kind of research that goes on in the disciplines—it is scholarly, researched-oriented work that results in the expansion of knowledge and innovation. I think we have gotten that message across fairly well.

The second challenge was—again not surprisingly—to garner enough resources to do the work properly. Although the Institute was willing to provide an adequate budget for assessment, a hiring freeze at the administrative level meant we could not add permanent staff members to TLL. After a concerted lobbying effort, we did receive permission to make one new hire, and we recruited Dr. John Newman as the associate director for assessment and evaluation. Other TLL staff members who are involved in assessment are Dr. Alberta Lipson, associate director for educational studies, who joined TLL from institutional research, and Cindy Dernay Tervalon, TLL's assistant director. Each staff member is directly responsible for assessing one or more courses or educational experiments, as well as consulting with PIs or faculty members responsible for other initiatives (again, more on this below). In August, Ms. MeiLin Chan will join TLL as a junior researcher.

III. An Operational Strategy

Given that most PIs and their staffs were more than willing to have their initiatives assessed, and that we did not have enough manpower to do a full-blown assessment of each project, we needed to devise a plan to manage the workload and insure—as much as humanly possible—that we were using our resources wisely.

Thus we began to assemble a stable of assessment experts who would work with us on a consulting basis. We currently have three consultants working on projects, and we expect to add a fourth this fall. One consultant is assessing a group of online programs that have been developed to enhance students' media literacy and communication skills. A second is conducting a longitudinal study of a new initiative that places upper class students in the dorms to serve as resident advisors for freshmen. And the third consultant is the assessment professional for the Cambridge-MIT Institute (CMI) Undergraduate Exchange.

We also sought out graduate students to work with us. Since MIT has no education school or department, we looked to other universities. We are now working with one Ph.D. student from Boston College, and will begin working with a Ph.D. student from Boston University in September. We have also employed half a dozen undergraduates as research assistants through MIT's Undergraduate Research Opportunities Program (UROP). The undergraduates, who have done phenomenal work, are very excited about the opportunity to participate in projects that will improve MIT undergraduate education!

For those projects for which we cannot do a full-scale assessment or for which we cannot assign an assessment consultant, we do provide coaching services to help PIs, or someone they designate, carry out their own assessment. Usually, we begin by helping project teams identify their goals; then we can also offer guidance on how to locate assessment instruments, create a research design, or carry out data collection and analysis. We are also available to review findings and determine next steps. In several cases, MIT master's students who are interested in engineering or science education have taken on an assessment project as their theses.

Finally, as mentioned above, there are other assessment professionals on campus, and we coordinate our work with theirs. Dr. Newman began the "A&E Brownbag Lunch" at the beginning of last year to provide a forum for all of us to meet to discuss work in progress, brainstorm problems, and share ideas.

IV. Common Themes: An Intellectual Strategy

At the urging of Professor Hal Abelson, co-chair of the Council on Education Technology, a team of MIT faculty and administrators met in the winter/spring of 2001 to group the d'Arbeloff and iCampus projects into "themes," linking them conceptually according to commonalities in objectives, technology, or pedagogical method—or some combination thereof. "My concern," Abelson has said [2], "is that at the end of some period of time we know more than simply how the individual projects fared. I want us to be able to say something about how we can provide MIT students with an overall higher quality education than we are giving them now."

We eventually identified eight themes: (1) employing active learning alternatives in the classroom; (2) producing on-line alternatives to lectures; (3) acquiring real-time data through remote means; (4) creating learning communities with alumni/mentor involvement; (5) using problem-based learning to impart life-long lessons; (6) enhancing media literacy and communication skills; (7) providing opportunities for international education; and (8) developing new methodologies for assessment of educational innovation. (Please see Appendix A for a graphic representation of the themes and their relationship to projects and research questions.)

Each theme encompasses several projects. By joining them conceptually, we can gain synergy of effort. By comparing the assessment data that from one project with the data from other projects in the same group, we will get a clearer picture of which innovations are worth exporting to other courses or learning situations, and which are not. Finally, coordination of methods and measures will provide credible, replicated knowledge that can be disseminated to the educational research community.

This is not the place to go into a detailed description of each theme, but to impart a better understanding of what a theme entails, I will briefly describe just one.

The idea behind "using problem-based learning to impart life-long lessons" is that there are a core of skills and capabilities that MIT students should be developing from the very beginning of their careers at the Institute through their four years of study. Examples of these skills include communicating effectively (using both the written and spoken word); finding credible information relevant to a particular topic or task; managing time efficiently; working well as part of a team; and solving complex, open-ended problems. The philosophy behind the two d'Arbeloff experiments that best represent this pedagogical approach — Mission 200X (the X stands for the year the subject is given) and Public Service Design — is that these skills can be targeted for development within a course in addition to the content that is being taught.

For example, in Mission 2005, whose official subject name is "Solving Complex Problems" (12.000), teams of students this past fall tackled the problem of building an underwater research facility on both a coral reef and in a deepwater environment. Solving that problem required students to cull information from a number of different disciplines, cooperate with one another on teams that tackled smaller pieces of the problem, and coordinate their work to devise a comprehensive plan. Each team was given a mentor, an MIT alumnus/alumna, and since most mentors lived outside the Boston area, the students needed to learn how to communicate with him/her effectively via e-mail. Finally, the students presented the solution to the problem—that is, the design for the facility—on a Mission 2005 website and in an oral report to a panel of outside experts.

Dr. Lipson has been working alongside Professor Kip Hodges, who teaches Mission 200X, to assess both last year's Mission 2004 and Mission 2005. She uses a variety of methodologies in that work—primarily participant observation, focus groups, and surveys. A part of the assessment plan is to follow the students who have taken the Mission 200X courses longitudinally throughout their careers at MIT and perhaps beyond. If courses like Mission 200X meet their objectives, we hope to be able to identify the pedagogical variables that bring about that result so that those techniques can be adopted in other courses.

In the same way, by assessing individual projects united by a common theme we hope to learn something about whether certain kinds of material are better presented online rather than in lecture; the ways in which electronic communication helps or hinders the formation of a community of learners; or, whether having students engage in hands-on activities in the classroom increases conceptual understanding. These assessment objectives are framed very broadly, I realize. Our work will entail refining them to make their answers useful to the MIT community and beyond.

V. A Research Agenda

As if all that were not ambitious enough, our long-range goal is to do the kind of work that will allow MIT to contribute to research into the question of how the introduction of educational technology affects teaching and learning. To that end, a team of assessment experts from both MIT and Microsoft, along with four UROP students, spent several months exploring the state of knowledge in that area and identifying the interesting, important questions that need to be explored. We settled on three areas for study. As Figure 1 in Appendix A shows, our research agenda is to study the impact of educational technology on conceptual learning, student engagement and student interaction, and resource allocation with a particular emphasis on faculty time and effort. Let me again briefly describe each.

A. The Impact of Educational Technology on Conceptual Learning

One of the weaknesses often cited in science and engineering education is that students are taught a relatively narrow set of skills. Often called "algorithmic learning," this skill set, at its worst, entails memorizing a collection of formulae/ equations and trying to determine which can be used to answer questions on a problem set or exam. However, another approach is to focus educational efforts more broadly, teaching students to solve the kind of novel problems they will face in their professional work. This is often called "conceptual learning."

More specifically, conceptual learning means students should be able to: understand and describe in concrete terms how physical objects, phenomena, systems, or processes behave and how they interact with other objects, phenomena, systems, and processes; understand how mathematical expressions can represent physical objects, phenomena, systems, or processes, their behavior, and their interactions; model various reasoning and problem-solving techniques; pose and solve paradoxes and dilemmas; and transfer material they have learned from the context in which they learned it to other contexts [3].

On the simplest level, then, our assessment goal is to discover whether or not the use of various educational technologies will add to, detract from, or have no effect on conceptual learning. For example, we are just launching a study that will look at the impact of the simulations being developed by MIT faculty and staff on this kind of learning.

B. The Impact of Educational Technology on Student Engagement and Peer Interaction

Student engagement in learning is defined as the extent to which students enjoy, take responsibility for, and participate in learning. Student engagement has three components: (1) behavioral (e.g., does the student attend class regularly?); (2) cognitive (e.g., does the student engage in educational activities with the goal of developing further and deeper understanding?); and (3) affective (e.g., was the student satisfied with the subject and would he/she recommend it to others?)

As with conceptual learning, we are trying to understand the extent to which educational technology enhances or detracts from student engagement. Do educational technologies contribute to students putting forth greater effort? Do they help students to enjoy the content of the course more? Do they aid students in taking more responsibility for their own learning? We are also interested in understanding change over time. If the educational technology is one that requires students to change ingrained ways of learning, for example, it is important to know how long it takes for habits to change, and the process by which that change occurs [4].

Educational research has shown that college students are satisfied with their college experience when the amount of interaction they have both with their peers and with faculty is significant [5]. The debate that technology either impedes or increases opportunities for communication is a hotly contested one both inside and outside of academia. Our focus is how educational technology changes interactions, and what the benefits or drawbacks of those changes are. For example, are there aspects of face-to-face interactions that lend themselves to the development of certain skills? If so, is that development stifled by technology? Are there technologies currently not being employed or ways of using current technologies that could benefit interactions and, therefore, learning? These are the kind of questions we will explore.

C. The Impact of Educational Technology on Resource Allocation

No one argues with the fact that implementing educational technology takes time and money. But how much time? whose time? and how much money? The first questions, then, to tackle in this area are essentially accounting ones, and it will be no easy matter to determine the costs associated with developing and implementing educational technology.

The next set of questions can be summed up in one simple one: are the costs worth it? Exploring the impact of educational technology on conceptual learning, student engagement, and student interactions will help answer that question. But there are also questions related to faculty and institutional concerns. For example, what will be the impact of implementing educational technology on a faculty member's scholarship, professional reputation, or place in the campus community? Does the faculty member feel more or less engaged with the topical content of the subject when using a new educational technology? Can technology create renewed interest in basic material? And, finally, do students and faculty members have different reasons for wanting or not wanting technology in the educational process? What about administration and staff?

VI. Examples of Assessment Projects

The table in Appendix B lists a sample of the assessment projects we have been involved in along with their scope and current status. In the eighteen months since we have begun coordinated assessment activities, we have developed fifteen different projects of varying degrees of complexity and provided coaching to approximately a dozen more. We are just now beginning to amass enough data to be able to draw some conclusions—albeit preliminary ones—about the strengths and weaknesses of the various experiments.

Once more, let me briefly describe one project, how it came to be assessed, some preliminary findings, and how it fits into our broader goals.

In 2001, Professors Edmund Bertschinger and Edwin Taylor received d'Arbeloff funding to develop and implement an experimental physics course, "Exploring Black Holes: General Relativity and Astrophysics" (8.224). They introduced several pedagogical innovations in this course. First, it was taught without traditional lectures. Second, it enrolled MIT alumni—most of whom took the course solely online—along with MIT undergraduates. Students (both the undergraduates and alumni) were to make use of a discussion board to aid each other in learning the material; in fact, every week two students were required to start a topic on the subject of that week. As Cindy Dernay Tervalon [6] writes in an unpublished case study of 8.224, ". . . the new structure was designed to engage students in the class material by allowing them to determine the direction of the conversation and the depth to which material was covered." There were also required evening seminars for the undergraduates, during which experts in the field presented material. Alumni were encouraged to attend these seminars, but again, most were not within commuting distance. Recitations were held once a week for the undergraduates.

Grades were based on weekly memos that were to be done on the assigned reading (and which provided a deadline for completion of the readings); contributions to the discussion board; problem sets; participation and attendance at the recitations and evening seminars; and a midterm and final exam.

Professors Bertschinger and Taylor attended one of the assessment workshops that were "required" for all applicants for d'Arbeloff funding. They showed a livelier-than-usual interest in assessment and subsequently met individually with Dr. Newman to discuss assessment of the project. (As an aside, Professor Taylor is an Oersted Medal winner, an honor given by the American Association of Physics Teachers for outstanding contributions to physics education.) We determined we should put resources into the assessment of 8.224 since it was an excellent example of two of our themes: "producing online alternatives to lectures" and "building learning communities with alumni/mentor involvement." (In fact, the instructors had hoped the alumni taking the course would become mentors to the undergraduates since several of the alumni had been physics majors. Since the alumni had led very diverse professional lives since graduation, they could illuminate a variety of career opportunities for the students). Finally, we recognized the data from an assessment of 8.224 would feed into all three of the questions on our research agenda.

Ms. Tervalon was chosen to lead the assessment; she eventually worked with four UROP students. After the end of the semester, focus groups, in-person interviews, and telephone interviews were conducted with all the students. In all, eleven of the thirteen undergraduates and seven of the nine alumni were interviewed. In addition, preparations are underway to do a content analysis of all the entries made on the discussion board. (There were a number of technical difficulties that had to be resolved in order to accomplish this.) To our knowledge, this will be the first content analysis done of a discussion board, and we hope to learn much from this study about how this tool is both used for and has an impact on interaction.

Two preliminary results from the interviews are interesting but for now raise more questions than they answer.

First, the undergraduates and alumni did not bond as well as hoped. "The undergraduates were satisfied with the material they learned in the course," writes Tervalon [7], "but they struggled to see the benefits of having the alumni participate. The alumni enjoyed the course immensely, but felt disconnected from the undergraduates." Are there ways to structure a learning environment such as this one—where one group is only participating remotely—to permit more mentoring? Or are the limitations of the medium such that this simply will not happen?

Second, while most undergraduates did not feel they would have benefited from a weekly lecture, they thought an occasional lecture to "pull the material together and to provide continuity" would have been helpful. This finding is similar to other reports we have heard from students in distance learning courses or courses in which all lectures are online: They want some face-to-face interaction during the course of the semester. We wonder if this will be a relatively consistent finding for distance learning/online courses.

VII. Toward the Future

We realize we have bitten off a lot to chew with this assessment effort. Questions and topics need to be sorted, refined, and prioritized. Some will fall by the wayside. Others may occupy us over a long period of time. Findings from current studies will need to feed into future work, and will cause us, no doubt, to rethink our focus and the ways in which we use our resources. But we are excited about the intellectual challenges associated with this work, and motivated by the contributions it can make to the improvement of undergraduate education not only at MIT but elsewhere. We hope there will be other venues for us to report to you what we discover.

References

[1] Sally Atwood, "The Innovation Bubble," *Technology Review*, May 2002, 8.

[2] Professor Abelson is quoted in Lori Breslow, "Strategic Assessment," *The MIT Faculty Newsletter*, January/February 2002.

[3] Judy Dori and Lori Breslow, "What Is Conceptual Learning?," memo to the Microsoft-MIT Assessment Committee, n.p., February 12, 2001.

[4] Alberta Lipson and Bonnie Burrell, "Impact of Technology on Student Engagement," memo to the Microsoft-MIT Assessment Committee, n.p., February 13, 2001.

[5] See, for example, Richard Light, *Making the Most of College: Students Speak Their Minds* (Cambridge, MA: Harvard University Press, 2001).

[6] Cindy Dernay Tervalon, "Student Views of 8.224: A Qualitative Case Study," n.p., June 28, 2002, 1.

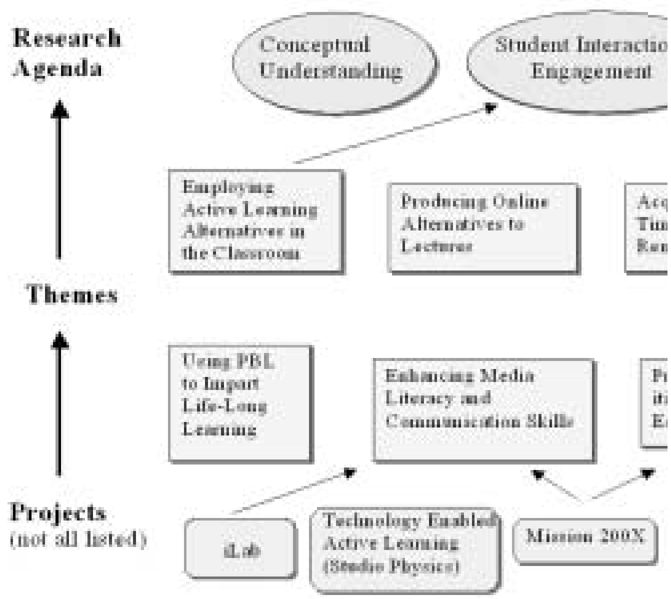
[7] Ibid., 16.

Author's Biography

Lori Breslow has been the director of MIT's Teaching and Learning Laboratory since its inception in 1997. Prior to that, she was Director of Teaching Initiatives at MIT. She is also a senior lecturer in the Sloan School of Management where she teaches courses in managerial and professional communication to MBA students and undergraduates. She also teaches two all-Institute courses on the Ph.D. level, "Teaching College-Level Science" and "Communication Skills for Academics." Dr. Breslow is a member of MIT's Council on Educational Technology. Her research interests are in interdisciplinary education and peer learning. She has a B.A. in history from Indiana University and a Ph.D. in Communication Arts and Sciences from New York University.

Appendix A

Figure 1: Intellectual



* Arrows for illustrative

Appendix B
Examples of TLL Assessment Activities 2001-2002

Subject or Project	Scope of Investigation	Status of the Study
Kinetic Processes in Materials (3.21)	Online survey to assess student satisfaction with the teamwork component of the subject.	Data to be analyzed
Structure and Interpretation of Computer Programs(6.001)	Experimental study, including: creation and refinement of an end-of-term survey; comparative investigation of conceptual and algorithmic understanding gained through either live or online presentations; selection and administration of standardized instruments.	Analyzing data
Biomedical Signal and Image Processing (6.555J)	Creation of a study design and grading rubric to compare an historical and experimental groups' use of a problem-based pedagogy.	Completed
Exploring Black Holes: General Relativity and Astrophysics (8.224)	Assessment of an experiment to enroll off-campus alumni along with undergraduates in a physics course;project entailed interviewing both undergraduates and alumni who took the course and conducting a content analysis of the discussion board used during the semester.	Qualitative report complete; content analysis to begin 8/1/02
Differential Equations (18.03)	Assessment of the introduction of groupwork into 18.03 recitations through classroom observation, focus groups, and surveys.	Analyzing data
MetaMedia/Shakespeare Video Annotation	Investigation into the use of online tools to enhance communication skills; methods used include interviews, focus groups, and surveys.	Analyzing data
Mission 2004-2005 (12.00)	Assessment of a problem- and teamwork-based freshmen subject through the use of classroom observation, surveys, focus groups, interviews.	Mission 2004 report complete; Mission 2005 preliminary report complete; expanded statistical report for Mission 2005 to follow
PIVoT	Analysis of use of a multi-media, Web-based learning environment for Newtonian physics.	Completed
TEAL Classroom	Observed classes conducted in 26-152 in order to assess the rooms's functionality and make recommendations for a second TEAL-like classroom.	Completed