innovations & implementations
Exemplary Practices in Teaching and Learning

Open Learning Initiative

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What is it?

Launched at Carnegie Mellon University in the fall of 2002, the Open Learning Initiative (OLI) is dedicated to the development of freely available, stand-alone college-level online courses informed by the best current research from the cognitive and learning sciences.[1] The OLI course-design process is unique in its dedication to teaming faculty content experts with cognitive scientists, learning scientists, human-computer interaction specialists, formative assessment specialists, and programmers. The initiative's commitment to ongoing course evaluation and iterative improvement also sets it apart. Ultimately, the collaborative nature of the OLI course-design process has had an additional, unanticipated effect: inspiring participating faculty members to rethink their approach to classroom teaching at the university. Although OLI courses are designed as stand-alone experiences, Carnegie Mellon faculty are successfully integrating OLI's Web-based instruction modules into their traditional instructor-led courses.

Most open-learning projects use the Web as a publishing medium for presenting existing course syllabi and materials that commonly represent the highly abstract and formalized perspective of the domain expert. While other open courseware efforts see the Web as a medium for publication and review, OLI regards the Web as an instructional medium whose interactive capacities have been underexploited. Integrating intelligent tutoring systems, virtual laboratories, simulations, and feedback mechanisms that capture rich information about student performance, OLI builds courses that are intended to enact instruction—or, more precisely, to enact the kind of dynamic, flexible, and responsive instruction available to students in small group settings.

By focusing on collaborative course design and evaluation, the OLI project promises to move online course development and evaluation beyond the current paradigms and to provide scientists with the data they need to test and improve on the efficacy of their learning theories. OLI's approach to open learning is based on cognitive research that shows the disparity between the way experts and novices approach the same system of knowledge. Each OLI online course is designed around the student, identifying and anticipating common mistakes and misconceptions. Informed by studies that show the effectiveness of active learning strategies, OLI courses offer students frequent opportunities to practice acquired concepts and skills within relevant and authentic problem-solving contexts, accompanied by immediate and tailored feedback on their performance—feedback that will help them transfer their learning to new situations.

At present, OLI has completed development of stand-alone courses in causal and statistical reasoning, introductory statistics, the chemistry "bridge course" (designed to strengthen student skills in stoichiometric calculations), and formal logic. In addition, OLI offers online course materials to be used with either textbooks or additional instruction, including a collection of Web-based experiments and workbooks in microeconomics, an intelligent tutoring system with more than 350 exercises in physics, and the StatTutor Labs course, with eight complete data-analysis problems—double the number usually used in traditional courses during a single semester. Modules from partially completed courses in biology, French, statics, calculus, and empirical research methods are also available on the OLI Web site.

In the fall of 2005, Carnegie Mellon undertook a study to determine whether students who take the stand-alone OLI statistics course performed as well as those who completed the university's traditional course. An all-volunteer test group of 20 students registered in the traditional course were asked to work entirely online. They performed as well on all four exams as those who attended class, with no significant differences between the two groups. Moreover, on a 4-point Likert scale, 75 percent of the students said they would definitely recommend the online course to other students, and the remaining 25 percent reported that they would probably recommend it. Currently, OLI's evaluation team is analyzing the detailed data log file that recorded all student activities. The team is looking for correlations between patterns of use and learning outcomes in order to produce design recommendations for future iterations as well as guidelines for effective teaching and learning strategies.

What problem does it solve?

In the realms of chemistry, physics, logic, and the like, traditional modes of instruction have followed the intuitions of expert researchers, faculty members who, for the most part, have never been trained in the art and science of instruction. Learning research demonstrates that the longer an expert continues to work in her discipline, the further removed she becomes from the perspective of the novice. Known as "the expert's blind spot,"[2] this inability to recognize (or empathize with) beginning students' difficulties means that the instructor tends to teach the course in a manner that makes sense only from the her perspective. Research shows that experts tend to expose beginning students to the central abstract concepts and equations of the field, assuming that novices will have an easier time working directly with symbols and equations than considering real-world situations in which domain knowledge and skills might prove useful on

a practical level. In traditional instruction, whether it takes place entirely online or in the classroom, learners are at risk of acquiring domain knowledge that remains "inert." That is, students become proficient in discrete skills but remain unable to apply those learned skills to new situations or to recognize how those skills and procedures fit into the discipline's larger narrative and systematic approach to problem solving.

How did they do it?

OLI's process for designing online courses works to mitigate against the expert's blind spot by using a variety of techniques to provide scaffolding for novice learners as they approach a particular discipline and its concerns for the first time. When moving to fully online instruction, course designers must compensate for the lack of immediate human intervention and tailored feedback. OLI's toolkit for providing this kind of feedback to learners includes sophisticated tutoring systems and virtual laboratories, as well as short Flash animations with spoken narration (based on the cognitive principle that students learn best if given mutually reinforcing information over both auditory and visual channels).

For example, OLI's chemistry course teaches stoichiometry, the mathematics that underlies chemistry, by having students explore a solution to arsenic contamination of the water supply in Bangladesh, a real-world problem through which learners are introduced to key concepts and practice targeted stoichiometric skills. As the student works, sophisticated assistance is provided, including frequent multiple-choice comprehension checks designed by experienced instructors who are aware of common student misconceptions and mistakes. So-called Cognitive Tutors provide hints as students work through complex problems, providing immediate and tailored feedback, along with "what-if" questions devised to help students think flexibly about applying their acquired skills to other situations.

Why is it noteworthy?

- **"Cognitively informed" approach to online course design:** OLI asks its faculty content experts to question their intuitions about teaching by participating in a multidisciplinary course-building process in which team members from the cognitive sciences construct a profile of a novice learner based on observations of beginning students tackling key concepts and skills within the faculty member's knowledge domain. Reminded of the novice learner's perspective throughout the design process (owing to the varying levels of domain knowledge represented by the members of the multidisciplinary design team), the faculty content expert often rethinks his or her entire approach to classroom instruction as well.
- **Ongoing, formative course evaluations:** OLI documents the course-development process, including the methods and assumptions used when applying learning science theory to online instructional design. The program has also established a systematic procedure for evaluating courses on a routine basis, using that evaluation to improve each course and feeding evaluation results back into the cognitive and learning-science research communities. These results can then contribute to the development of more effective theory-based instructional strategies, which in turn will be fed back into the OLI course-design process.
- **Broad dissemination:** Modular in nature, OLI courses are designed to be disseminated openly and freely to individual learners and (at low cost) to other interested institutions where faculty may deliver an entire course as designed or modify the course content and chronology to fit their students' needs and curricular goals.

To learn more

Visit the OLI Web site at **http://www.cmu.edu/oli/**.

To share your innovation

If your institution has a practice that you believe would be of interest to the EDUCAUSE Learning Initiative, please share it with us. To submit your innovation for review, please use the ELI Innovations Contribution Form on our Community Exchange page <http://www.educause.edu/ELICommunityExchange/6797>. A panel will review your submission and make a recommendation to the ELI staff.

About the EDUCAUSE Learning Initiative

The EDUCAUSE Learning Initiative (ELI) is a community of higher education institutions and organizations committed to advancing learning through IT innovation. To achieve this mission, ELI focuses on learners, learning principles and practices, and learning technologies. We believe that using IT to improve learning requires a solid understanding of learners and how they learn. It also requires effective practices enabled by learning technologies. We encourage institutions to use this report to broaden awareness and improve effective teaching and learning practice.

[1] OLI is supported with a $1.9 million grant from the William and Flora Hewlett Foundation and "in kind" contributions from Carnegie Mellon University, and the effort builds on prior work from a variety of federal research grants.

[2] Nathan, M. J., & Koedinger, K. R. (2000). Teachers' and researchers' beliefs of early algebra development. *Journal of Mathematics Education Research, 31*(2), 168–190.