ESSAY D

UCLA's Educational Technology Initiatives: Enhancing Learning and Teaching

Introduction

UCLA embraces the potentially powerful contributions that educational technology can make in enhancing learning and teaching, and we are proud of our accomplishments toward establishing what we believe is one of the best technology-enriched educational environments in the country. Our efforts are grounded in the belief that the utility of educational technology lies in the extent to which it can be used to solve perennial pedagogical challenges that faculty confront and eliminate inherent constraints that characterize conventional teaching situations. We are not interested in educational technology for its own sake or for its "automating" capacity. Rather, our focus is on understanding how the application of educational technology can enhance learning and teaching.

We approach this work with high levels of optimism and commitment. At the same time, we are reluctant to move too quickly based on our awareness that within real-life educational contexts, *increases* in learning, as opposed simply to *changes* in learning, are difficult to identify. While there is considerable literature on applications of technology to learning environments, the contexts within which research has been conducted are diverse and the findings are not definitive. Like our colleagues at other universities, we are still in the early stages of understanding the true impact of educational technology on learning and productivity.

UCLA's academic community is rich with ideas for using technology-enabled pedagogy to facilitate selected learning outcomes, and we are committed to providing well-equipped teaching spaces, assessing pilot efforts, sharing findings, broadening implementations, and rewarding innovators. Our technology enhancement efforts are supported by a broad-based planning process[1] that is redefining what we strive to accomplish and how we intend to achieve our goals, particularly in light of severe current and near-term economic pressures. We view our continued progress to be tightly linked with our ability to establish and maintain a cohesive instructional technology environment through collaborative efforts and creative leadership.

Our technology enhancement efforts are also supported by a recently proposed UCLA Information Technology (IT) Plan: 2009-2018[2]. The plan describes a model for the co-existence of IT-supported innovation at the unit level, and individual and large-scale innovation through IT-supported collaborations as well as interdisciplinary and inter-institutional programs. The plan also introduces the concept of the digital UCLA citizen who is literate in IT but also understands the responsibilities of being an IT-user in a community and an institution.

In *Essay 6*[3] of our *Capacity* report, we reflected on our past successes in: providing support for technology in instruction; establishing a governance structure for deciding institutional information technology direction, policy, and investment; developing a campus-wide vision for educational technology that enriches learning, teaching, and research environments; using the Internet to engage students in scholarly interaction; and enhancing external access to UCLA. We also considered how to most effectively, and efficiently, continue developing a Common Collaborative Learning Environment (CCLE). In its report[4], the WASC Site Visit team commended UCLA's focus on using educational technology to enhance students' academic experiences:

Unlike many institutions that perceive educational technology as merely a utility or a suite of tools, UCLA is forward thinking and leverages educational technology to support active learning, scholarly interaction, and intellectual pursuit—enabling its graduates to be informed and discerning global citizens and contributing working professionals.

In the present essay we update our progress in three key areas. First, we highlight campus efforts to create effective teaching spaces, understand student perspectives on educational technology issues, and develop a cohesive instructional technology environment at UCLA. Second, we showcase selected faculty-initiated efforts to engage students more actively in course content through the use of educational technology tools and to enrich technology-enhanced instructional efforts. Third, we spotlight College librarians' efforts to provide information literacy instruction to students across many disciplines, then focus on the information literacy development of entering students enrolled in the Freshman Cluster Program. We close the essay with a brief summary of future plans.

Common Solutions for Campus Educational Technology Issues

The three topics selected for this section of the essay grew out of our *Capacity* essay on Educational Technology and discussions with the WASC Site Visit Team in 2008. The topics, which include: 1) creating effective teaching spaces, both virtual and real; 2) understanding student perspectives on educational technology issues; and 3) creating the Common Collaborative Learning Environment (CCLE), are subjects that are important to faculty and students alike. These topics are also key to many of our discussions on enhancing learning and teaching.

Creating Effective Teaching Spaces, Virtual and Real

The concept of teaching spaces has long surpassed the standard physical environment of classrooms and laboratories. These categories of space, however, are still critical in applying many kinds of educational technology. At UCLA, the approximately 200 general assignment classrooms are 100% network-connected, 98% equipped with projection or monitor display hardware, and 50% equipped with computers. As noted in the OID website listing[5] for Audio Visual Services, rooms are also equipped to support multiple media sources and outputs.

General assignment rooms are equipped, upgraded, and prioritized according to a five-year management plan[6] that is overseen by a classroom committee composed of administrators (representing Facilities Management, Capital Programs, Instructional Development, the Registrar, and Classroom Services) and faculty. The group established one of the earliest examples of classroom design standards[7] in higher education in the late 1970's, and the most recent version was issued in Fall 2006 to address current expectations for teaching with technology. Annual reports[8] highlight changes and emerging issues. The Committee has surveyed students about their classroom experiences and, apart from the provision of left-handed writing tablets in lecture halls (an issue addressed nearly two decades ago), the students seem to have little concern about classroom features and technology. They have extensive comments about perceived temperature and ventilation issues in classrooms, but technology itself seems transparent to them – it is just "there." Student data, therefore, have not contributed to a plan for action.

Additional special physical environments have also been built for instruction, such as the Visualization Portal[9] that enables presentations in vivid 3-dimensional formats, the Keck GIS Laboratory currently under construction in the Young Research Library, the College Library Information and Computing Commons (CLICC), Academic Technology Services, the Center for Digital Humanities, Social Sciences Computing labs, Office of Residential Life labs, and numerous departmental or divisional laboratory spaces. Of these, the CLICC teaching space, located in the

Powell Library Building (the undergraduate library), sees the heaviest utilization, and almost 97% of its total use is by undergraduates.

Since opening in 1996, CLICC has conducted annual surveys[10] of user populations to follow changes in student perceptions, needs, and use. A ten-year longitudinal study of those data revealed a number of key differences between the UCLA population and national IT industry predictions about student behaviors. For example, although most UCLA students own personal computers and increasingly have high-speed Internet access from their residences, lab use remains steady and, in some cases, has even increased moderately. In addition, despite widespread wireless access to Internet resources on campus, the overwhelming majority of UCLA students who have their own laptops do not bring them to class or to campus. Preference for the Windows platform has also remained high, yet a resurgent student interest in Macintosh laptops caused CLICC to change the inventory of its hardware and to dramatically expand the number of available laptops to meet student requests. In response to student requests, during the last seven weeks of each quarter, CLICC now also provides 24-hour access. Additionally, CLICC operates three dedicated computing classrooms where faculty can teach in-class, computing-intensive material.

In 1997-98, UCLA took a major, innovative step to digitally expand the concept of teaching spaces by establishing the Instructional Enhancement Initiative[11]. Through the introduction of course websites, the pioneering *MyUCLA* portal[12], and enhanced access to computing laboratories, the Initiative has guided a concerted effort to promote the use of digital resources both within and outside the classroom and has affected almost every aspect of undergraduate education at UCLA.

The vast digital resources of the Library have enormously expanded and enriched UCLA's digital learning space. While books still comprise the major part of College Library reserve materials, digital materials in e-reserves have also become an established part of the student resource base. Additional resources of original data in digital formats via the Institute for Social Research[13] or the Center for Embedded Network Sensing[14] provide a wealth of materials that can be readily adapted from research to instruction. The Institute for Digital Research and Education[15] exists specifically to serve as a focal point for expertise in digital domains in a cross-disciplinary environment and to serve instruction as much as research. To align student performance with the richness of these resources, the campus must also help students develop additional skill sets and provide them with supporting library tools and software instruction.

Another response to providing supplementary instruction and virtual access has been webstreaming through the UCLA BruinCast[16] program. BruinCast is a service offered by the Office of Instructional Development (OID) to video stream and/or audio podcast regularly scheduled undergraduate lectures for review purposes. Video Streaming allows students to see the instructor, whiteboard, slides, and any image that is shown through the video/data projector. Audio podcasting can be an equally powerful review tool when combined with materials made available through an instructor's course website. While the current intent of these services is to provide augmentation of the lectures and to respond to the asynchronous study behaviors of students, the program may be asked to serve additional purposes.

The UC Office of the President is currently examining the feasibility of providing additional online instruction to promote inter-campus cost savings. Within the local UCLA context, which is severely hampered by the lack of large lecture halls, BruinCast may also provide a tool to increase the capacity of individual courses. The campus will experiment with the concept of "e-sections" that would permit students to access the lecture from their laptops at almost any location and leave physical attendance an optional activity. While this instructional format is not universally

applicable or desirable, the changed fiscal environment described in *Essay A* requires that UCLA explore alternate delivery and instruction systems that can be both effective and highly efficient.

One reason for optimism is that the Office of Instructional Development, which has monitored Bruincast use since the service's inception in 2005, has conducted surveys[17] of students and interviews with faculty in BruinCast supported classes. Over the past three years, both students and faculty have consistently supported the service based on its positive effects on learning and teaching. For example, as illustrated in Table 1, 96% of student survey respondents (N=917) reported that webcasting was "somewhat helpful" or "very helpful" in affecting their learning.

Table 1. BruinCast Survey Questions and Responses for Three Spring Terms

A. To what extent do you think the webcasts/podcasts affected your learning in this class?

	Spring 2006	Spring 2007	Spring 2008	Average
Very Helpful	90%	86%	79%	85%
Somewhat Helpful	5%	10%	16%	11%
No Effect	3%	4%	1%	3%
Somewhat Detracted	1%	0%	0%	1%
Strongly Detracted	0%	0%	0%	0%
Did not use webcast/podcast	0%	0%	4%	1%

B. To what extent did having the lectures available online affect how often you came to class for lecture?

	Spring 2006	Spring 2007	Spring 2008	Average
More likely to attend class	1%	12%	9%	7%
Somewhat more likely to attend class	5%	4%	4%	4%
Did not affect my attendance	36%	36%	50%	41%
Somewhat less likely to attend class	24%	31%	24%	26%
Less likely to attend class	33%	18%	11%	20%
Did not use webcast/podcast	0%	0%	3%	1%

C. How do you agree with the following? "I think that having access to the webcasts allowed me to spend more time reviewing course materials than I would have if the webcasts were not available."

	Spring 2006	Spring 2007	Spring 2008	Average
Strongly agree	73%	68%	68%	70%
Agree	19%	23%	20%	21%
Neutral	8%	7%	7%	7%
Disagree	0%	1%	1%	1%
Strongly disagree	1%	0%	0%	1%
Did not use webcast/podcast	0%	0%	3%	1%

Faculty members were also largely supportive of BruinCast. They recognized that students appreciated the service and noted that it enabled them to use office visits and e-mail to address more substantive questions. Faculty also reported instructional benefits, including that they needed less time in class to review material and were less bound by their textbook's offerings since students had the ability to review lectures for clarification. Nearly every faculty member commented that BruinCast was a "great way to disseminate knowledge." Even so, many continue to restrict access to their lectures given concern that they might accidently commit copyright infringement or compromise protection of their own intellectual property.

The growing demand for BruinCast reflects the overwhelmingly positive response from students and faculty regarding the service. Presently, BruinCast serves roughly 50 to 60 courses per quarter, which is the current capacity of the system. Plans are underway to incorporate newer technology and expand capacity during the 2009-10 academic year.

The utility of BruinCast underscores the transitional state of distance learning at UCLA. Long-used by multi-campus programs (e.g. Armenian Studies, Transportation Studies, Religious Studies, etc.) in a synchronous format, BruinCast has moved to include the "Less-Commonly Taught Languages," and is now finding additional adherents in larger language departments. Asynchronous and completely online instruction has also taken hold, most noticeably in the professional schools. Engineering offers an entirely online Masters Program, while Management provides several online courses that are widely offered within the UCLA Extension Program. While the main campus curriculum has not previously defined distance learning and/or exclusively online instruction as a priority need, the preliminary success with the supplementary BruinCast program and the new fiscal realities may accelerate adoption of such approaches.

Understanding Student Perspectives on Educational Technology Issues

Most incoming UCLA students are reasonably comfortable with a limited set of core technologies. As they proceed through their undergraduate studies, the set of skills they are expected to demonstrate expands. One major set encompasses so-called "universal skills," which include: developing search strategies; using logical operators; employing various communications networks and devices; and demonstrating graphical literacy as well as presentation skills.

Incoming students express varying self-assessments of their technology experience and skill levels. The Cooperative Institutional Research Program (CIRP) Freshman Survey[18] asks UCLA freshmen to provide self ratings. In the 2007 Survey, roughly 33% of freshmen respondents (N=4,140) rated their computer skills "above average" or "highest 10%" relative to their peers, while slightly over half rated their computer skills as "average." About 11% rated their skills "below average" or "lowest 10%." When asked how often they used the Internet for homework, 86% indicated they used the Internet "frequently," 14% "occasionally," and less than 0.5% "not at all."

Comparing these two categories of responses, we might conclude that despite their sense of familiarity with using Internet resources, freshman are only moderately confident in their ability to use computers relative to their peers. However, this may have more to do with experience than capability. When asked to rate how well they "…do each of the following tasks as compared with the average person your age," student responses, reported in Table 2, demonstrate confidence with tasks they have already performed but uncertainty about tasks they have yet to undertake.

Table 2. CIRP Items Related to Information Technology Skills (2007 Survey)

	N	Above Average	Average	Below Average	NA* or don't know
Ability to download & use file (text, music, photo)	1,826	50.3%	43.6%	5.6%	0.4%
Ability to send an attachment with email	1,824	61.0%	35.7%	2.9%	0.4%
Ability to manage files on your computer	1,813	42.1%	46.3%	10.0%	1.4%
Ability to create a presentation electronically	1,810	33.5%	48.6%	15.1%	2.6%
Ability to download and use a podcast	1,781	16.0%	30.1%	28.9%	9.2%
Ability to upload a file (text, music, photo, etc)	1,798	31.4%	36.7%	21.8%	9.2%
Ability to contribute to a wiki	1,788	10.8%	20.2%	22.3%	41.6%

* NA = Not applicable

These findings are also supported by data gathered independently through the annual CLICC lab survey, which show that only 5% of respondents feel they lack the skills they are expected to demonstrate. Over time, as students become increasingly more familiar, and proficient, with a broader range of computer skills at even younger ages, we expect that entering cohorts of UCLA students will exhibit increased skill and confidence with respect to technology use. We cannot assume though that their self-assessments will always match their actual performance abilities.

As counterpoint to the question of how well prepared students perceive themselves to be when they enter UCLA, we also asked seniors how they experienced the UCLA educational technology environment. Findings from the 2007 Senior Survey[19] reveal that among College of Letters and Science respondents (N=4,607), 60% said that they had "often" or "very often" used web-based course materials and tools over the last two years. Only 9% said that they needed technical assistance. The majority of respondents "agreed" or "strongly agreed" that the availability of web-based materials and applications:

Increased engagement in the course	71%
Increased interest in the subject	50%
Made it easier to collaborate with classmates	70%
Helped in learning effectively outside of class time	72%
Helped to better understand complex concepts	62%

Our seniors have also shared their insights on how UCLA's web-based course materials could be improved. Looking across the four divisions of the College of Letters and Science, it was not lower cost or more technical training that seniors wanted. Rather, they encouraged further investment into the websites themselves, greater access to web-based materials, and more extensive faculty use of websites. Students also had issues with the multiplicity of website formats, and we will address this in the section below on creating the Common Collaborative Learning Environment (CCLE). One challenge in analyzing future Senior Survey data will be to differentiate trends that are fundamentally the result of changes in entering students' skill sets from those attributable to changes in the UCLA website environment, both of which are developing rapidly.

Creating the Common Collaborative Learning Environment (CCLE)

UCLA's commitment to using educational technology to improve student learning is reflected in ongoing, campus-wide collaboration to foster the adoption of a single course management system that is also suitable for research applications. The process illustrates UCLA's commitment to collectively addressing instructional issues and adapting to changing environmental circumstances. It also reflects our efforts to critically examine the cohesiveness of the instructional technology environment.

Numerous (more than two dozen) course management systems have been employed at UCLA. Arguments in favor of sustaining such diversity were eventually overcome by increasing institutional cost and the complexity of maintaining and interacting with so many systems. The Faculty Committee on Educational Technology[20] (FCET) made a strong recommendation in May 2005 that UCLA converge on a single solution for a course management system through a "consistent, powerful, and transparent application." An intense period of discussion through two campus *ad hoc* groups (the Functional Support Group and the Technical Support Group) resulted in a recommendation that the application selected should be an open source solution. Further analysis and debate resulted in a subsequent report[21] and the selection of Moodle, in October 2006, as the open source platform. By April 2007, an Alpha Moodle service was in place as an extensive campus discussion ensued on the various governance and funding models that might be employed. The CCLE Planning Team was appointed to "engage in broad campus consultation and to recommend the appropriate scope, scale, staffing, architecture, operation, use, and funding for the next phase of the CCLE initiative."

By August 2007, the Planning Team submitted its report and, at the first opportunity, that October, it had submitted its request for funding to the Chancellor's Office through the Committee on Information Technology Infrastructure (CITI[22]). Funds were allocated in early 2008, and the plan was implemented through defining and recruiting staff positions, selecting a "home" for the CCLE functions in the Office of Instructional Development, soliciting the deans to "opt-in" to the shared system, and establishing CCLE's own advisory and oversight group, the CCLE Standards and Practices Group (S&PG.) In addition, the S&PG established a shared training, support, and development infrastructure, worked out the technical and legal (FERPA) public and private controls for course materials, and developed batch creation of courses and pre-population of course rosters. A special subcommittee of the S&PG took on the task of defining a process and selection criteria for awarding Innovation and Development grants within the larger Moodle structure, and made its first round of allocations in April 2009.

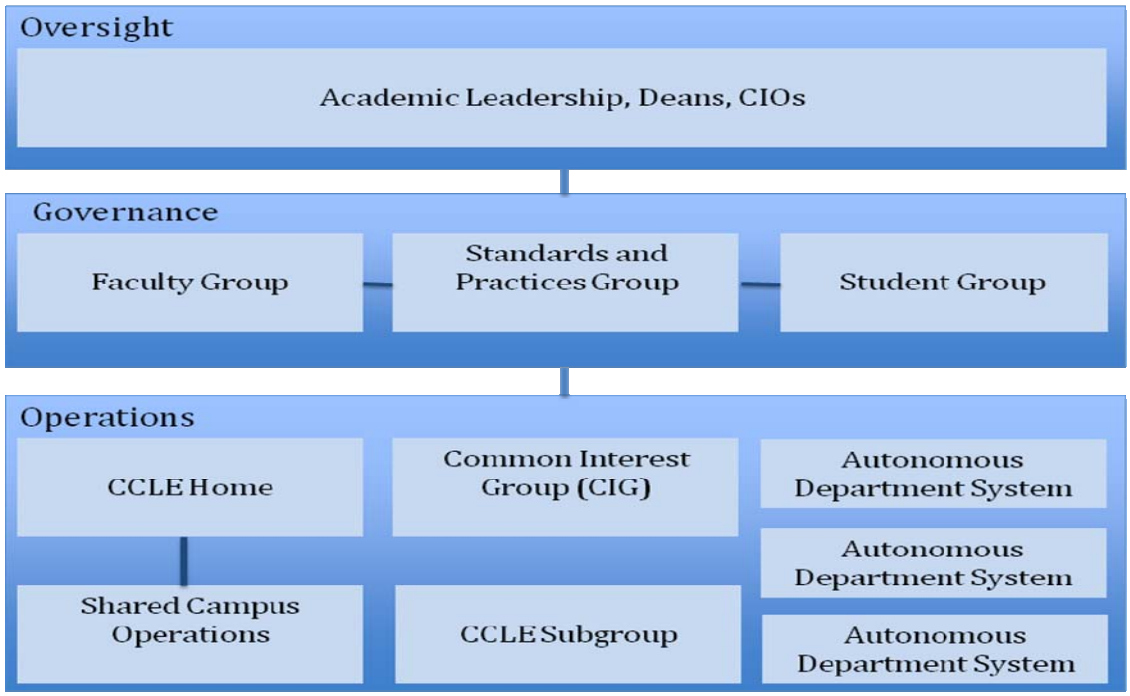
Universities are often criticized for their inability to move quickly as they engage in lengthy review and approval processes. UCLA's implementation of the CCLE, however, has been both expeditious and extensively consultative. Its collaborative structure depicts a model of federated management–one of shared participation and responsibility–that is likely to become more commonplace within university structures as solutions to learning and teaching issues expand beyond the ability of individual departments and schools to respond.

The CCLE has established a three-tiered shared governance model that distributes responsibilities for overseeing operational and pedagogical needs campus-wide. In response to the site visit team's report[23], a brief overview of CCLE's organizational plan for oversight, governance, and operations follows, and sets the framework for future assessment of the collaboration's educational effectiveness.

Developing a cohesive instructional technology environment is a test of leadership, governance, and resources. The CCLE Initiative has engaged each of these needs as it moved from conception to implementation. As delineated in the initial Planning Team's five-year implementation plan[24], a shared governance model requires academic leadership that depends on faculty and student participation. Moreover, successful operations rely on campus-wide collaboration for technical support at the department level. Figure 1 illustrates the general framework of the governance model. The multi-tiered shared model of governing CCLE is consistent with UCLA's overall approach to managing information technology on campus, which is discussed in the new proposed IT Strategic Plan.

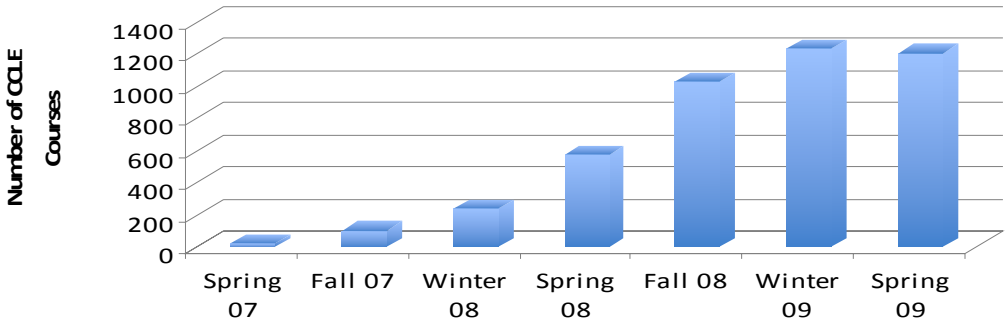
The Faculty Committee on Educational Technology (FCET), the Information Technology Planning Board (ITPB), and various deans of Schools and Divisions who have opted into the collaboration provide oversight for CCLE's shared governance. The S&PG works with faculty and student groups to provide balanced governance across campus constituencies. Operations are maintained by shared campus operations under the supervision of the CCLE home, which resides within the Office of Instructional Development (OID). Various regional and autonomous department systems offer hands-on support at local levels.

Figure 1. Overview of the Three-tiered Shared Model for Governing CCLE



Ensuring that the ideals of the planning document manifest in the structures built in response to the plan has been no small effort. Even so, the growth of the CCLE has been successful beyond initial expectations. As of April 2009, 12 of 14 deans had committed to the CCLE, and appointed voting representatives to the S&PG. The number of different Classroom Management Systems on campus has significantly decreased, and additional independent systems are likely to be dropped as their license agreements expire. The number of collaboration sites has grown to roughly 300, and the number of courses using the CCLE reached 1,200 by Winter 2009 (Figure 2). A summary of the program's progress and development is contained in the first CCLE Annual Report[25].

Figure 2. Number of Courses Managed through CCLE



Results from a recent survey of students and faculty who use CCLE's course management system indicated that 82% of the 752 student respondents found CCLE "easy" or "very easy" to use, with slightly over half (51%) reporting they "haven't had any difficulties." Nearly two-thirds of student respondents rated their "overall experience" with CCLE as "good" or "excellent." Among the 132 faculty respondents, 62% reported that CCLE was "easy" or "very easy" to use, and 40% cited "general usability" as the "most significant advantage of using CCLE to deliver course materials." A summary[26] of the survey results, including student and faculty comments, is posted as a UCLA WASC document.

Assessing Learning and Teaching Using Educational Technology Tools

Like their counterparts at other universities, UCLA faculty members have historically tended to rely too heavily on indirect and affective indicators to assess educational effectiveness. These types of student perception and self-assessment measures provide important information about the added value of instructional enhancements, but they do not provide direct indications of learning. With the collective support of the various assessment offices across campus, UCLA instructors are now pursuing more direct assessment efforts (see *Essay B*). In this section, we spotlight faculty's use of Moodle-based tools to enhance instruction and assess learning. We have selected three examples; two focus on language instruction in introductory Hebrew and Italian classes. The third comes from the incorporation and assessment of Quiz Tool in an introductory statistics course and involves a multi-year assessment project.

Introductory Language Courses: Two Pilot Studies

Dr. Nancy Ezer (Lecturer in Hebrew) has created the Hebrew E-Workbook Project, wherein she has created a fully online workbook using CCLE Moodle's Quiz Tool. The primary features of this workbook include fully automated grading, instant feedback, and the ability for students to make multiple attempts on classwork and homework. It also provides grade and other detailed statistical information for instructor monitoring of the class as a whole and individual students. UCLA's Center for Digital Humanities[27] compiled data on student performance during a pilot study of the E-Workbook and compared it to the performance of students using a paper-based version of the same workbook. The data support significantly improved student learning for those using the E-workbook due to:

1. Instantaneous feedback that increases students' motivation to produce perfect, or near perfect, work. Each student, on average, makes 3-4 attempts on a particular homework or in-class assignment, which results in better performance on important exams when compared to students using the paper version of the workbook.

2. Increased accessibility that allows students to drill and master difficult concepts at their own pace.
3. Automated feedback and ready availability of lessons, class work, and exercises. Instructors can refer students to the workbook, saving instructor time and effort and allowing intensified focus on students' mastery of Elementary Hebrew.
4. Availability of detailed statistical data, which enable the instructor to design lessons and materials tailored to strengths and weaknesses of individual students and the entire class.
5. Easy monitoring of ongoing assignments, which can be improved instantaneously when the instructor discovers errors, thereby minimizing potentially negative impacts for students and maximizing learning potential.

As one of the early adopters of CCLE Moodle, Dr. Ezer has successfully demonstrated its robustness and validity as an effective instructional tool. Similarly, Dr. Elissa Tognozzi (Lecturer in Italian) found that CCLE Moodle supported the use of WIMBA, a voice tool communication product, to significantly improve student learning in Italian language courses. In a Fall 2007 pilot study, Dr. Tognozzi assessed the accuracy and fluency levels of two groups of Elementary Italian students, with one group using WIMBA and a control group engaging in the same oral activities exclusively in the classroom. The study evaluated the integration of WIMBA into the traditional curriculum and the effectiveness of technology in improving students' speaking ability and confidence. The WIMBA group completed weekly oral activities on the web and received oral feedback from instructors through web communication; the control group completed the same weekly oral activities in the classroom with student-teacher interaction and feedback taking place in the classroom.

At the end of the quarter, both groups recorded identical final oral exam scores using the WIMBA software. After an inter-rater reliability study was done, a trained rater recorded errors for all speech samples. The scores were attached to the students' pre- and post-surveys to determine the general comfort level of students using voice technology, faith in voice technology to accurately represent their abilities, and expectations of the increased accuracy of this type of voice technology. Findings showed that students who used WIMBA produced a greater number of words, had a wider range of vocabulary, were more accurate in their word order, and demonstrated better fluency. As such, WIMBA is now integrated with CCLE Moodle for all level 1 through 6 Italian Language courses.

Introductory Statistics Courses: A Multiyear Assessment

The following case study of Statistics 10[28] – *Introduction to Statistical Reasoning* illustrates the experiences of a large-scale general education course that explored, assessed, and eventually implemented a blend of in-class instruction and Moodle's Quiz Tool in order to achieve a critical transformation of learning through innovative applications of technology.

Beginning in Winter 2005, Dr. Mahtash Esfandiari (Senior Lecturer in Statistics) extensively redesigned Statistics 10 by using online quizzes, weekly labs, and homework to maximize students' roles as active learners, and minimize their roles as passive recipients of information. In doing so, she believed that she could capture students' attention and motivate them to think about statistics as a "science of data" for answering real world questions rather than as a series of stepwise calculations with no real context. Her primary instructional objective was to minimize lecturing and maximize time working directly with students to help them construct their own terms for understanding through a generative learning process. The process required students to use prior

knowledge to create new ways for answering questions and necessitated considerable instructor/student interaction. Considering the number of students involved (up to 2,000 annually), Dr. Esfandiari needed to identify, and ultimately develop, an instructional tool that made it possible for the instructor and the teaching assistants to facilitate this process.

Moodle's Quiz Tool function allowed Dr. Esfandiari to develop an automated test bank of nearly 1,500 multiple-choice statistics questions that engage students' higher order thinking skills, including application, analysis, synthesis, and evaluation. Instructors can create online quizzes by selecting test bank items based on lecture material topic and desired difficulty level. Typically, Statistics 10 instructors create two weekly quizzes. The first quiz is administered via Moodle the day after lecture, prior to the week's discussion section in order to measure student comprehension of lecture material. Teaching assistants have the ability to monitor student progress online, allowing future instruction and discussion to be tailored to the strengths and weakness of students' quiz results. They can also assess which students are progressing similarly and create compatible small groups for in-class discussions. This allows the teaching assistant to focus on the groups' needs more efficiently and encourages students to discuss their misconceptions as a group, thus further developing their knowledge through peer collaboration.

After students attend the week's discussion section, the second quiz is administered via Moodle. This quiz addresses the same concepts as the first quiz by using similar questions from the test bank, which are easily identifiable through the test bank's search function. Like the teaching assistant, the instructor then monitors student progress via performance on the second quiz and adjusts the upcoming lecture accordingly. Dr. Esfandiari's application of Quiz Tool allows instructors to consolidate their workload by automating the construction and grading of the quizzes, so there is more time to focus on reordering instruction to support student progress. It also provides an opportunity for formative evaluation at the individual student level. Immediate quiz feedback allows students to monitor their progress by identifying which concepts and procedures they need to revisit. This process helps students self-pace their learning and also enhances scaffolding capabilities by aiding students in mastering the foundational knowledge that will make it easier for them to learn new, more advanced material.

An experimental study was designed to investigate the educational effectiveness of blending standard in-class teaching methods with Moodle's Quiz Tool when teaching introductory statistics to a large group of students (100 or more). For the purpose of this study, educational effectiveness was defined by a student's ability to apply statistical principles to solve or interpret real world questions versus simply mastering statistical formulas. This included the ability for higher order thinking such as application, analysis, synthesis, and evaluation. In addition to the study's overarching goal of determining the educational effectiveness of blended instruction, there were other operational objectives to consider. Nearly 2,000 students enroll in Statistics 10 annually, so the impact on teaching loads is great. As such, the study also addressed the logistics of accommodating large numbers of students without sacrificing learning or hands-on instructional support. Direct and indirect assessment methods were employed to evaluate knowledge-based and affective measures of student progress.

The study involved two separate Statistics 10 courses; one served as the experimental group and the other as a control group. Every possible effort was made to identify and control for variables that could skew the study's findings. However, it proved challenging in this course to create a controlled learning environment where the same lessons were taught with absolutely no technology component since without technology aids, certain critical aspects of the standard curriculum would be impossible to implement. In particular, it would be inordinately time-consuming to assess

student progress within such large courses without online weekly quizzes. It was determined, therefore, that the control group would have the choice to complete similar weekly practice quizzes; however, they would not experience the customized discussion groups based on monitored progress, which were critical to the experimental approach.

At the end of the term, students from both the experimental and control groups were surveyed about their impressions of how, and why, they developed understanding throughout the course. Attendance, homework, student interactions, active learning, memorization, knowledge application, and critical thinking elements were all addressed. Students also completed a final examination to assess learning outcomes that ranged from solving mathematical equations to evaluating real world cases.

Overall, the findings supported Dr. Esfandiari's premise that blended instruction would foster student reflection and self-generated learning and lead to higher order thinking. For example, students from the experimental and control groups performed equally well when asked to respond to open-ended questions that related to hypothesis testing calculations. However, experimental group students performed much better than control group students on open-ended questions that related to the Central Limit Theorem, which involved analysis and evaluation. When control group students responded to these questions they were able to use the correct statistical terminology to describe the problem, but they were unable to elaborate on what the terminology meant.

The experimental group's perceptions of the generative nature of lecture, lab, homework, quiz, and group discussion of the quiz also differed significantly from the control group's learning experience. When asked to rank the factors that enhanced their knowledge generating capacity, experimental-group students indicated that online quizzes ranked highest, followed by class discussions, assigned homework, laboratory, and lecture. When asked what led to enhancing their ability to apply statistical principles, they credited the very tools and active learning techniques that had compelled Dr. Esfandiari to restructure Statistics 10, using Moodle to incorporate blended instruction.

Based on these findings, Dr. Esfandiari worked with other faculty in the Department of Statistics to implement blended instruction for all Statistics 10 courses. She has revised all syllabi to reflect the course objectives and expected learning outcomes, and all instructors and teaching assistants now also explain to students the motivation behind generative learning. In addition, Dr. Esfandiari has developed a peer mentoring system for experienced teaching assistants to support new teaching assistants in learning how to teach in the new format. Finally, she continues to improve the test bank by expanding the scope of the questions, while regularly assessing the tool's effectiveness for instructional purposes.

Developing and Assessing Information Literacy Across Disciplines

In this final section of our Educational Technology essay, we highlight UCLA's efforts to develop and assess information literacy through the Information Literacy Program[29], which has been developed by UCLA Librarians for undergraduate and graduate students. We then focus on a pilot study that examines the information literacy development of entering students enrolled in the Freshman Cluster Program[30] during the past two years.

The Library's Information Literacy Program

UCLA faculty expect students to master information skills that will increase their capacity for conducting research in general education and major courses, as well as facilitate lifelong learning.

Toward that end, UCLA librarians have created an Information Literacy Program to develop requisite abilities and skills. Under this program, librarians define an information-literate undergraduate student at UCLA as one who can:

- articulate an information need clearly, search effectively for and find sources to meet that need, and evaluate both the sources and the information provided for authority and relative worth;
- synthesize materials to create a suitable product, such as a research paper or presentation, that properly credits all sources and research partners;
- understand how research is produced in his or her major; and
- discuss important societal issues regarding information access and new information technologies.

Librarians work with faculty to help students meet information literacy expectations. Librarians also create online tutorials, research guides, tip sheets, workshops, and courses, such as "Research Information Literacy," a two-unit course designed to assist students who plan to conduct a major research project in the behavioral and social sciences. Although most programs are tailored specifically for undergraduate students, librarians also provide guidance for graduate students.

The challenge to helping students develop requisite information literacy skills is compounded by the dynamic nature of informational databases and technology, variations in emphasis among disciplines, and cost-efficiency challenges. In 2007-08, librarians conducted 368 face-to-face information literacy sessions, involving over 6,000 undergraduate students. Table 3 illustrates that most students (70%) reached through Library instruction are in the humanities and social sciences, or associated with special programs. At present, the English Composition (Writing Programs) and UCLA's Freshman Cluster Program are the predominant users.

Table 3. Information Literacy Activities among Various Departments and Programs

Department or Program	Students	Sessions
English Composition (Writing Programs)	1,124	101
Freshmen Cluster Program	996	37
Sociology	629	19
Communication Studies	361	18
Anthropology	288	20
History	183	11
Ancient Near East	181	9
Information Studies	157	56
Athletics Tutorials	84	13
College Honors Collegium	74	15
English as a Second Language	54	5
Freshman Summer Program/Transfer Summer Programs	52	3
Totals	4,183	307

In an effort to broaden earlier approaches to promoting information literacy, a blend of online and in-class instruction was built into the yearlong interdisciplinary Freshman Cluster Program courses

(included in Table 3.) The Clusters enroll roughly half of all incoming freshmen, and provide a learning environment that ensures an emphasis on developing information literacy occurs early in a student's undergraduate experience.

Information Literacy Approaches in Freshman Clusters

Each UCLA freshman cluster consists of about 200 students, a teaching cohort of faculty and advanced graduate students, and an instructional support network including librarians and writing consultants. These courses provide purposeful opportunities for students to develop research skills early in their college careers. Spring quarter culminating seminars enable students to solidify these newly acquired skills.

In Spring 2008, instructors of four spring cluster seminars teamed with librarians and assessment professionals to conduct a study[31] to determine whether students were meeting information literacy expectations through the revised general education curriculum. Evaluating instructional processes and student competency levels were primary goals.

Three tools were used to assess student information literacy. The first was the UCLA Library's *Road to Research*[32] online tutorial, which is a collaborative tutorial/instructional process coordinated between librarians and instructors that directly measured students' information literacy skills at course entry (pre-test) and completion (post-test). Once students completed the pre-test, they proceeded to interactive, online tutorial lessons. Students also attended a mid-quarter information literacy session in the library to expand and further reinforce information literacy strategies. The second form of assessment, completed after the *Road to Research* tutorial, was an annotated bibliography assignment that required students to clearly describe their use of relevant search engines and databases along with the search strategies they used to support the utility of these sources. A common grading rubric based on search and discovery task completion, as well as content analysis competence, provided consistent grading standards for each seminar. An end-of-course evaluation that asked students to self-assess their annotated bibliography assignment performance and evaluate their *Road to Research* experience provided the third assessment tool.

Students' *Road to Research* scores roughly paralleled their annotated bibliography scores, and the students' end-of-course evaluations suggested that both activities were useful. Additionally, instructors and librarians observed changes in students' awareness and application of information literacy methods that were reflected in their annotated bibliography assignments and final research papers. Further, it became clear that the use of educational technology for information literacy required intentional efforts to orient instructors and students to that technology.

Initially, it was unclear how to best coordinate instructor and librarian efforts. The strategy used in the first year of the study was to have both librarians and instructors review students' annotated bibliography assignments to produce two unique rubric-based scores. This approach had the strength of generating large amounts of rich student performance data. However, the process was time intensive, making it less practical for large-scale application. An additional challenge with this approach was the substantial difference in instructors' and librarians' areas of expertise. To increase effectiveness, librarians felt they needed to develop additional content knowledge, and instructors felt they needed to acquire more information literacy knowledge.

The second year of the study focused on ways to consolidate the assessment tools and expand implementation. The *Road to Research* was used again and administered at the beginning and end of the course. The end of course evaluation was also re-employed but was refined to ask questions

directly related to the core components of information literacy: locating, evaluating, and applying research information resources. In place of the annotated bibliography assignment, an existing course assignment was used to assess students' applied information literacy. Librarians' role shifted from directly assessing students' work to training instructors in how to measure information literacy. This greatly reduced the librarians' overall time commitment and suggested that the project could efficiently scale upwards. A final change in the second year was the use of six seminars from one cluster to facilitate greater measurement reliability. The Center for Educational Assessment has posted a report[33] for the two-year study, along with the measurement tools and evaluation rubrics developed for cluster freshmen.

Interpreting assessment findings has been complicated by inconsistent results. For example, in some seminars, students and faculty consistently perceived the *Road to Research* tutorial as a useful, integrated assessment mechanism. In others, students and faculty alike expressed mixed feelings about the tutorial or provided inconsistent evaluations of its merits. Variation was also evident in students' perspectives on when and how direct interaction with librarians was most helpful. Overall, findings to date suggest that additional efforts are needed to provide consistent and universal information literacy skill development opportunities to *all* UCLA students, and to do so in a cost- and time-efficient manner.

Looking to the Future

UCLA's longstanding commitment to excellence in undergraduate education provides a strong foundation upon which we can build new initiatives to enhance teaching and enrich student learning. As detailed in this essay, we view the effective use of technology as a core component of our educational effectiveness mission. As noted at the outset, our continued efforts in this area are anchored by an increasingly cohesive instructional environment, highly collaborative design and implementation efforts, and creative leadership. The new fiscal realities we face (described in *Essay A*) underscore the importance of proceeding thoughtfully in evaluating the merits of various approaches to incorporating educational technology and determining how to use available resources in the most educationally sound, and cost effective ways.

Our campus community has made good progress in establishing common solutions for educational technology issues, including creating effective teaching spaces, understanding student perspectives, and creating the CCLE. Taken together, the examples highlighted in this essay provide valuable insights that will inform future technology-enhanced educational efforts. Fundamentally, our work to date demonstrates the importance of establishing an institutional infrastructure that supports multiple individual efforts; enables careful assessment and evaluation of those efforts; and provides opportunities for colleagues to share ideas and learn from each other's experimental pedagogical undertakings. As we envision our technology-related educational enhancement priorities, continued efforts to understand our students' abilities, needs, and perspectives and to engage them actively and innovatively in their own learning processes also figure very prominently.

By ensuring that we incorporate these key components as future plans evolve, we will be well positioned to identify which educational technology approaches have universal merit for enhancing undergraduate education, and which are best uniquely tailored for selected types of study and/or student preparedness levels. We will also be increasingly well prepared to support faculty in developing and applying new technology tools and engaging in data-based examinations of how those technologies impact educational effectiveness.