Embedding video-based learning modules for library research methods in an online graduate engineering degree program

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Abstract

At the University of California, Berkeley, the College of Engineering has launched a fully online Master's degree program in integrated circuits. As part of this program, students are required to complete a comprehensive capstone project requiring access to the research literature and training on its use.

The Library plays an important role in providing the information resources and instruction to help students succeed in their capstone. In response to student need, we designed an online instruction environment that supports common information challenges, uses rich and robust instructional videos to explain information concepts and demonstrate research techniques, accommodates different learning styles, and engages students through interactive and feedback-rich instructional resources.

This paper showcases the value that we derived from the use of popular digital and web-based formats and publishing sites and through experimentation with emerging instructional techniques. It documents our team and technology-driven approach to developing the instructional modules, outlines our lessons learned, and discusses issues we encountered in supporting fully online degree programs.

Introduction

Targeted to working professionals, the Master of Advanced Study in Integrated Circuits (MAS-IC) at the University of California, Berkeley, is an online degree program where students access course material asynchronously while also engaging in real-time learning activities with instructors and teaching assistants. Students complete a capstone project that includes a final report with an oral presentation delivered live, using online presentation technologies.

The Library plays an important role in providing the information resources and training to help students succeed in their capstone. The requirement to engage with the information literacy elements of the program is prominently noted in the technical requirements for the course and is considered a foundational element of the program on par with high-speed Internet access, a personal computer, and general Internet proficiency. This elevated role of the library in supporting online education has provided an opportunity for librarians to engage in instructional design and explore issues related to different instructional paradigms in our high quality embedded library services. We focused our efforts as a librarian team to create problem-based learning, multimedia rich, and interactive online modules to facilitate self-directed learning.

Background

Systems view of distance education

The instructional design process used as its foundation a systems-based view of instructional design. In particular, Moore and Kearsley[1] have defined a systems view of distance education that helps conceptually frame the elements of an online degree program. This view recognizes an interaction of parts, technologies, actors, and other elements that are at play for any distance education program. The six components of this framework underscore the many relationships that need to be considered in instructional design (Table 1).

Table 1. Elements of the systems view on distance education[1]

1. Content sources, the people or organizations who teach content knowledge and provide the program
2. Program/course design to organize the learning materials and activities
3. Delivery of the courses through media and technology
4. Interaction between students, instructors, and support personnel to facilitate learning
5. Learning environment, which recognizes the different contexts and needs of learners
6. Management and administration to coordinate policy, needs assessment, resource allocation, evaluation, and other subsystems

Predictors of online learning satisfaction

In addition to understanding the key relationships between technology, learning environments, and policies outlined by Moore and Kearsley, we also found a need to review studies that explored the factors behind positive learning experiences. Song et al.'s survey of graduate students identified course design, learner motivation, time management, and comfort with online technologies as key contributors to a successful online learning environment.[2] The study also identified motivation for online learning because of its flexibility and convenience, which also have been identified by Petrides[3] and Poole.[4] The top reported challenges include technical problems, perceptions of a lack of community, time constraints, and unclear course objectives and goals. Consequently, Song et al.[2] recommend that online course development is more than the design and implementation of learning delivery technologies. It is important to focus on instructional design, clear communication of learning objectives and activities, and provision of student support in a responsive manner.

A primary difference between online instruction and traditional in-person instruction is the mode of interaction between instructors and students and among the students.[5] In terms of learning outcomes, studies show no significant differences between online and in-person instruction.[6, 7] But in terms of learner satisfaction, the element of interaction is an important predictor.[5]

Learner-instructor interaction is a significant predictor of online learning satisfaction, but learner-content interaction is the strongest predictor.[5] By contrast, learner-learner interaction was not a significant predictor. Learner-content interaction occurs when learners elaborate and reflect on the course content which helps to cognitively integrate the learning with previous knowledge.[8]

Online videos for instruction

Video-based instruction can be an engaging and effective manner for delivering instructional content while minimizing technical challenges for learners. For instance, an investigation by Choi and Johnson[9] compared learners' perceptions of video-based instruction with traditional text-based instruction for an online context-based lesson. There was a statistically significant difference in learner satisfaction for video instruction over text-based version, and there was also greater attention paid towards the learning content. Participants noted as well that the video-based instruction was more memorable. These findings suggest that online instructional videos have implications for enhancing learner motivation and learning retention.

Academic libraries have found that they could improve students' information literacy instruction through video tutorials. When Thornton and Kaya[10] at the Bilkent University Library, Turkey, used humorous and interesting content, they found improved student learning and enjoyment of instructional videos. Additionally, the video format may improve students' perception of the library as well as market the library's resources and services. At Texas A&M University Libraries, Xiao et al.[11] found that videos developed for task-oriented information literacy problems provided visual, interactive, and just-in-time responses to patron demand at their point of need. Furthermore, their on-demand streaming provided 24/7 instruction in a cost-effective manner.

For the design of online videos, Koumi[12] has prepared helpful guidelines. Of note, it is important to focus on skills development and to provide vicarious experiences that facilitate learning.

Academic library support for online learning programs

Academic libraries have a history in distance education with ACRL guidelines first established in 1963 and most recently updated in 2008.[13] Online learning is a current paradigm for distance learning, with massive open online courses (MOOCs) as an emerging model raising big questions about library support.[14]

Johnson and Fabro's review of the literature on the role of libraries in distance learning identifies three core areas where libraries are influencing distance and online education.[15] The first is connecting with users, which includes promoting awareness of the resources and services, providing reference services, and conducting assessment in order to meet the learning and information needs of instructors and learners. Next, libraries play a crucial role in providing

access to information resources by expanding the electronic resources available, providing required and optional reading materials through electronic course reserves, and providing document delivery services. Finally, libraries play an important role in promoting information literacy by establishing institutional support for information literacy initiatives, delivering this instruction, developing pedagogical approaches for online library instruction, and conducting assessment of student skills.

Development of our online information literacy instruction program

In describing the development of our online information literacy module, we organize our discussion along the six components of the systems model for distance education (Table 1). Referring to this model helped us conceptualize the different elements to be implemented. The checklist of elements was helpful to ensuring the creation of a comprehensive instructional program, to anticipate challenges to a positive learning experience, and to facilitate the management of the program.

1. Sourcing content through a collaborative team of specialists

Supporting online degree programs for graduate education is a new challenge for our library system. The online-only interaction breaks from our traditional in-class information literacy instruction and our face-to-face reference interactions. Additionally, graduate programs may require more intensive use of the research literature to complete more complex research projects. Furthermore, with different technology platforms available for online instruction, we needed to carefully select the system that works for our library and our students. These issues of online pedagogy, learning materials development, support for intensive graduate research needs, and technology selection and implementation are complex ones that can be difficult for any one individual to undertake.

To cope with the novelty and complexity of developing an online learning program, we adopted a team approach, pulling together internal library collaborators from across various instruction, management, technology, and engineering subject expertise. A librarian with a strong interest in emerging technologies and instructional design served as project manager to coordinate technology identification, instructional design, and development of the online learning materials. Library administrators contributed to policy issues in order to build the teams and to identify the funding for needed equipment. Library subject experts and liaisons prepared the instructional modules and provide day-to-day support for student questions. Our e-learning librarian led the development of instructional modules for general information tasks such as the mechanics of retrieving literature in our library system and citation management. This team approach was very helpful in creating a sustainable workload and ensuring that challenges and opportunities were addressed as they arose.

While much of our work focused on these internal partnerships we also found that working closely with the College was important in this process. The College of Engineering's Masters Student Services Advisor initially contacted the library to propose a library training module for the program. We met and discussed how this program would be delivered. The College was interested in a learning module embedded into the program's orientation module, and there was interest for the library to produce learning materials that match the program's video-based courses. Furthermore, the College worked with the Berkeley Resource Center for Online Education (BRCOE) to design, develop, and build the online education courses, and this team also offered technology support for the library's instructional program. By partnering with these external groups, we could rely on the College's instructional resources and gain access to web design and other technology support.

2. Program/course design

We designed the course around the student experience. Students are based in locations across the country and potentially internationally. As working professionals, their opportunity for study may be outside of regular working hours, so there is a need for 24/7 access to training materials that are targeted and quick. Furthermore, there may not be opportunities for face-to-face interactions with students or the opportunity for students to visit the library to work with a librarian in-person.

These geographic, timing, and interaction challenges forced us to re-think library instruction for supporting online students (Figure 1). We came up with design principles (Table 2) to focus instruction on authentic experiences in library research so that learning is practical, to accommodate student preferences and experiences for a positive learning experience, and to outline heuristics and core principles to help learners resolve information literacy problems. We assumed that students would turn to this module as a reference source when they face an information challenge and did not expect learners to follow the training materials along in a linear sequence.

Figure 1. Key elements in re-thinking library instruction for online degree programs

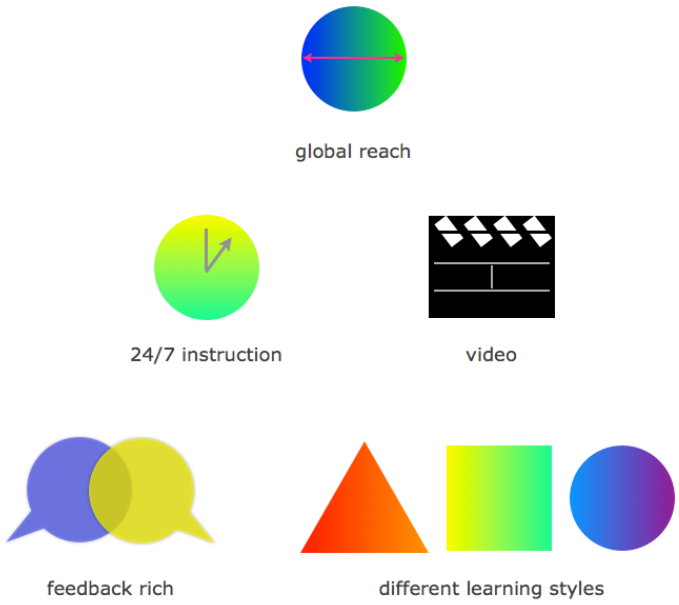


Table 2. Instructional design principles for online information literacy modules

• Provide self-directed training responsive to common information challenges through a problem-based approach
• Design instruction around authentic, real-world research experiences
• Accommodate different learning styles (visual, verbal, aural, solitary), since learners may have different preferences for learning
• Use rich and robust instructional videos to explain concepts and demonstrate library techniques
• Engage students through interactive and feedback-rich instructional resources to offset the lack of in-person interaction

With these principles in mind we developed learning objectives centered on skills development for resolving core information challenges in the research process. Our instruction includes "deep-dives" into topics including phrasing a research question, determining keywords, identifying the best information source, searching databases, retrieving articles, and creating a searchable database of journal articles with personal annotations and highlights (Table 3).

Table 3. Learning objectives

Learning Unit	Learning objectives
1. Welcome to the Kresge Engineering Library	• Outline the resources, services, and support available at the Engineering Library
2. Select the right information source	• Recognize the taxonomy of resources available • Identify when and why particular resources are used • Find recommended resources
3. Identify search terms	• Articulate a research question • Identify keywords • Expand searches by truncation and keyword adjustment and elimination • Narrow searches with more specific concepts and keywords
4. Find ebooks for background information	• Identify sources of and approaches to searching for ebooks
5. Search for articles on a topic	• Construct a search strategy • Identify databases to search • Refine search terms to improve relevance and size of results • Navigate search results
6. Find an article from a citation	• Outline options for retrieving journal articles (e.g., link resolver, ILL, retrieval from storage)
7. Manage citations	• Create a personal database of information resources consulted • Insert citations into a paper with citation management software • Describe the differences between various citation management software

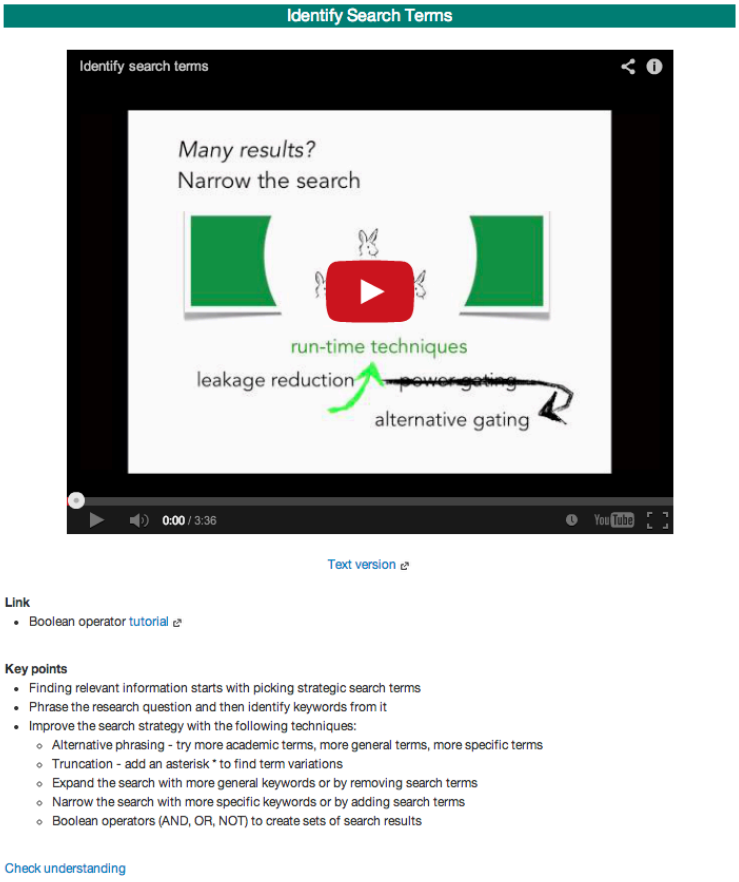
In the design of our learning content, we focused on video development. Our videos offer a rich multimedia learning environment, rather than text-heavy paragraphs of library procedures. Students can view videos at 2x speed, scrub through, review, and pause instruction as needed.

Video-based instruction may communicate a lot of skills and content efficiently because of vivid demonstrations not always possible in online text. We used graphics to visually demonstrate key concepts and music to keep the viewer interested. We produced 6 videos for our learning module (http://www.youtube.com/playlist?list=PLvUnm_QSNuupKEmtcTcuvb4onRaNUXbQB). With an average length of 3 min 6 s and the longest video clocking in at 4 min 24 s, these videos are short enough to keep the viewer's attention.

For the library instructor, online videos are ideal for teaching online degree program students for a variety of reasons. 24/7 access and viewer control makes them a good investment of our development time. You can record the instruction once and reach many students over a long period of time. The videos are also highly scalable, which we found after re-using this content for other courses and students outside of the College of Engineering.

We complemented the video with text-based instruction as well (Figure 2), as not all students prefer learning from videos. Each learning unit has a text summary with key points from the video. Additionally, there are captions for every video, and there is a text version of the video for skimming and searching for content. These contextual markers help learners quickly determine whether the video will be helpful for their specific information need.

Figure 2. Typical module unit with video, text summary, and supplemental links



The primary learning activities are the quizzes at the end of each unit to help students check their learning. Focused on key learning objectives, the quizzes are interactive with automatic assessment that provides tailored instructional feedback for students who select an incorrect response. Because no grade is assigned, it is a low-pressure activity. Students are able to see their progress, and librarians can review the scores to assess whether instruction is effective.

In short, our program supports students in their self-directed learning. Online videos and quizzes address specific and real problems in pragmatic learning units as they engage and demonstrate library research methods to students.

3. Delivery of course materials

In delivering course content via distance education, Moore and Kearsley advise instructors to "recognize that no single technology is optimal for delivery of every kind of message to all learners in all locations."[1] Our objective was to employ different multimedia tools that automatically embed across the different platforms of students' computing and mobile devices. To ease content management and publishing, we also employed online-hosted services (Table 4).

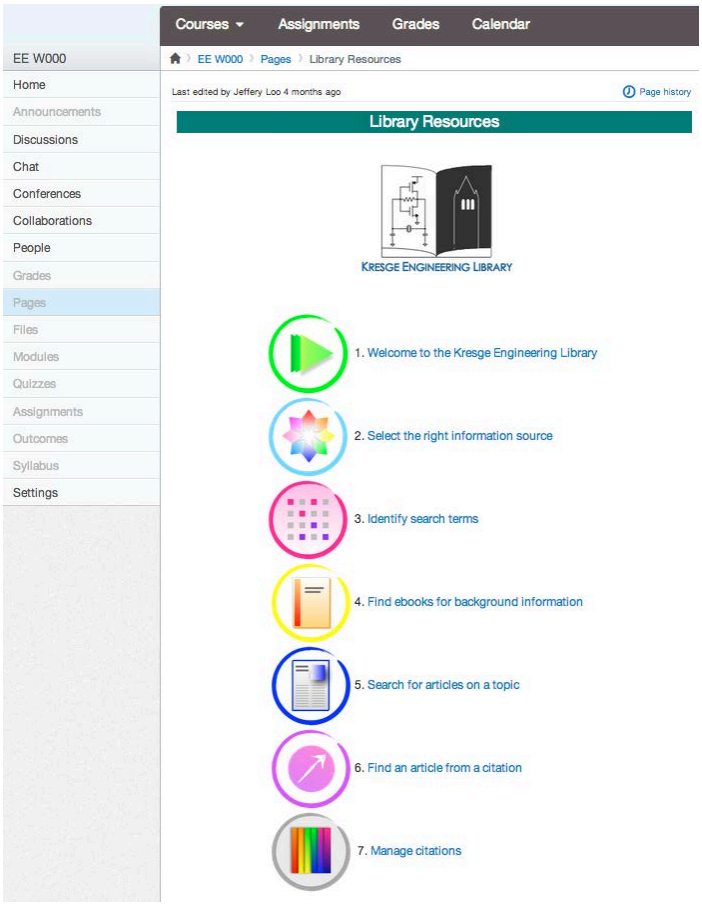
Table 4. Objectives for course materials delivery

• Accommodate different communication formats including text, audio, video, and graphics
• Accommodate different technology platforms and mobility; content should adapt to different operating systems and devices across computers, laptops, tablet computers, and mobile phones
• Use online-hosted services for embedding learning materials across different technologies and to facilitate online-based content management
• Instructors need systems authority to revise content and materials within the learning management system

Software and online hosting services

We embedded the learning module into students' Canvas learning management system for greater visibility and accessibility (Figure 3). We posted all our learning materials, videos, and quizzes into the library research methods module of the compulsory orientation program. Therefore, our library training was never more than a few clicks away from their lectures, discussion forums, and learning activities. Additionally, we had the necessary permissions in Canvas to edit and revise module content, participate and monitor discussion forums, and access statistics on quiz results, student participation, and other usage markers.

Figure 3. Learning modules are embedded into the program's learning management system



Our video demonstrations and lectures were recorded with ScreenFlow (for Mac only, http://www.telestream.net/screenflow/), software that offers screen recording, video editing, and sharing functionalities. This enabled us to produce professional-caliber videos with animations, transitions, and graphical call-outs, to zoom in/out for emphasis and visibility, and to incorporate PowerPoint presentations for brief lectures.

Instructional videos were exported to YouTube for online hosting and streaming, allowing us to embed videos easily into web pages with simple code and enabling videos to be viewed seamlessly across devices. Analytical statistics and social media features enable us to understand usage and engage with the viewer. YouTube also provides a captioning service (https://support.google.com/youtube/answer/2734796?hl=en) to improve the accessibility of the videos and accommodate viewers who prefer to read along with the video. Captions were added simply by uploading a transcript into YouTube, and the service automatically syncs the captions with the audio.

For every video, a link was provided to a text version of the lesson in a Google document hosted in Google Drive. This text version is a transcript of the video with supplemental details like links to helpful websites and further examples. This allowed students to bypass the video and

search and review the text to find specific learning content more quickly. Using Google Drive allowed us to publish the transcripts as web pages that also adapt to a variety of computing interfaces and permitted us to make revisions that can be published immediately.

Online hosting services like YouTube and Google Drive were critical to easy online publishing of learning materials that are viewable across devices. However, one key limitation should be noted. Currently, some nations prohibit Google products, so our learning materials may not be accessible globally. At this moment, all enrolled students have access to these tools, but in the future, should students be unable to access the Google Docs and YouTube videos, we would encourage use of the University's virtual private network connection for access.

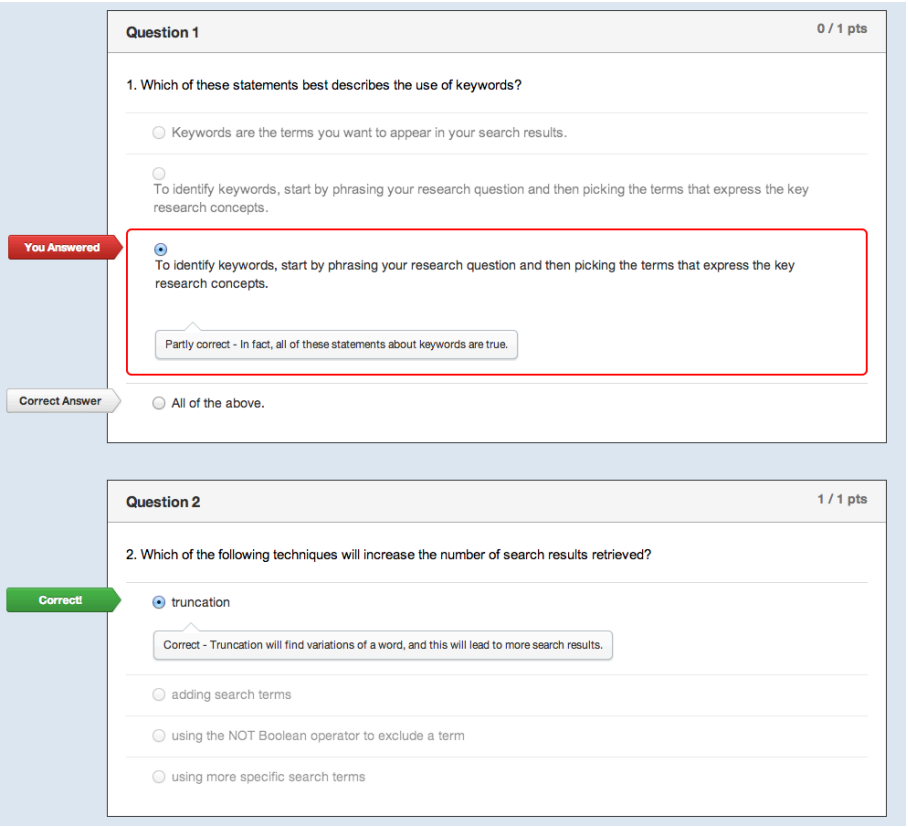
Hardware and video recording equipment

With the exception of our first welcome video, all instructional videos and other materials were developed using a MacBook Air laptop with Screenflow software. Clear audio recordings were possible through a professional USB microphone plugged into the laptop. Our first video, a welcome video with a personal greeting from our library head, was recorded in a full professional recording studio at the College of Engineering. This facility enabled us to produce a professional HD-quality video to greet incoming students.

4. Interaction

We complement self-directed learning with support and guidance at an individual level. Our online quizzes provided automatic evaluation and quick feedback for students' learning progress and motivation (Figure 4). This is a highly scalable form of individual assessment with little effort by librarians to interact with many learners. Additionally, students are encouraged to contact the librarian via email. However, librarians will also be proactive in reaching out to students. The liaison librarian will enroll in the capstone project class in order to review and respond to students' library research problems.

Figure 4. Quizzes with automated evaluation and interactive instructional feedback



Our team is also open to synchronous interaction with students. This will match the real-time discussions and interactions that the degree program courses offer**.** Firstly, students have access to a 24/7 chat reference service that is provided by the libraries across the University of California system. Additionally, liaison librarians for this program are available for online reference sessions via instant messaging or web teleconferences (such as Skype or Google Hangouts) to add an element of face-to-face and personal interaction. We hope that these avenues of interaction will give the library a personal identity that motivates students to engage with our information resources.

Student and instructor feedback are important to us for improving the learning module, responding to students' learning needs, and ensuring optimal learning. We look forward to developing more videos and instructional units as needed and intend to regularly revise the materials to meet student needs. After our monitoring and evaluation, we will discuss potential improvements to the learning program with the instructional design team at the College of Engineering.

5. Learning environment

Earlier we discussed accommodating different technology platforms of students, but it is also important to accommodate learners who have different learning environments, experiences, needs, and behavior. To address these different styles and abilities, we delivered our learning materials in different modes. Videos appeal to visual and aural learners; captions and text-versions of videos are helpful for verbal learners and those with hearing or vision challenges.

Acknowledging the professional context of the students is also important. As working professionals, the students in the program have more demands on their available time for study. We designed our training module with small learning units that allow the students to review and study in short bursts. This is in line with Moore and Kearsley's assertion that "[m]ost designers believe that courses should be organized into short, self-contained segments, with frequent summaries and overviews."[1] Our learning module followed this guideline by designing succinct learning units with clearly defined objectives, summaries of key points, and video and text-based versions of learning content for rapid review and browsing.

6. Management and Administration

The unit head of the Engineering Library had an active role in this program and positioned the embedded online training program as an important virtual interface to our physical library's services and resources. This administrative guidance was critical to developing our teams of expertise, writing policy on program administration, and of particular note, forging a partnership with instructional designers and technology developers at the College of Engineering who supported the library instructional development.

Key administrative challenges included the policy and service issues for library resource access, in particular, access to print resources by students who reside outside of the geographic area and do not have the opportunity to visit the library and check out a book. This raised important access questions:

- Should we digitize our print-only materials (i.e., book chapters, journal articles) upon student or faculty request? Should we scan items for online course reserves? What is the ideal level of print digitization support the library should provide?
- Should print digitization services be conducted by our document delivery service? Should departments sponsor this service for students?
- Should the library lend entire print monographs via courier or postal mail?

These are challenging questions that our library is still discussing and trying to formulate policy around. In the meantime, we notify students that in order to borrow print resources they need to physically visit the Kresge Engineering Library; otherwise students should rely on our electronic resources and interlibrary loan of digital content or digitized print materials (article scans from journals in our storage facility). Due to the challenges in lending print materials, our information

literacy training module covered online library resources only, emphasizing the electronic journals, books chapters, and databases available remotely.

Sharing print resources like textbooks and other readings with online students is new for course faculty as well. Librarians have been consulting instructional designers on the responsibilities and restrictions for digitizing and sharing copyrighted readings. As online education grows, we see an increasing role in purchasing digital content for instruction, lending print materials, and consulting with instructors on the fair use of instructional materials.

Discussion

Online-only degree programs are a relatively new model for many academic libraries. Our foray into this arena of instructional support was directed by four guidelines (Table 5) to address course design, implementation, and delivery. These four principles allowed us to engage learners and provide 24/7 instruction to help students solve information problems at the point of need. The videos and quizzes enhanced learner-content interaction and provided responsive feedback. The team-based approach enabled us to distribute our efforts and to cultivate expertise to address challenges that may arise in instructional development.

Table 5. Guidelines for online instructional module development

Guidelines	Details
1. Adopt a systems view of distance and online education for developing a comprehensive information literacy course	• Develop a team-based approach that brings together library staff with diverse expertise and interests in engineering subject knowledge, instructional design, library management and policy, and technology development. • Collaborate with external partners at the College of Engineering and central campus for technology and instructional design support.
2. Create problem-based learning, multimedia rich, and interactive modules to facilitate self-directed learning	• Center instruction on skills development for resolving core information challenges in the library research process. • Facilitate learner-content interaction for students to elaborate and reflect on the course content through interactive online quizzes. These quizzes could offer automated evaluation with responsive instructional feedback to motivate and help students monitor learning progress. • Engage students through rich instructional videos to offset the lack of in-person interaction from traditional classroom settings.
3. Accommodate diverse student backgrounds and learning styles	• Accommodate visual, verbal, aural, and solitary learning styles by delivering learning materials in different modes. Videos appeal to visual and aural learners; captions and text-versions of videos accommodate verbal learners and students with hearing or visual challenges. • Design the course around students' professional context as working engineers. Focus on authentic, real-world research experiences that they'll encounter in the professional world.
4. Employ online hosting, streaming, and publishing services for instructional delivery	• Use online-hosted services for publishing and embedding learning materials (e.g., videos, audio, web pages) that automatically adapt for viewing on different devices (e.g., computers, tablets, mobile phones) and operating systems. • Identify technologies that accommodate different communication modalities including

	text, audio, video, and graphics. • Embed the information literacy modules into the program's online learning management system. Request library instructor authority for revising content. • Be open to online synchronous reference sessions via instant messaging or web teleconferences to enhance personalized interaction with students.

Reflecting upon the obstacles in developing our online library instruction modules, technology and instructional design were not the primary challenges. Instead, the principal challenges centered on the legal, policy, and service delivery issues with providing library resources to distance education students.

Currently, our instruction and resource sharing focus on electronic content. But not all resources are available online, and this raises the challenge of sharing print resources to online students and faculty. Digitizing our print collections for course reserves and the document delivery of physical materials to students could impose tight copyright restrictions and financial expenses. As our library continues to explore print resource sharing for online programs, online students are encouraged to visit the library to borrow a physical item. To mitigate the print sharing challenge, we review the required texts and readings for the program curriculum to identify and acquire those works that are available online, and we have encouraged faculty to adopt instructional materials that are available online. Into the future, academic libraries may need to design collections services that assume all patrons are distance patrons in order to re-envision our services for the increasingly geographically distributed and online approaches of teaching and learning.

Conclusion

In review, the Kresge Engineering Library as part of a team of librarians created an entirely online information literacy program with instructional videos and content embedded into students' online learning management system. Ungraded quizzes provided interactive feedback for students to monitor their learning progress and provided instructors with valuable data for revision and future development. These elements may help libraries support fully online degree programs in a rich, robust, and scalable manner.

This project has had a positive impact on our library. It spurred new ways of thinking about information literacy instruction and encouraged the library to develop the facilities and skills to support emerging online degree programs and, eventually, massive open online courses (MOOCs) — in which the University of California, Berkeley, is participating through the EdX program.

We also feel that our efforts are sustainable and scalable, and we look forward to growing our online instruction efforts. The online video content has been shared with other classes – even non-engineering disciplines. This has been an efficient approach to providing instruction, which frees more time for providing personalized reference support. We hope our first online instruction module also will serve as a prototype that may encourage faculty to consider embedded library instruction for their online courses. We look forward to growing partnerships with campus groups and developing more modular library instruction units that could be re-purposed for different audiences and classes.

Overall, by embracing popular digital and web-based formats and publishing sites, by experimenting with emerging instructional techniques, and by integrating information literacy into the curriculum, we are filling an important role in online education while also showcasing the library's engagement with cutting-edge innovation for teaching and learning.

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