Student Usage and Assessments of the Benefits of On-Line Access to Lecture Recordings with Synchronized Presentation Slides

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Abstract

Students in multiple sections of an introductory Digital Design course were provided with on-line access to recordings of every class lecture. These recordings were made using the Panopto Coursecast tools, and included live audio recordings of the instructor along with video capture of compressed still image representations for each presentation slide shown. The audio and slide changes were captured concurrently and in real-time so that during replay students experienced the complete presentation very similarly to how it was originally delivered. Since the lecture recordings did not include full live video capture, the data storage and connection bandwidth requirements were minimized. Anonymous student surveys at the end of the quarter indicated that a large majority of students found this to be a very helpful tool and would prefer to have this tool available for other classes as well. Reported usage rates and purposes varied widely between students; ranging from no use at all, to occasional replay of short excerpts to clarify segments that were not clearly understood during the lecture, to complete replay of most lectures as a study aid in preparation for midterm or final exams. While many students assessed the most helpful benefit of on-line lecture captures to be the ability to make up a missed lecture, most also self-reported that having this available did not diminish their attendance at lectures. Student comments revealed that they recognized the superiority of the live lecture experience compared to the captured lectures. Probable contributors to this impression include the inability to see anything written on the blackboard in the on-line presentations, the loss of some slide animation features, the inability to see the instructor's gestures and pointing to slide highlights, and the partial loss of student comments, questions, and interactions in the audio recordings

Introduction

Lecture capture, the recording of face-to-face classroom lectures in digital format, and making these recordings available for asynchronous first-time viewing or reviewing by students, is an important and beneficial tool for engineering education that has been in use for several years now; but that has experienced a slow adoption rate. In the 2010 National Survey of Information Technology in Higher Education[1], a survey of senior campus information technology officers from 523 public and private colleges and universities across the United States, more than sixty percent of the survey participants either "agree" or "strongly agree" that lecture capture is an important part of their plans for developing and delivering instructional materials. However, this technology is not yet very widely deployed. According to this same survey, as of fall 2010, only 4.4 percent of higher education classes make use of lecture capture technology.

In the study presented here, the impressions of students using one such lecture capture tool suite in an electrical engineering digital design class were collected using a post-class written survey tool. The survey sought to quantify the number and duration of on-line lecture viewing by students, as well as their impressions of the helpfulness of the tools in achieving several potential benefits for the course, from the point of view of students using the tools. Since these tools are not widely used, the experiences captured here are likely the first experiences that students would have had with this supplemental learning technology.

Lecture Capture Tool

The lecture capture tool used in this study was Panopto Coursecast - a software-based presentation capture system originally developed at Carnegie Mellon University. Using this tool on their own laptop computers, instructors record any content displayed on their screen, such as Powerpoint slides, as well as an audio channel and an optional video stream from a web cam or other video source attached to their computer. These streams are integrated into a narrated presentation video that can then be uploaded to a server and shared with students online. Once uploaded, students can view captured lectures using standard web browsers supplemented with the Microsoft Silverlight plug-in. Panopto integrates with both Blackboard and Moodle, allowing captured lectures to be accessed by students through the same courseware system interface they already use for their classes. Students can also download the lecture audio from the server in .mp3 format.

For the instructor, recording a lecture with Panopto simply requires them to start up the Recorder application on the computer from which they will be presenting, and then select the audio and video sources that are to be captured. For digital presentation content, the instructor must select whether compressed images of their Powerpoint slides will be captured or if snapshots of their screen will be encoded periodically. For Powerpoint slides, the Recorder captures a new image of the slide whenever the presentation is advanced by the instructor or by an animation sequence. For periodic screen encoding, the frame rate at which new images are captured is set by the user for between 1 to 15 frames per second. The capture frame rate greatly affects the loading on the presentation computer's CPU. Choosing too high a frame encoding rate can interfere with the instructor's presentation, slowing down slide advances and animations.

For the lectures in this study, Powerpoint slide image capture was selected for all videos created, as the higher frame rate encoding of screen snapshots did, in fact, severely interfere with the projected Powerpoint presentations due to the limited computational capability of the instructor's laptop computer. No additional video input was used for the recordings, to minimize the server storage file size and required playback bit rate of the resulting lecture capture video. Therefore, only the Powerpoint slide content was viewed by students in the captured lectures. The gestures of the instructor and any exposition on the classroom white boards were not recorded. With these recording selections, the video produced by Panopto included an image of the currently displayed Powerpoint slide, a window with preview thumbnails of a few slides preceding and

following the current slide, a window with time stamps and slide titles for each new slide in the presentation, and a synchronized audio track providing the same narration that occurred during the original lecture presentation.

Using the slide capture mode instead of higher rate screen captures had several consequences for the rendering of Powerpoint animation sequences in the final video. While smooth motion animations played properly during the projected presentations, most of the motions were lost in the recorded versions. This is because a new slide image would be captured only at the end of each animation step. On playback then, animations would appear somewhat disjointed. Also, the recording of a new slide image with each animation step resulted in many slightly changing copies of each Powerpoint slide appearing in the timestamp and slide preview windows of the recording. This made searching and forwarding in the captured lecture a little more cumbersome for students.

The audio stream for the recordings was captured from a USB wireless microphone worn by the instructor. The directional microphone provided a clear recording of the instructor's voice. However, it was unable to clearly pick up comments and questions from students during the lecture.

For playback of the captured lectures, students were provided a simple link from Blackboard to a listing of all the available lectures. Clicking on a particular lecture opened the Panopto recording in a new browser window. The recorded lecture would automatically begin playback. Students could pause and stop the playback at any time. Using the slide thumbnail preview window or the slide timestamp window, students could advance or rewind to any particular slide in the presentation. Therefore, they could view as much or as little of the captured lecture as needed – from simply checking one or two slides to be sure they completed their notes properly, to seeing and hearing the entire lecture for a second time.

Course Design

Lecture capture was incorporated into a ten-week introductory Digital Logic Design class (CPE 129) as part of a pilot program to evaluate the Panopto Coursecast tools for possible broader deployment at California Polytechnic State University. This class is the first in a series of three digital circuit and computer design courses required in both the electrical engineering and computer engineering bachelor of science degree programs at CalPoly. In these degree program curriculum sequences, this class is typically taken in the spring quarter of the freshman year for electrical engineering students, and in the fall quarter of the sophomore year for computer engineering students. The course is structured with three fifty minute lecture classes each week and has an associated laboratory course that meets once a week for three hours. In this structure, design and analysis methodologies for digital circuits are introduced and developed in the lecture classes, and students then implement and practice these methods using computer-aided design tools in the laboratory sessions. Typically, between thirty-two and forty eight students are

enrolled in each lecture class section. Lecture classes are conducted in traditional classrooms that include digital projectors and screens, as well as chalkboards or whiteboards. Depending on the academic quarter and holiday schedules, the total number of lecture classes for the course varies between 28 to 30 sessions. As with all CalPoly courses, students access all on-line content for this class using the Blackboard learning management environment.

The lecture presentations used in the course sections surveyed for this study were almost entirely rendered using Powerpoint. Only occasionally were concepts elaborated or examples worked out using the classroom white boards. This was important for compatibility with lecture capture, as these elaborations would not appear in the lecture recordings. The Powerpoint presentations for the class were somewhat unique, in that they made extensive use of graphics and animation to illustrate the information and methods being taught. Careful attention was placed on revealing information in each slide at the moment that it was presented, so that students both in the classroom and on-line would not be overwhelmed with too much information at once. Because of the complexity of the graphics presented, the volume of material covered, and the pace of the course, students were provided with copies of the lecture slides as handouts at the start of the class session. These handouts were also made available on-line as PDF files, so that students who missed a live lecture could use the handouts when viewing the lecture on-line. Course handouts included most of the information projected onto the screen during the lecture. However, key terms and example problem steps were left out so that students would have to actively engage with the lecture, whether viewed live or on-line, and reinforce their learning by writing notes on the handouts.

Students are expected to attend all face-to-face lecture classes. This is not compulsory, however, and classroom attendance was not monitored or incorporated into the course grade computation for this class. Grading was based primarily on each student's performance on two midterm examinations and the final examination. A portion of the course grade (20%) was based on the completion of homework assignments and graded projects. Homework was assigned after every lecture class, which was due at the next class session. This required students to keep up with the course pace, and to assimilate and practice each lecture's material shortly after hearing it.

Study Survey Methodology

The data for this study were collected using a written survey administered at the end of the CPE 129 course. The survey was conducted in three different academic quarters with students from a total of six lecture class sections (two sections in June 2010, three sections in June 2009, and one section in March 2009). The survey was provided to students online via Blackboard following their final lecture class. Students were asked to return the completed survey in hardcopy form at their final examination session; generally three to five days after the request for their participation. The surveys were anonymous, other than answers to two demographic questions - year in school and degree program. As an incentive to increase the participation rate in the survey, two bonus points on the final examination were awarded to students who turned in a

survey paper. This was also intended to broaden the participation to include those students who might not otherwise take the time to complete a survey that had no direct effect on them. Anonymity was maintained and redundancy of responses was prevented by having students check off their names from a class roster when turning in a survey sheet. Students turned in surveys in a random order when they arrived at the final examination. The large number of surveys returned and the relatively high participation rate maintained anonymity to the satisfaction of the students; despite there being a record that they had each turned in a survey. Of the two hundred twenty eight students in the five sections surveyed, one hundred and forty provided survey responses (61% participation).

Survey questions queried students about the number of times they accessed the on-line lectures, how much of each lecture they typically viewed, how helpful the on-line lectures were in achieving several delineated potential benefits, and whether they preferred to take courses in the future with lecture capture. All answers, including quantitative ones regarding number to times used and viewing durations, were based on student's recollections, rather than objective measurements.

Survey Subjects

Students who took the survey were predominantly electrical engineering majors, with a small number of computer engineering students and computer science students. Sixty eight percent (95 of the 140 students) were college freshmen. Of the remaining students, 23 percent were sophomores, seven percent considered themselves to be juniors and two percent were seniors (4^{th} year students). Typically, junior and senior (3^{rd} and 4^{th} year) students would not take the CPE 129 course surveyed. However, transfer students who arrive after two years of community college start the EE curriculum at the beginning of the sophomore year in the degree program, despite being "3^{rd}" year students (Juniors). Therefore, for transfer students, taking CPE 129 in their first year at CalPoly is appropriate.

Survey Results - Student Usage Rates of On-Line Lectures

Students were first asked if they used the Panopto system at all to view on-line course lectures during the quarter. Eighty-one percent of students responding (113 of 140) indicated that they had used the system at least once. Compared to the twenty eight total lecture capture videos available to students, 5.8 was the average number of lecture viewings reported per person for all respondents. This number increased to an average of eight lectures viewed when considering only those students who had accessed the system at all. Figure 19 shows the histogram breakdown of the number of lecture views reported by all students.

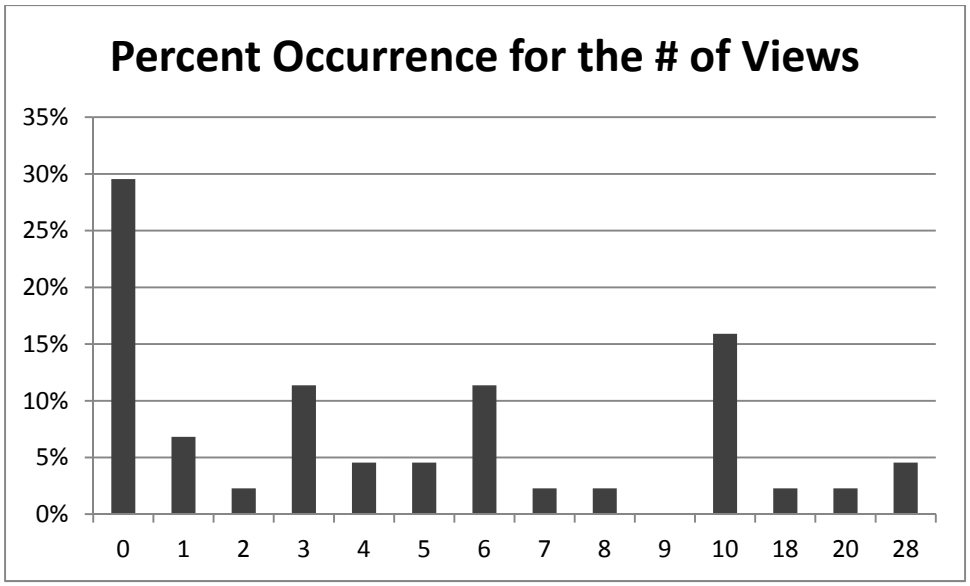

Figure 19. Occurrence percentage for each reported number of lecture views for all survey participants

To determine what portion of each lecture students were viewing on-line, the survey asked students first to report the average number of minutes viewed for each lecture accessed. For those students who used the on-line lecture viewing at all, the average viewing time was just over half of a standard lecture (26.6 minutes average viewing time reported). Students were then asked to divide their total number of viewing times into categories of "less than 5 minutes", "1/4 to ½ of the lecture" (12-25 minutes), "more than ½ of the lecture", or "most/all of the lecture." Figure 20 shows the resulting histogram of reported viewing times by students.

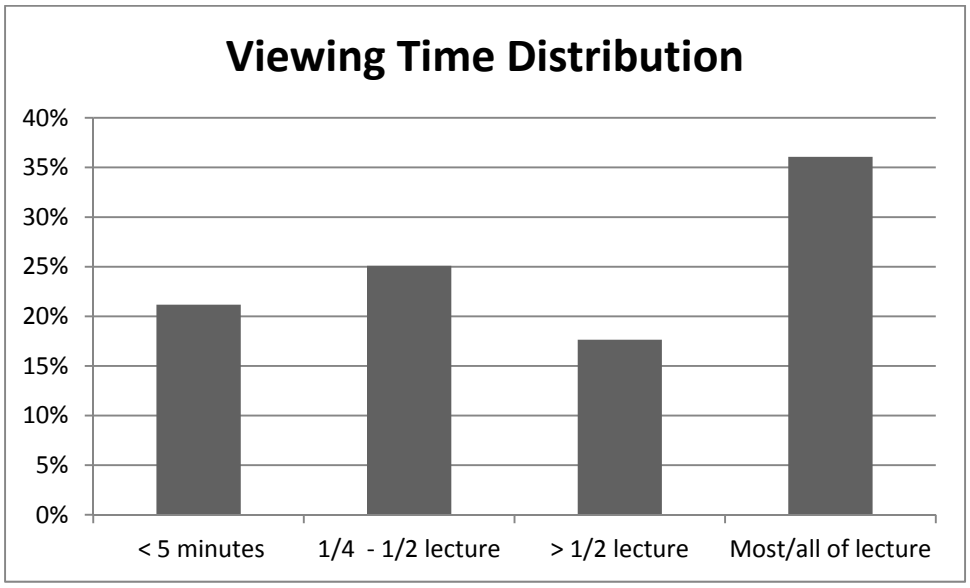

Figure 20. Viewing time distribution of on-line lectures reported by students in CPE 129 Digital Design.

These results indicate that students were likely using the on-line lectures for a number of different reasons, rather than for one single purpose. A brief reference to a short segment (< 5 minutes), such as to check or complete lecture notes or to review one concept, was sufficient for one-fifth of the students. Viewing most or all of a lecture, possibly to make up for a missed class or to review for an examination, was the most reported viewing duration.

Student assessment of potential lecture capture benefits

The survey presented students with several potential benefits of on-line lecture recordings, and asked them to assess how helpful they found this tool in achieving these benefits in our particular course. Students assessed the helpfulness of lecture capture using a 1 to 4 scale, with 1 = not at all helpful, 2 = nice but not necessary, 3 = somewhat helped learning, 4 = very helpful / big improvement in learning.

The average ratings for each of the benefits proposed, by students who viewed at least one lecture capture were:

- Making up for a missed class – 3.36
- Clarifying information or finishing notes from a prior class – 3.35
- Improving retention of class materials – 3.07
- Reviewing material before class – 2.93
- Improving test scores – 2.77

Students found the ability to view the lecture from a missed class or to review information and clarifying their understanding of the presented lecture material as the most helpful benefits of on-line lectures. While several individual students made specific written comments around using the on-line lectures to review for examinations, overall students did not find it to be as helpful for that purpose as for the other proposed benefits. These ratings also indicate that students generally found lecture captures to be at least somewhat helpful and effective for all the potential benefits.

When asked the broad question of "did lecture capture help you succeed in this course?", 75 percent of students said "Yes". The remaining 25 percent were made up mostly of students who had not used the tools at all (20%), and 5 percent of students who actually used the tool at least once but still assessed that it did not aid their success.

Finally, to gauge their overall satisfaction with lecture capture, students were asked if they had a choice between taking a course with or without lecture capture in the future, which would they prefer? Fully 95 percent of students indicated they would prefer to have lecture capture available. The remaining 5 percent indicated that either it did not matter to them or that they preferred not to have lecture capture. The written comments as to why students preferred to have lecture capture echoed their ratings of the potential benefits. Being able to see missed class lectures and to review and clarify course material were again the most cited reasons for

preferring that lecture capture be available. Even those student who were generally less enthusiastic about the tool in their usage or ratings of benefits felt that it was still helpful to have lecture captures in future courses "just in case."

Effect of recorded lecture availability on class attendance

One concern with providing on-line lecture recordings commonly voiced by instructors[2] is that it might encourage students to stop attending classes, or to at least diminish their attendance significantly. Indeed, the attribute of on-line and hybrid courses most highly appreciated by students is the scheduling flexibility they afford, as lectures can be viewed whenever it is most convenient for students. Therefore, instructors question whether students will take advantage of recorded lectures intended as supplemental course material, and treat the course instead as an on-line class and stop attending live lecture sessions. By this line of thinking, students might at least take a more casual approach to class attendance, as a more convenient alternative is provided to them in the recorded lectures. Thus, any provocation not to attend a class might be sufficient to convince students that it is not necessary to do so.

Students in the present survey were queried about this issue. In the survey, students were asked "what effect, if any, did having on-line lectures have on your class attendance?" Ninety-three percent of students (130 out of 140) indicated that there was no effect at all on their attendance. Just under six percent (8 out of 140) indicated that they skipped one or two additional lectures than they might otherwise have if lecture capture was not available. Two additional students (1.4%), one senior and one sophomore, responded that they skipped three or more additional lectures. Since both of these latter students also reported reviewing five lectures on-line, it is reasonable to consider five lectures as the upper bound of the number of classes skipped due to the availability of recorded lectures.

These results are consistent with findings of other studies. For example, the 2009 ECAR Study of Undergraduate Students and Information Technology[3] published results indicating that nearly two-thirds of students polled either disagreed or strongly disagreed with the proposition that "I skip classes when materials from course lectures are available on-line." Another study[4] of the effect of unlimited access to on-line lectures showed no discernable effect on the attendance in two sections of an introductory psychology class. Likewise, a similar study[5] conducted in a second-year pharmaceutical therapeutics course showed no correlation between classroom attendance and the amount of time students accessed on-line lecture material.

Student comments

Students were asked to provide suggestions for improvements to the on-line lectures provided during this study. The most frequent suggestion was to add a video stream with a view of the blackboard so that the few examples worked out there could be seen, or so that the instructor's pointing to highlight projected information on the slides could be viewed. This capability is available with many lecture capture tools, including the Panopto tools. It was not used here due

to the significant additional server storage required for the digitized video stream. The second most common problem that garnered comments was that students were unable to hear questions or comments from students in the classroom at the time of the lecture capture.

In summary, students found lecture captures to be very helpful and were generally very positive about the experience. Quite a few students made similar comments indicating that they wished that all their classes made this tool available.

Conclusion

Considering the ease of capturing and uploading lectures with integrated tools like Panopto Coursecast (now Panopto Focus), the benefits to students and their very positive impression of these on-line aids, and the lack of negative impact on classroom attendance, it is reasonable to expect that the very limited current deployment of this technology in engineering education programs should not continue. These resources will become far more ubiquitous in the next several years as tools improve, as server storage capacity continues to become more affordable, and as network bandwidths and infrastructure expand.

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