Proceedings of the 2012 ASEE PSW Section Conference
Cal Poly - San Luis Obispo

In-Class Lecture Recording: What Lecture Capture has to Offer to the Instructor

Vladimir I. Prodanov, EE Dept., Cal Poly, San Luis Obispo, CA

Abstract

The purpose of this study is to determine the impact of lecture recording upon the instructional faculty. The following aspects are explored: 1) impact on class enrolment; 2) impact on class attendance; 3) usefulness of obtained statistical results for course improvement. The study is based upon data collected in a junior-level Electrical Engineering class with enrolment of 76 students. The data was collected using anonymous surveys and Blackboard's statistical tracking utility. The results from the survey show that providing lecture recordings does not have significant impact upon students' decision to attend lectures, but it has pronounced impact upon their enrolment decisions. Sections where video capture is used are likely to attract more students resulting in a larger class size compared to sections where no recordings are provided. Collected statistics of video usage were found useful in identifying the topics that students had most difficulty with. Video usage statistics seems to provide also a glimpse into the self-efficacy of students completing the course.

Introduction

Lecture capture means the recording of face-to-face lectures and making those recordings available to students for asynchronous viewing [1], [2]. The commonly-stated benefit (for the students) is the ability to review material and catch up with missed lectures. As noted in [3], there is an abundance of studies that discuss the positive and the negative impact of lecture recordings upon students, but there are very few studies that discuss the impact of lecture recordings upon the academic staff. Furthermore, the existing literature seems to suggest that the benefits for the faculty are minimal and unclear. Chang [4] states:

> Both academic and student respondents found it difficult to identify the benefits of Lectopia for the lecturer.

While the benefits might be unclear, the concerns are not. The most commonly-stated ones are: low attendance rates and expectations/pressures from students (to use the technology) [4]. An additional concern is identified in this paper – increased class size of sections where lecture capture is used. This is only a potential issue for classes with multiple sections. Most engineering classes at Cal Poly, SLO - however are multiple-section classes.

Lecture recording at Cal Poly's EE Department is not common. Only two studies have been conducted to date [5], [6] and neither of them discusses the potential benefits of lecture recording for course improvement. This study argues that video usage statistics represents a unique feedback which when used properly could lead to improved learning outcomes.

Lecture Capture Strategy

Presently Cal Poly does not have centralized lecture-capture capability. Also, there are very few rooms where traditional "chalk & talk" lectures can be video recorded. To circumvent this issue, PowerPoint slides were prepared beforehand and screen capture was used to record the in-class delivery. The resulting "video lectures" are therefore simple voiced-over PowerPoint presentations. To retain the flow and the interactive nature of a chalkboard instruction, the PowerPoint presentations were developed in accordance with the following "rules":

1. Each PowerPoint Presentation includes material that can be covered in a 50 min. chalkboard lecture (not more).

The per-lecture rate of delivery is intentionally slowed down to match the rate of a traditional chalkboard lecture.

2. The content of each PowerPoint Slide is brought on screen in a sequential manner.

As a result, the PowerPoint lecture flows in the same sequential fission as a chalkboard lecture. This approach also allows instructor to stop at certain critical points in the presentation and engage the audience.

3. Ovals, arrows & *Lucida Handwriting* text are used to emphasize important "discussion items".

Here the aim is to mimicking a chalkboard instruction where short face-to-face discussions are interspersed with derivations. However, even with the use of the above strategies, a 50 min regular lecture is delivered in approximately 40 min.

4. Additional slides containing simulation results are usually added to each presentation.

These additional slides bring the total presentation time to 50 min. These slides do not contain new material. They serve as a "practical" demonstration of presented theoretical concepts. The faster pace of the PowerPoint presentation and the inclusion of simulation results make taking notes difficult. This issue is addressed by providing handouts.

5. Handouts in PDF format are provided for download (via Blackboard) on the day before the lecture.

These handouts represent a "stripped down" version of the PowerPoint slides where some of the key derivations and conclusions as well as all "discussion markings" (see 3.) are removed. Removing critical material allows for a meaningful engagement with the audience. Majority of the students print the notes and fill the "blanks" during in-class lecture. A similar strategy is described by Pilkington [5].

Usually, a complete PowerPoint presentation consists of only 12 slides. This includes: a title slide, a slide that reviews the last lecture, and finally a slide dedicated to a relevant textbook material. All of the other nine slides contain technical material and on average take 5 min and 10-20 mouse clicks to be fully displayed. A representative PowerPoint slide and its stages of evolution are shown in Figure 1. The image shown in Figure 1(d) is the "stripped down" version provided to students.

Creating PowerPoint presentations described above is immensely time-consuming. The author estimates his efforts at 1h (or more) per slide, or 12 hours for every 50 min. lecture.

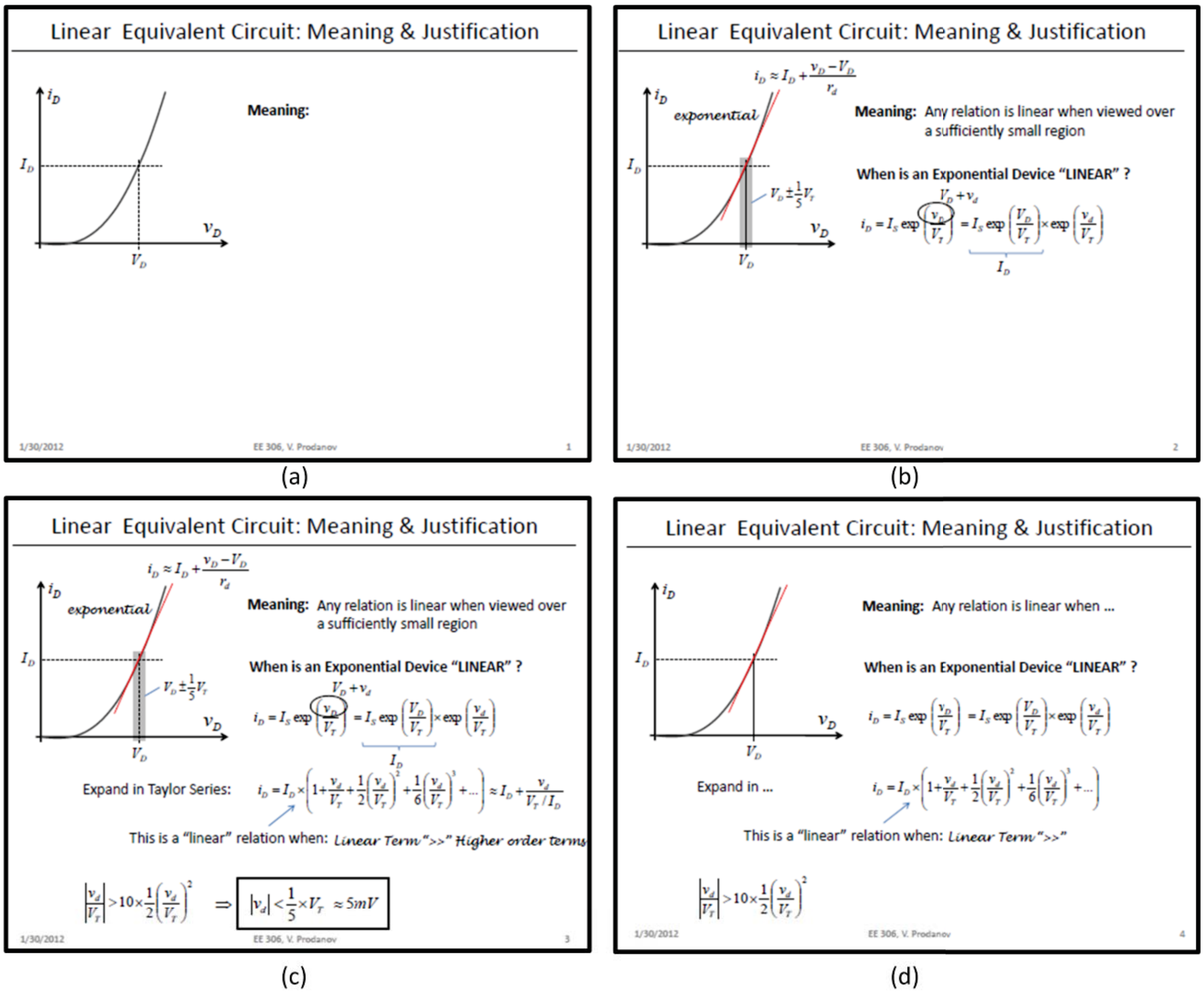

Figure 1: Exemplary PowerPoint Slide. The starting point is (a) and the end point is (c). The image shown in (d) is the "fill-the-blanks" version provided to students.

A digital projector was used to deliver the PowerPoint lectures. The presentation was screen-captured using *SmartRecorder*. External clip-on microphone was used to achieve acceptable audio quality. While other options are available [5], *SmartRecorder* was chosen because of its simple interface and its ability to produce WMV files. Windows Multimedia Audio/Video files incorporate the audio narration and deliver reasonably-good video quality. They are also very common and relatively small in size. Typical .wmv file containing 50 min slides-based lecture has size on the order of 12-16Mb. The WMV encoding of a 50 min screen capture usually takes 10-15 minutes. In our case, this was not an issue since one of the course sections was scheduled at 8am and the other at 12 noon. Screen capture was used in both sections of the course and produced video files were uploaded to Blackboard. Students have reported no issues with files provided or report access issues. The statistical utility of Blackboard was activated to monitor downloads.

Course Design

The lecture capture was incorporated into a ten-week introductory Semiconductor Device Electronics class (EE 306). This class is the first in a series of four electronics circuit classes (EE306, EE307, EE308 and EE409). The first two classes in the sequence are mandatory for all students pursuing a bachelor of science degree in electrical engineering and computer engineering at Cal Poly. In the curriculum of these two programs, EE306 is typically taken in the Fall quarter of the junior year. The course is structured with three fifty-minute lectures each week. There is also an associated laboratory course that meets once a week for three hours. The total EE306 lecture enrolment is usually 150-160 students. Four to five individual sections of the same course are offered. The enrolment of each section varies, but it is on the order of 30-40 students - each. Two or often three different instructors teach the individual sections.

Reported here results are for two (out of five) sections. These two sections were taught by the same instructor and had combined enrolment of 76 students. The lecture recording was not officially advertised. However, most students anticipated that lecture recordings will be used, because the instructor has been providing such recordings in all other classes he teaches.

Students were expected to attend all face-to-face lecture classes, but no attendance was taken or enforced. The grading was based upon each student's performance on weekly homework assignments, one midterm, three quizzes and a comprehensive final exam. The quizzes and the midterm were scheduled so that there was approximately two weeks between them. Homework was assigned every lecture class and collected weekly on Fridays.

Study Methodology

The data for this study was obtained using an anonymous survey. More objective data was also collected using the statistical tracking utility of Blackboard. The written survey was administered and collected at the end of the course. Only those students present at last meeting took the survey. Sixty-four students in total participated. The participation rates for the two sections were 78% (28 out of 36 students) and 90% (36 out of 40 students). The survey had only four questions. Those are provided below.

1a. Was this section the Only EE 306 Section that fit your schedule?

If "NO", please answer the following:

1b. Was your decision to enroll in this particular section influenced by the fact that lectures are being recorded?

2. Approximately how many lectures have you attended in-person?

3. Approximately how many recorded lectures have you watched?

4.Where do you print your EE306 Lecture Notes?

Subjects

Fifty-three percent (40 of the 76 students) were Electrical Engineering majors; the remaining 47 percent were Computer Engineering majors. Seventy-six percent (58 of the 76 students) were seniors, 22% (17 of 76) were juniors. One was a graduate student.

Students' Interest in Lecture Recordings and Class Size

The following two questions from the Survey attempt to determine how many students value lecture capture sufficiently to select a section where such recordings are provided. The students must first have a choice of section selection, before they could exercise it, hence the inclusion of Question 1a.

1a. Was this section the Only EE 306 Section that fit your schedule?

If "NO", please answer the following:

1b. Was your decision to enroll in this particular section influenced by the fact that lectures are being recorded?

Table 1 summarizes students' answers to Question 1a and Question 1b. The data in the third column shows the "big-school/small-class" advantage of Cal Poly. It is remarkable that more than 70% of the students had several class options. The fact that more than 25% of the respondents have chosen these particular sections is a clear indication of the attractiveness of lecture capture.

This level of interest is not surprising. In a recently-conducted Cal Poly survey, *"Which technology has the most potential to improve your teaching and learning experience at Cal Poly in the next 3 to 5 years?,"* 25% of the respondents (1,292 Cal Poly-affiliated individuals) have answered: *"On-Line/Hybrid/Blended Learning (including recorded lectures)"* . At 18%, the second most-popular choice was "Mobile applications and devices (personal response systems, iPad, iPod, iPhone, e-Books, etc.)".

Table 1: Students' Interest in Lecture Capture

	Students Responding	Negative Answer to Question 1a.	Positive Answer to Question 1b.
EE306_01	28	21 (75% of 28)	7 (25% of 28)
EE306_03	36	26 (72% of 36)	10 (28% of 36)
Total	64	47 (73% of 64)	17 (26.5% of 64)

High interest in recorded lectures (or any other widely-appealing technology), coupled with students' ability to choose among several sections of the same course, brings the issue of course enrolment and teaching load. Considering the highly polarized opinions on use of in-class lecture recording [7], it is unlikely that instructors leading different sections of a same course will all use the technology. It is therefore conceivable, that those who provide lecture recordings, will have more students in their classes and therefore larger teaching loads.

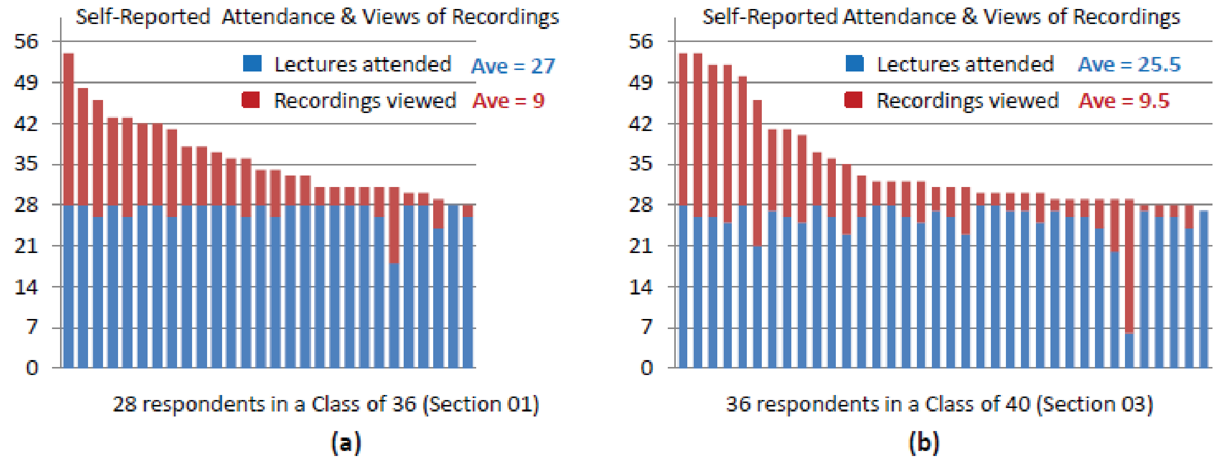

Figure2: These bar graphs capture the responses of all 64 participants to Questions 2 and Question 3 of the Survey.

Self-Reported Class Attendance and Use of Video Recordings

The bar graphs shown in Figure 2 depict self-reported lecture attendance and viewings of lecture recordings. Each graph corresponds to a specific section and each bar corresponds to a specific respondent in this particular section.

Despite the fact that lectures were recorded and no attendance was taken, very few (of the responding) students have missed more than 3 lectures. This might be explained with class size. As shown in [8], students are less likely to skip classes that are small in size. This is important finding, because many classes at Cal Poly are small.

It is noted, that the sum of lectures attended and recordings viewed exceeds 28 for nearly all students; there were total of 28 individual lectures. This implies that the purpose of most viewings is to improve the understanding of the material rather than catch up with missed lectures. Several students have commented on their surveys that they use the recordings to clarify certain aspects they might have missed during lecture. Based upon the results presented in Figure 2, one could extrapolate that most students have similar usage pattern. This conclusion is also supported by the statistical data presented in Fig. 3.

Cost and Scalability of Lecture Capture

Our lecture recording strategy seems to have a monetary cost near zero. This conclusion however is not entirely correct. For effective screen capture, we use PowerPoint presentations and because of the use of PowerPoint presentations, we need to provide handouts. In our case, handouts are delivered in electronic (PDF) format and students are responsible for the printing.

An average PowerPoint lecture contains 12 slides and provided handouts are arranged at two slides per page. Therefore, when printed, a handout will consist of 3 double-sided pages. Supporting a class of 76 students for 28 lectures will require on the order of 6,400 double-sided pages or 12,800 single-sided ones!

Who shoulders the printing cost? The last question of the survey tries to determine the answer. Nearly all of the respondents state that they printed at the senior design lab and at home. This implies that nearly all of the printing is done in a single-sided form. We do not have good estimate for the actual cost of printing, but at "library rates" of 10 cents per copy this amounts to $1,280 ($17 per-person/per-course).

Most students recognize the printing cost as an issue. On the class evaluation forms one student writes: *"The notes to print should be subsidized by the department. Printing that much adds up."* In a private conversation, another student who admits she prints "for free" in the senior design lab, commented *"May be there should be a tipping jar."* Students at some schools have shown willingness to pay as much as $90 for lecture capture [9]. In this study, no attempt was made to determine how much money (if any) our students are willing to spend for lecture capture.

Apart from cost, the required high-volume printing raises questions of lecture-capture scalability and sustainability. We hope that the need for printing will diminish as more students use tablet-like computers to take notes "electronically". In the surveyed class, only 3 students (5%) of the 64 students responding, made use of such technology.

A better way to deal with the "production cost" of lecture capture is to "reuse" the recordings and offer distance learning program. One possible way of implementing such a program (in a lab-heavy curriculum) is to treat lecture courses as prerequisites to lab courses – successful on-line lecture completion allows the distance-learner to complete the corresponding lab course on campus in an accelerated manner.

Statistical Results Obtained Using Blackboard

Video usage data was also collected using Blackboard. Such data can be used to study access patterns over time and access patterns for different students. It can also be used to determine most/least accessed materials. This information allows the instructor to better understand study habits of students and potentially improve the organization and the delivery of the course.

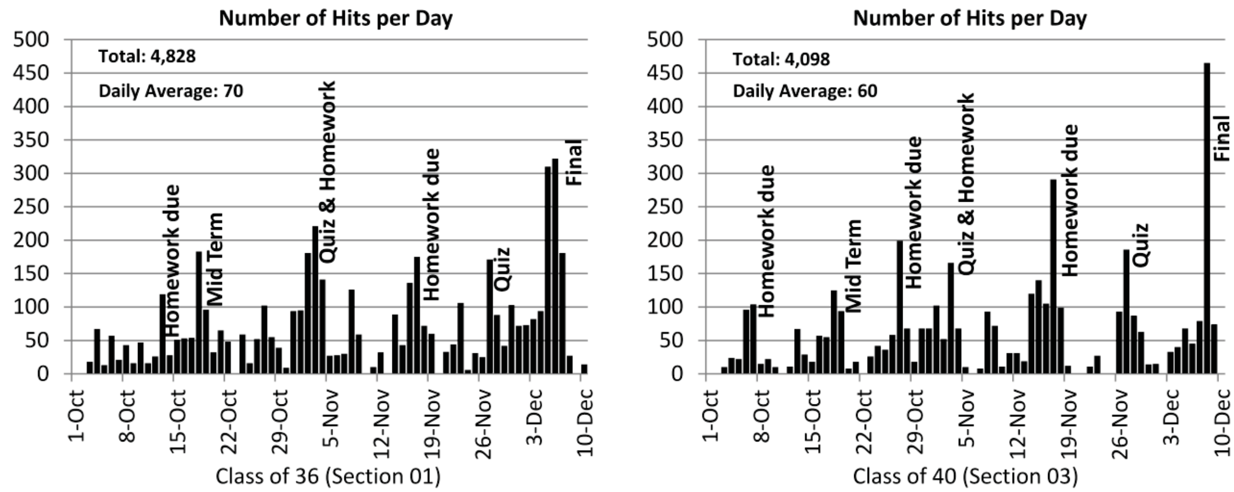

Figure3: Each bar captures the total number of hits generated by all students in a given section.

Homework Assignments, Exams and Video Usage

As shown in Figure 3, there is very strong correlation between the number of hits and specific course events such as quizzes, homework deadlines, mid-term and final exams. It is observed that peak access occurs a day before the event. The total number of hits on the day of the event is also large, with most of those hits occurring in the early hours of the day. This data clearly demonstrates that the proverbial "cramming for an exam" is a reality. It occurs not only for exams, but also when homework is due for collection.

Table 2 and Table 3 show the total hits related to a specific type of an event. Only hits occurring on the day of the event and those occurring on the day before the event are counted as "related". This calculation was applied to all events except for the final exam. For the final exam the author counted all hits within a three day period – the day of the exam and the two days that precede the exam.

It is notable that assigned homework triggered the highest number of hits. This would imply that students access the recording in an attempt to clarify a few very specific (homework-related) topics. This is an important factor showing the perceived importance of completing homework assignments. Nearly all homework assignments were prepared by the instructor (as opposed to being taken from the textbook) and were tightly related to specific lecture topics. This might also explain the high number of homework-related viewings.

Table 2: Approximately 57% of all viewings are related to specific course events. The data is for the class with enrolment of 36 students.

	Hits Related to:			
Hits Total	Quizzes	Homework	Mid Term Exam	Final Exam
4,828	701	911	279	813
100%	15%	19%	6%	17%

Table 3: Approximately 61% of all viewings are related to specific course events. The data is for the class with enrolment of 40 students.

	Hits Related to:			
Hits Total	Quizzes	Homework	Mid Term Exam	Final Exam
4,098	553	1144	219	618
100%	13%	28%	5%	15%

Identifying Challenging Material by Student Access

For continuous improvement, an instructor must to be able to identify the topics with which students have most difficulty. This can be done by grading homework, exams and quizzes. Due to heavy teaching loads, the author grades exams and quizzes, only. This level of grading does not provide sufficient information to determine which topics are most troublesome for the students.

Here we show that data from video usage can be used to identify the topics with which students struggle. As shown in Figure 4, Lectures 1 through 13 are perceived as the most difficult. Nearly all students in the class have accessed those lectures at least once when the course was in progress. The same lectures were also viewed by many students during finals' week. On the other hand Lectures 16 to 28 have been viewed by very few students.

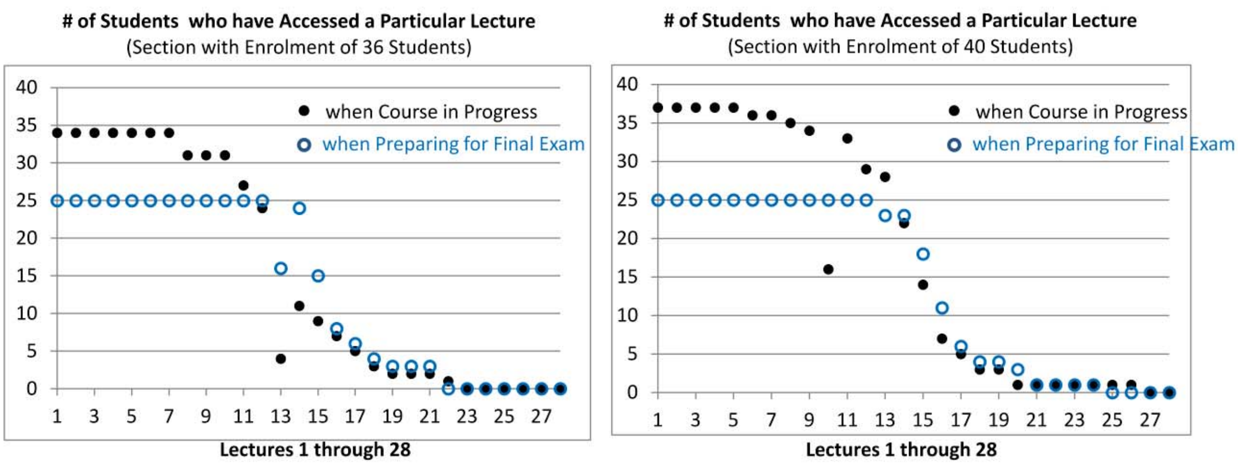

Figure4: Number of students that have accessed a particular lecture at least once when the course was in progress and during finals' week.

While the author did not expect such a drastic difference between different lectures, the results are consistent with the organization of the course. The first 10+ lectures introduce many semiconductor-related topics that are not intuitive to new students. The later lectures introduce material that makes heavy use of the material presented in the earlier lectures.

Reduction of Video Usage and Perceived Self-Efficacy

As students' knowledge of the subject matter improves, the confidence that they know the subject should also improve. This confidence is called perceived self-efficacy [10]. The most successful individuals are usually those that have the knowledge and the confidence to succeed. While self-efficacy is important, instructors do not have the tools to determine whether or not their better performing students have the corresponding self-efficacy. The author argues that reduced access to lecture recordings during finals' week might serve as an indication of knowledge and improved self-efficacy.

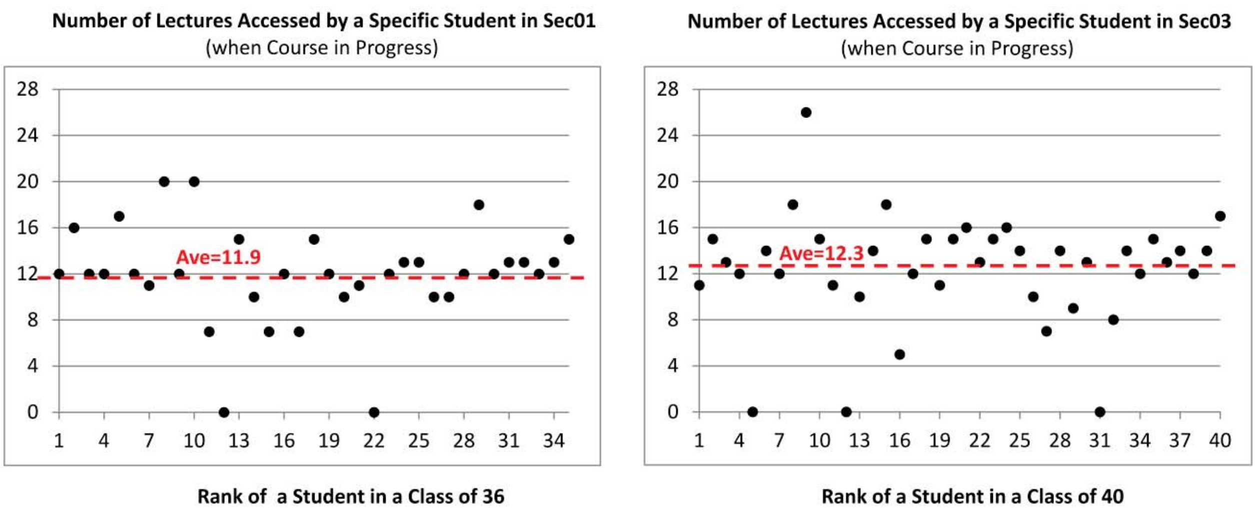

Figure5: Use of recordings during 10-week of instructions.

As shown in Figure 5, the actual averages are slightly higher than the self-reported averages presented in Figure 2. Also notable is the fact that the best performing students cannot be identified by the number of lectures they have accessed during 10 weeks of instruction. In fact, averages and variances of the best and the worst performing students are nearly identical.

If all missed and misunderstood aspects of the material presented are clarified during 10 weeks of instruction, the access of lecture recordings prior to final exam will be substantially diminished. One expects such statistics for the best-performing students only. Any reduction of use (in this population) will be indicative of an improved self-efficacy. As shown in Figure 6 evidence of healthy self-efficacy can only be found in the 40-student section. Seven of the top ten performing students (70%) have not used any recordings during finals' week. In the 36-student section no such trends are observed.

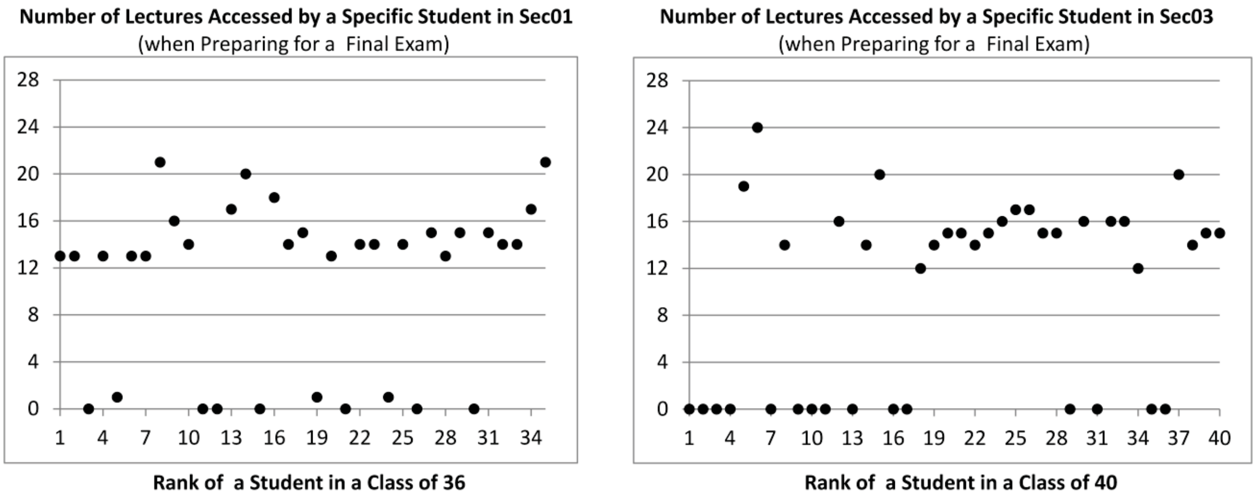

Figure6: Use of recordings during finals' week

Conclusions

Lecture recording and distribution has direct as well as indirect impact upon students' learning. The direct impact is the creation of materials that students could use for review and catching up with missed lectures. The indirect impact is the creation of course statistics that instructor could use for course improvement. We have demonstrated that collected data can be used to determine the topics with which students have most difficulty. This capability, allows the instructor to make specific course modifications that could lead to improved students learning. It is also argued that the same statistical data can be used to determine the self-efficacy achieved by students completing the course.

Lecture recordings could also have direct and indirect negative impacts. Reduction in class attendance (not observed) will have direct negative effect upon learning. Increase in class size (when allowed) will have indirect negative impact upon learning, because it increases instructor's teaching load.

Acknowledgment

The author would like to thank Prof. Lloyd-Moffett for his review of the manuscript and for his many useful comments and suggestions. One such comment identifies another benefit of lecture recording that was experienced but overlooked by the author.

> *When I provide (recorded) lectures, the main reason for me is that it lessens the office hours because instead of coming to me with questions, the students can reference the lecture material. Thus, those that come into hours have more interesting and deeper questions. Such a "reduction" in office hours replaces (some) the hours it takes to put it (the recording) together.*

References

1. Zhu, E. and Bergom, I., Lecture Capture: A Guide for Effective Use, Available on line at http://www.crlt.umich.edu/publinks/CRLT_no27.pdf
2. Pursel, B and Fang, H., Lecture Capture: Current Research and Future Directions, Available on line at http://www.psu.edu/dept/site/pursel_lecture_capture_2012v1.pdf
3. Secker, J., Bond, S., and Grussendorf, S., 2010,. Lecture capture: Rich and strange, or a dark art? LSE Research Online. Available on line at http://eprints.lse.ac.uk/29184/
4. Chang, S., 2007, "Academic perceptions of the use of Lectopia: a University of Melbourne example," Proc. ASCILITE 2007, 135-144.
5. Pilkington,W., 2011, "Student Usage and Assessment of the Benefits of On-Line Access to Lecture Recordings with Synchronized Presentation Slides," Proc. 2011 PSW-ASEE, 282-291.
6. Dolan, D., Prodanov, V., and Taufik "Student Perception of Lecture Video Use as a Means to Increase Time for in Class Problem Solving", Proc. of 118th ASEE Annual Conference and Exposition, Vancouver, Canada, June 2011.
7. Bennett, E. and Maniar, N., 2007, Are videoed lectures an effective teaching tool? Available on line at http://podcastingforpp.pbworks.com/f/Bennett%20plymouth.pdf
8. Friedman P, Rodriguez F, McComb J., 2001, "Why Students Do and Do Not Attend Classes: Myths and realities," College Teaching, 49(4), 124–133.
9. Flores, N., and Savage, S., 2007, "Student Demand for Streaming Lecture Video: Empirical Evidence from Undergraduate Economics Classes," *International Review of Economics Education* 6, 57-78.
10. Bandura, A., 1977, "Self-efficacy: Toward a unifying theory of behavioral change," *Psychological Review*, 84, 191 – 215.

Biographical Information

Vladimir Prodanov is an Assistant Professor of Electrical Engineering at Cal Poly. He earned M.S. and Ph.D. degrees in Electrical Engineering and in 1997 joined Bell Labs-Research at Murray Hill, NJ. He remained with Bell Labs (Lucent Tech.) and Agere Systems until 2004. From 2004 to 2008 he was with MHI Consulting, LLC. Vladimir's technical interests are in the field of analog & mixed-signal circuit design. He has authored/co-authored two dozen peer-reviewed technical articles and has been granted 17 US patents. Dr. Prodanov has taught analog and RF circuit design at State University of NY and Columbia University – NY City.