120th ASEE Annual Conference & Exposition
FRANKLY, WE DO GIVE A D*MN
June 23-26, 2013

Paper ID #8036

Work-in-Progress: Videos and Video Podcasts - What Engineering Educators Ought to Know

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Abstract

The use of recorded video for education has been around for several decades since the advent of film. But recent technological advancements, in particular the continued growing popularity in the U.S. and in other countries of devices that can be used for viewing videos, require certain key questions to be re-visited and new questions to be answered.

A project was recently initiated to study these questions within the context of using videos and video podcasts as a teaching/learning tool specifically in engineering education. Chief among them is the question of how its use can improve the teaching/learning of engineering material. A review of recent literature regarding this was performed, and a brief summary of the findings is presented. Another major question relates to how these videos and video podcasts are produced and made available for dissemination, and how much time and effort this requires from an already over-worked engineering educator. So the various approaches for doing so, and how much time/effort they require, are also described. In addition, this paper provides a few examples from the author's recent first experience on using videos for teaching and learning. It also includes an analysis of surveys conducted in the author's classes during the Fall semester of 2012 to gauge the students' opinions on such videos.

Introduction

The use of recorded video for education has been around for several decades since the advent of film. Its typical mode of delivery has been on an *asynchronous* basis (delay between production and viewing), although recent technological advancements has led to more instances of *synchronous* delivery (no delay between production and viewing). The focus of this paper is on asynchronous videos and video podcasts as a teaching/learning tool in engineering education.

Several factors have driven, and are driving, the greater use of video in engineering education. Among these are:

a. Incoming millennial generation college students are typically technologically savvy and have high expectations of using Web 2.0 technologies[1]

b. Engineering students are overwhelmingly 'visual' learners[2]

c. Recorded lectures gives students the option to replay the video as many times as they need to clarify concepts they missed in the classroom; a feature that was used and appreciated by the students most often, and has made the most positive impact in students' minds about the use of video in engineering education[3]

d. Exponential growth of smartphone adoption in the U.S. and many other countries means recorded video - made available as vodcasts (video podcasts or compressed video files playable by portable electronic devices) - allows users access to that media even when they are not in front of desktop or laptop computers.

e. Vodcasting allows students the opportunity to receive *supplemental* multimodal presentation, which is generally accepted as beneficial, particularly in the comprehension of complex concepts[4].

Finally, among the strongest evidence of recorded video's growing role and importance in engineering education is the surging popularity of Web sites offering such courses, including MIT's OpenCourseWare[5], Stanford's Engineering Everywhere[6], etc. Hence, we can note that there are several general compelling reasons for engineering educators to begin using recorded videos and vodcasts for teaching/learning if they have not already done so. Let us now consider in the next three paper sections the documented specific experience of certain engineering educators, the work of producing and publishing videos, and then the author's own experience, regarding recorded videos.

The Specific Experience of Certain Engineering Educators

Firstly, recorded videos have been used by engineering educators recently to demonstrate and teach actions to be taken in lab (hardware and/or software use) settings. Specifically, Johnson[7] described using videos to help students learn/gain familiarity with the use of foundry casting equipment, while Shreve *et al*[8] implemented - and studied how students used - online video demonstrations related to solid modeling software instruction. The latter found better learning outcomes in those students who watched more of the videos during the semester. In addition, video-taped Electrical Power and Machines lab experiments had been used as a virtual substitute experience for distance learning students, and it was concluded that the video-taped laboratory was as effective as the traditional laboratory in attaining the desired course outcomes, while the students' overall evaluation was very positive[9].

Secondly, recorded videos of entire lectures or else short video clips of lecture-related material (e.g., topical summaries or illustrative demonstrations or solving supplementary examples) have been employed in engineering education. It has been determined that such lecture videos improved students' learning of how to solve typical problems in thermodynamics, and enhanced their conceptual understanding[10]. Similarly, when a portion of face to face lectures was replaced with prerecorded lecture video whose viewing was assigned for homework, and the freed lecture period was used for additional in-class problem solving development, students felt they were able to learn more effectively and gain a better understanding of conceptual material as well as problem solving experience, via this approach[11].

In the flipped/inverted classroom approach[12, 13], the in-class problem solving time is extended to take up the whole period while the knowledge and skills typically taught by lecturing in the class is to be conveyed to the students outside of class-time, and this is typically done via prerecorded lecture videos and/or shorter video clips. Many examples have been documented in the literature, including for teaching undergraduate electrical engineering classes[14], Statics[15], an undergraduate architectural engineering class[16], a MATLAB course for freshmen[17], and a mechanics of materials course[18].

Moreover, having students in an Environmental Control Systems course view relevant video clips demonstrated a positive influence on their learning, although it was found that class attendance continues to be an important factor in terms of student learning performance[19]. This last-mentioned study raises an interesting issue that educators need pay attention to and guard against: when lecture videos are recorded for later viewing at the students' convenience, this

positive aspect (which students overwhelmingly like) has the potential negative consequence of encouraging some students to skip class. Clearly, some counter-measures must be simultaneously employed to deter chronic student absenteeism.

The Work of Producing and Publishing Videos

Now that we have been persuaded recorded videos and vodcasts are a good teaching/learning tool, the follow-up question is how are these produced and disseminated? The various methods of recording a lecture to a video file can be classified into two categories: software-based systems, and hardware+software-based systems. The former requires only a PC or a laptop with the video-recording software installed. At its most basic level, this method will just record whatever is displayed on the PC/laptop screen. For example, commercial products such as Tegrity[20], and Techsmith's SnagIt and Camtasia[21], are being used at University of Central Florida[22] and at Manhattan College, Bucknell University and University of Kentucky[10], respectively. However, free open-source software, such as RecordMyDesktop[23], are also available (see Oncul[24] for an excellent detailed description of *free, open-source* video-recording) although most of these are based on the Linux operating system rather than on the Windows or the Mac operating systems. With an additional (or laptop-integrated) webcam, some of these software can simultaneously capture the webcam video. This then becomes a hardware+software-based system, which can be quite sophisticated, an example of which is the Echo360 system[25] that is currently being used at the author's university. It is important to note that some of these systems include varying degrees of editing capability (such as Echo360), while others do not; for the latter group, acquiring another software program will be needed to edit the captured videos.

Engineering educators should be aware that the recorded video files can be saved in various digital file formats, such as the OGG open-standard format[26], also WMV Microsoft's proprietary format, and MOV Apple's QuickTime format, etc. These files can be played/viewed on a desktop or a laptop computer with the appropriate video player, such as VLC Media Player[27], Windows Media Player and QuickTime Player, respectively. But given the proliferation of portable electronic devices and smartphones, conversion to a vodcast file format such as MPEG-4 (MP4) and a compressed video format such as H.264, would be an important and necessary step in the video publishing procedure. Note that the above-mentioned only presents the tip of the iceberg vis-à-vis video formats, with each having their particular characteristics and corresponding advantages and drawbacks.

By now, most engineering educators are likely feeling intimidated, like the author, by the maze of possible options in producing videos for their students. However, there's still the needed step in the process of where to publish/host the videos. The possibilities include Google's YouTube site, Apple's iTunes store, and also course/learning management system sites such as WebCT Vista and Desire2Learn, which are the formerly and currently used systems at the author's university. Of course, these represent only a small sample of what's possible.

As cautioned by Ellis and Cohen[28], instructional multimedia supplements are intuitively attractive, but their use must be weighed against the time and effort of production. The above simply described the needed technical effort but the videos' educational content requires time and effort too. In Brown *et al*[29] the authors found vodcast production software relatively easy to use.

However, the entire process of production and distribution required a good deal of arcane technical knowledge, and the expenditure of well over two days' time creating and making available two 30-second vodcast episodes. Hence, it should be clear that most educators are going to need an easy-to-learn and use video production and dissemination system, as well as knowledgeable support staff, in order to make video podcasting work efficiently and effectively for them and their students.

The Author's Own Experience

For the Fall 2012 semester, the author decided to make use of recorded video, for the first time, as part of his two classes. In the first class, Electronics - at the *junior*-level, the Echo360 system was used to produce, edit and publish the recorded class lecture videos, with the help of a camera at the rear of the lecture hall and a microphone on the podium. In the other class, Electric Drives - at the *senior*-level, students were asked to view 10- to 15-minute custom-produced topical summary video clips (vodcasts) recorded by the textbook's author, a University of Minnesota faculty member, and hosted on the University of Minnesota's web-site. The following describes the results of surveying the two groups of students regarding their opinion of the respective videos.

For the *junior*-level class, with twenty-eight survey responses, highlights of the survey include the following:

- Constrained-response: the questions asked in this category are shown in Table 1.

  A quarter of the students who responded indicated they did not watch any of the recorded videos at all, leading to an average of only 2.74 videos (out of the thirty available videos) watched by each student. One reason for their failure to do so could be that the instructor stopped sending out weekly reminders that the videos were available for them to watch after the third week of instruction. For those who did watch, about 55% of the students watched the lecture videos in their entirety, while the rest watched only part(s) of the videos. None indicated they watched the videos on a portable electronic device even though a vodcast file version was available for them to download, and they could also subscribe to a feed of these vodcasts. It remains to be determined if the students are not knowledgeable enough about media feeds, or if there's some other issue involved here. Finally, just over 50% of these students thought it a good idea to have future students watch previously captured lecture videos before class, and then spend class time working problems and taking a short quiz on the material. Those objecting mostly referred to the part regarding the quiz.
- Free-response:

  Regarding the question "What did you like and dislike about the captured lecture videos? And then provide any suggestions you may have on how they can be improved." Most of the students who did watch the videos expressed only positive comments, along the lines of liking them as a good alternative for missed in-class lectures, and as a good review aid. A few of the students commented that they couldn't read the whiteboard writing on the videos, while a couple of other students wrote that my writing/annotations on the PowerPoint slides were not as clear as my writing on the board. This feedback will help improve the author's future efforts at using the Echo360 system for lecture capture.

For the *senior*-level class, with nine survey responses, highlights of the survey include the following:

- Constrained-response: the questions asked in this category are shown in Table 2.

  An average of 10.7 videos (out of the twenty available videos) were watched by each student. This seems reasonably good, although the author was reminding them during almost every class meeting about which video clip they should be watching to prepare for the next class, so it's nevertheless a little disappointing that this average was not higher. Moreover, 50% of the students indicated they did not watch these video clips as preparation before coming to class, which was the main function of these clips. One student indicated watching the video clips on a phone and on a tablet device. Furthermore, one student thought these clips were too short, but the others indicated these were the right length.
- Free-response:

  Regarding the question "What did you like and dislike about the video clips? And then provide any suggestions you may have on how they can be improved." Most of the students expressed only positive comments, along the lines of liking the convenience of watching the videos outside of class and being able to watch them multiple times; also that these helped to prepare them for class, or to understand the covered material better, which other similar studies have also found. A couple of students expressed only negative comments, about the shortness of the video clips and the covered examples being too few and too simple.

Conclusions

The available literature provides ample evidence that recorded videos can improve student learning in engineering courses, both of skills and of concepts. Moreover, the experience of other educators and of the author is that students relish being able to re-watch the lectures on video in part or in full, and at anytime, anywhere and any number of times they desire to do so. This should motivate more engineering educators to use recorded videos and vodcasts as a teaching/learning tool for their classes.

However, educators should be wary that production and publication of videos is a major undertaking without the right integrated package of hardware and software. But even with the right package, some care must be taken to obtain good and effective video recordings. Finally, we need to be aware that even good and effective video recordings may not always lead to better learning outcomes if the students are not motivated/incentivized to watch these videos, or if the videos are used as an excuse by students to skip classes frequently.

The author is teaching the junior-level Electronics class again during the Spring 2013 semester. He will take steps to increase the students' viewing of the captured Electronics lectures compared to the Fall 2012 semester, and then study how these videos and vodcasts impact their learning of the material.

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Table 1 – Constrained-response questions asked of students in the *junior*-level Electronics class

On a scale of 1 to 10, how interested are you in learning about Electronic Circuits ? (with 10 = Maximum interest)
On average, how much time do you spend reading the book as preparation ***before*** coming to class ?
How many of the captured lecture videos have you watched ?
Did you watch the video(s) on a PC, laptop or other portable electronic device ?
Did you watch the video(s) at home, school or other location ?
Typically, do you watch the videos from start-to-finish ? If not, why ?
What do you think of the idea to have future students watch previously captured lecture videos before class, then spend class time working problems and finally taking a short quiz on the material ?

Table 2 – Constrained-response questions asked of students in the *senior*-level Electric Drives class

On a scale of 1 to 10, how interested are you in learning about Electric Drives ? (with 10 = Maximum interest)
On average, how much time do you spend reading the book as preparation ***before*** coming to class (in hours) ?
How many of Dr. Mohan's short video tutorials[30] did you watch ?
Did you watch the video(s) before coming to class ?
Did you watch the video(s) on a PC, laptop or other portable electronic device ?
Did you watch the video(s) at home, school or other location ?
Was the length (and detail) of the video clips (a) too short/little, (b) too long/much, (c) just right?