AC 2008-1282: WATCHING VIDEOS IMPROVES LEARNING?

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Watching Videos Improves Learning?
An Effective Use of Short, Simple, Instructor-Made Videos in an Engineering Course

Abstract

Keeping up with trends in technology use among students is always a challenge. Students, like much of society, are increasingly "pulling" their desired content from the web (news, entertainment, etc.) rather than simply acting as passive receivers. The growth of on-demand internet viewing on YouTube and NetFlix in combination with the diminished power of the big three networks is a great example of this trend. Education, however, remains generally out-of-sync with this trend; we still rely primarily on a "push" approach. Today's students desire more and more control over how they get their information both in their courses and in their lives. This paper reports on a notably successful attempt to create a resource which augments traditional classroom instruction and can be used at the time and place of the student's choosing. By creating short, simple videos using easy-to-use technology, instructors discovered that students not only appreciate having the resource available, they also improve their learning with its use. Students in the civil engineering program at the United States Military Academy who used these videos as they prepared for mid-term exams performed better than those students who chose not to make use of the resource. In addition to the marked improvement in academic performance, feedback from students was overwhelmingly positive.

These videos are unique compared to other web-based learning objects in a number of ways. First, they are created using very simple, easy-to-learn technology and do not require assistance from outside the department. Second, they do not duplicate any of the material presented in the course or the traditional classroom activities; rather, they augment the course content and provide an additional resource for students to consult when studying and solving assigned problems. Third, they are short and focused on a single concept; they do not require a large time investment for a student to benefit. We believe that this resource blends traditional presentation and current technology in a unique way that is demonstrably beneficial and does not require significant time or computer "know-how" on the instructor's part.

This paper summarizes the initial implementation of short, instructor-created tutorial videos in our introductory engineering course, Fundamentals of Engineering Mechanics and Design, and includes quantitative support for the conclusion that using these videos improves academic performance and students' attitudes. This paper also includes an explanation of how to create the videos using inexpensive and easy-to-learn resources, outlines our lessons learned, and concludes with a discussion of best practices.

Introduction

Keeping up with trends in technology use among students is always a challenge. Our students, like much of society, are increasingly "pulling" their desired content from the web (news, entertainment, etc.) rather than simply acting as passive receivers. The growth of YouTube in combination with the diminished power of the big three networks is a great example of this trend.

Education, however, remains generally out-of-sync with this trend; we still rely primarily on a "push" approach. Recent research by the Pew Internet and American Life Project indicates that the current generation of high school and college students are dissatisfied with the "digital disconnect" between their lives and the classes they take in school[1]. Today's students desire extensive control over how they get their information both in their courses and in their lives, and the mixture of "life" and "work" information is complex. Many professors have begun providing some content over the internet, experimenting with podcasting, vodcasting and other modes[2,3]. The vast majority of this content is recordings of the conventional classroom lectures that students can then access at their leisure[4]. Education repositories such as ED-CAST or MERLOT[5] contain examples of these. Other professors have integrated digital videos to provide access to demonstrations[6] or present laboratory preparation guidance or even allow for conduct of a laboratory experiment from a remote location[7].

The authors recently implemented an alternative method of using recent technology to provide students with a learning resource that they can use at a time and place of their choosing. The method is referred to here as "Video AI" (AI stands for "Additional Instruction") and has been implemented in the United States Military Academy's Department of Civil and Mechanical Engineering with measurable positive effects on both academic performance and student perceptions of learning (for a detailed statistical examination of the impact of this resource on academic performance, see "On-Demand Learning"[8]). The first course to use the concept was CE300, The Fundamentals of Engineering Mechanics and Design (a course combining statics and mechanics of materials), and it is now being used in several other courses (both lower- and upper-level) within multiple departments.

These videos are unique compared to other web-based learning objects in a number of ways. First, they are created using very simple, easy-to-learn technology and do not require technical assistance to create. Second, they do not duplicate any of the material presented in the course or the traditional classroom activities; rather, they augment the course content and provide an additional resource for students to use when studying and solving assigned problems. Third, and perhaps most importantly, they are ***short and focused on a single concept*** (similar in length and content density to YouTube videos); they do not require a large time investment for the user to benefit. We believe that this resource blends traditional presentation and current technology in a unique way that is appealing, effective, and free from technological barriers for both the instructor creating the video and for the student using it.

This paper focuses on the implementation of this learning aid and outlines the resources required to implement something similar in other courses. A collection of "best practices" accumulated over two semesters is also presented, along with some use and performance data.

Video AI – An Initial Success

At about the midpoint of the 2007 Spring semester, the first video was posted to the CE300 (Fundamentals of Engineering Mechanics and Design) website. The topic covered was shear and moment diagrams, since this is a problem topic for many of our students. The posting came a few days before a homework assignment requiring the completion of several shear and moment diagrams was due and about two weeks before the second mid-term exam (WPR2). Immediate anecdotal feedback from the students was overwhelmingly positive: "This Video AI is awesome! Can you make one for every topic in the course?" was a common response. Instructors overheard students talking to one another in the hallways about Video AI – asking each other if they had "checked it out yet." Motivated by such positive feedback, three more videos were created prior to the mid-term exam: calculating the first moment of outward area, beam design using normal stress criteria, and beam analysis for shear stress and deflection. The two on beam design were grouped together since they were portions of the same example problem.

All four videos were created by writing in Microsoft Journal on a Tablet PC, speaking into an inexpensive computer microphone, and using Camtasia screen capture software. Two videos simply used a blank piece of virtual paper; for the other two, the instructor wrote on a virtual copy of a handout that students had worked through in class. Each video was kept to less than 10 minutes in length in order to ensure that it remained focused on a single topic or example, was accessible, and was not overwhelming.

Following the mid-term exam, a survey was conducted to gather data about the ways in which students used this new resource as well as to determine their opinion of the concept (see Appendix A). Using statistics tracking available on Blackboard, we were able to determine who accessed the resource and when. The exam results were correlated with the tracking statistics to determine if the use of Video AI had any impact on student performance on the exam. The group for whom statistics were gathered for this study included 124 students in seven sections taught by three instructors. All survey and exam results were extremely positive: the students use and like the resource, and its use improved their grades.

Video AI Improves Student Performance

At first glance, the grade results for the WPR2– for which students had Video AI resources available – appeared to indicate that performance was improved from the first mid-term exam (WPR1). Statistical analysis proves that this was true. The average was higher, the standard deviation was less, and the distribution was more skewed – that is, more students scored in the A range than previously. (See Figure 1 for the comparative distribution of WPR1 and WPR2 grades.) Of course, this better performance on WPR2 could be attributed to several things: e.g., the exam may have been easier, the students had become accustomed to the format of exams in the course, or the students were more motivated to prepare for WPR2 given their lower performance on WPR1.

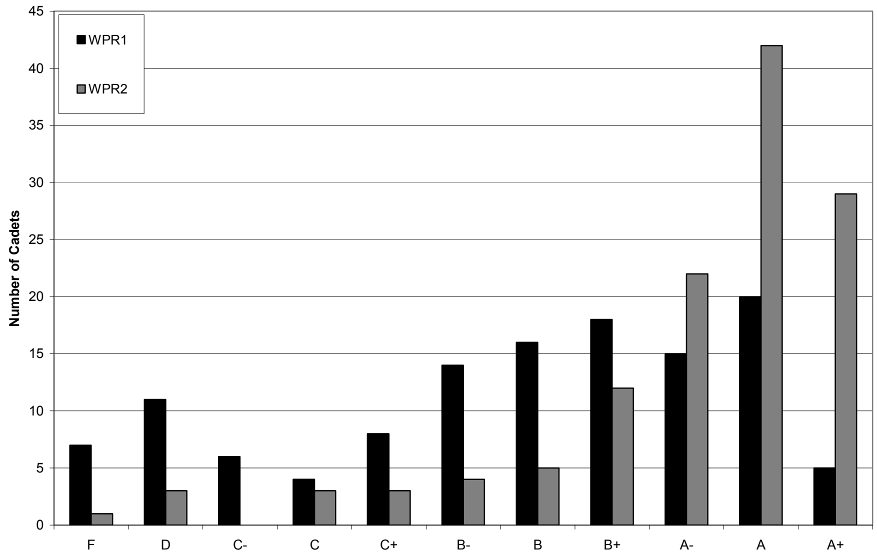
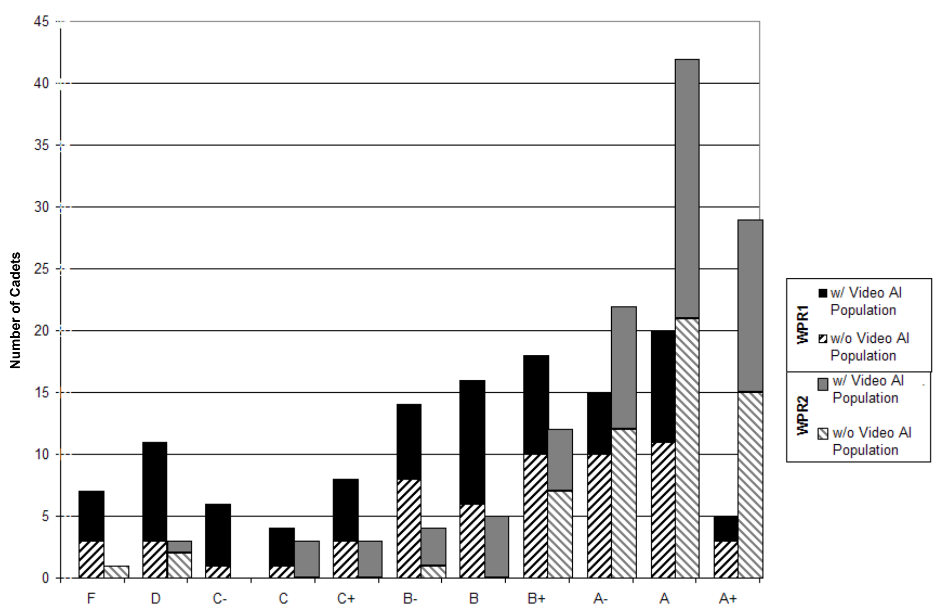


Figure 1 Comparison of Grade Distributions on Mid-Term Exams

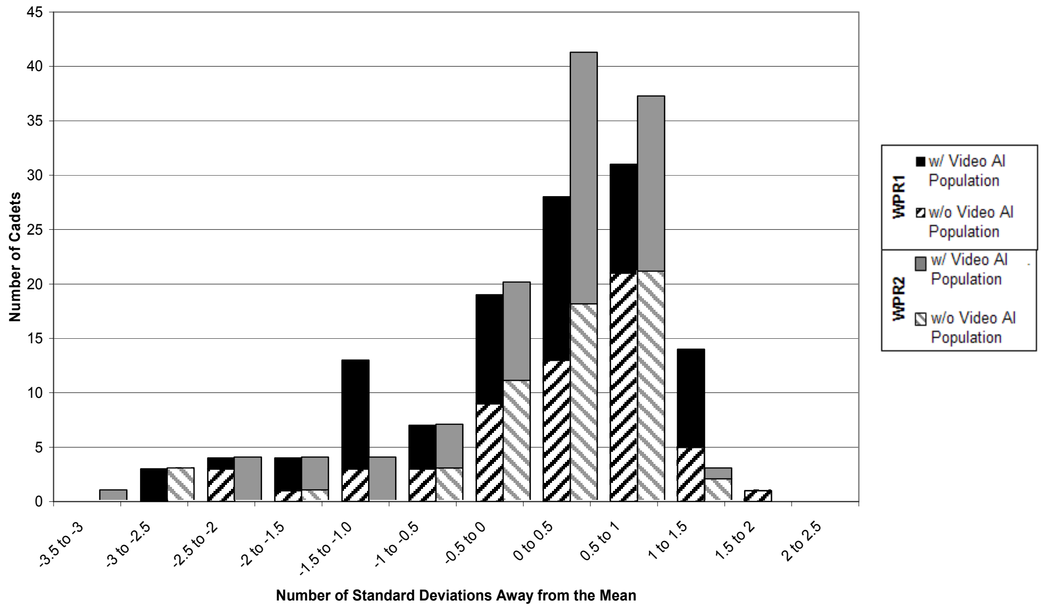
A critical question to answer concerning the increase in performance was "did those students who used Video AI in their preparation for the exam perform better than those who did not?" The answer is yes! Students who used the videos as part of their preparation for the exam were more likely to significantly increase their grade (at least one letter grade) on WPR2 than those who did not use the resource. This can be seen by breaking down the distribution of grades on both exams, as in Figure 2. Keep in mind that no Video AI was available for WPR1. It can be seen that those who did poorly on WPR1 used Video AI to prepare for WPR2 and dramatically improved their grades. The majority of those who did poorly on WPR2 did not watch any of the videos.



NOTE: Video AI was only available for WPR2, but the populations are broken down for both WPRs in order to see the impact of Video AI

Figure 2 Comparison of Grade Distributions on Mid-Term Exams (by Video AI users and non-users)

A graphical comparison of the z-score distributions for WPR1 and WPR2, separated by population, makes this point even more clearly. Notice that in Figure 3 the distribution of students on the positive side of the z-score distribution (that is, they outscored the mean) increases in favor of those who made use of Video AI.



NOTE: Video AI was only available for WPR2, but the populations are broken down for both WPRs in order to see the impact of Video AI

Figure 3 Comparison of z-Score Distributions on Mid-Term Exams (by Video AI users and non-users)

How Students Use Video AI

More than half (52%) of the 124 students enrolled in the course accessed at least one Video AI. 12 students watched all videos, 48 watched two, and 5 students watched only one. It is worth noting that the majority of the students with an A in the course did not use Video AI. This resource was used primarily by students in the C and B range, as shown in in Figure 4, students performing at less than an 80% average in the course were nearly twice as likely as higher-performing students to use VideoAI. This is the population we had in mind when we developed the videos – those who need a little extra assistance to fully grasp and apply the material.

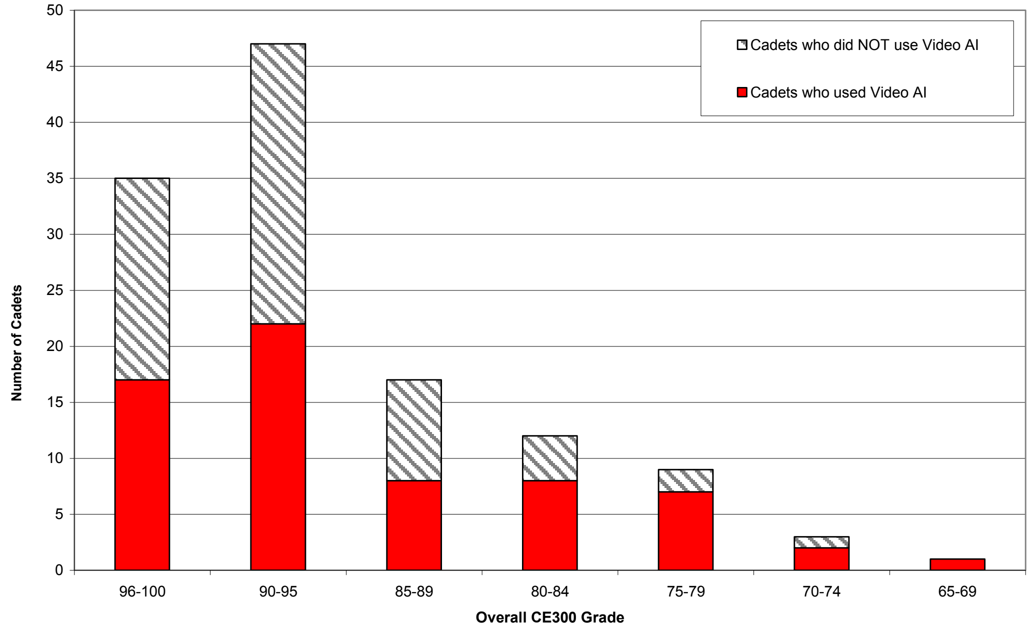


Figure 4 Who Makes Use of Video AI? (grade at the start of Video AI availability)

The survey was administered through Blackboard. Response to the survey was lower than desired – 18 of the 65 students (28%) who used Video AI responded. Despite the low response rate, anecdotal feedback from other students corroborates the survey data.

When asked why they used Video AI for, most of the students (72%) reported watching the videos primarily to prepare for the WPR, but nearly as many (67%) reported using it to improve their understanding of the material (see Figure 5).

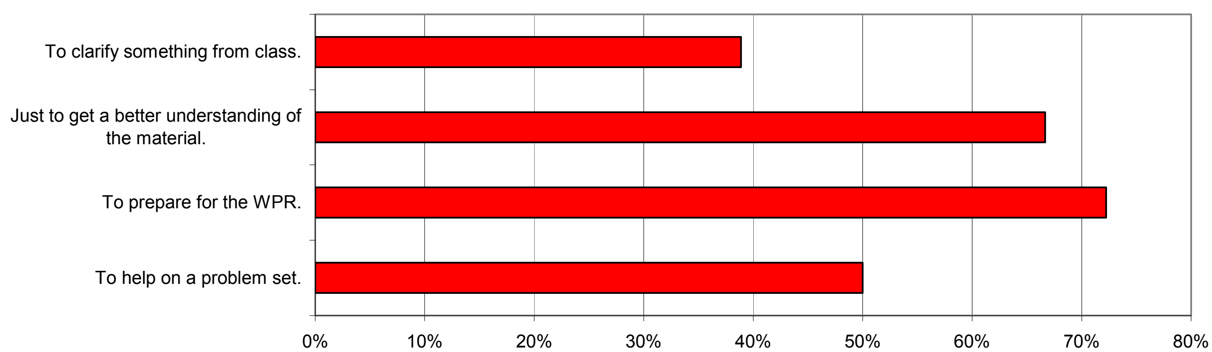


Figure 5 What Do They Use Video AI For?

It is interesting to note when students made the most use of this resource. Corroborating the information provided in Figure 5, statistics from Blackboard (see Figure 6) show that they accessed the videos in the greatest numbers before problem sets were due and in the days leading up to the mid-term exam (WPR2). Problem Set #8 (PS#8) required the completion of two shear and moment diagrams and the analysis of beam cross-sections for normal and shear stress. Problem Set #9 (PS#9) was an open-ended beam design. WPR2 was a mid-term exam covering beam analysis and design. An encouraging inference from this figure is that many of the students began their completion of assignments and preparation for exams well before the due dates.

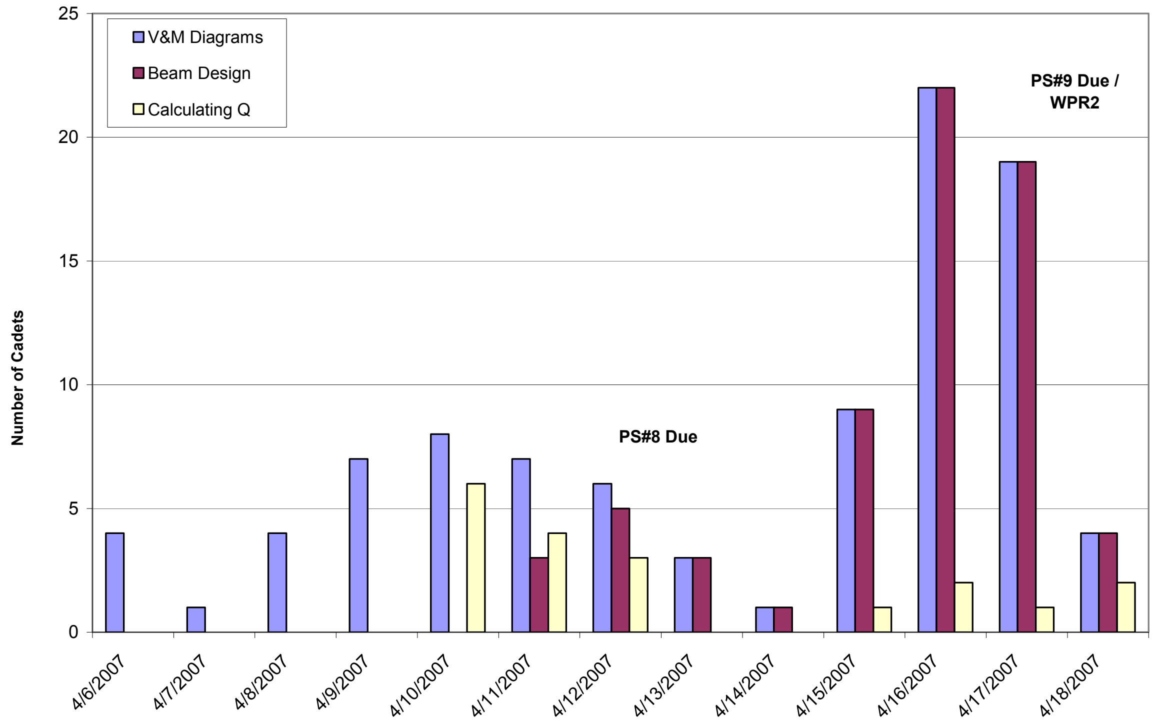


Figure 6 Access of Videos by Date (leading up to WPR2)
(Note: The "V&M Diagrams" video was made available on 6 April, "Calculating Q" became available on 10 April, and "Beam Design" was available beginning 11 April)

Most students providing feedback through the survey reported pausing the video while watching it in order to apply the concept described in the video to the problem they were working on. Very few of them reported watched the videos straight through without pause. See Figure 7 for further details about how students used the videos.

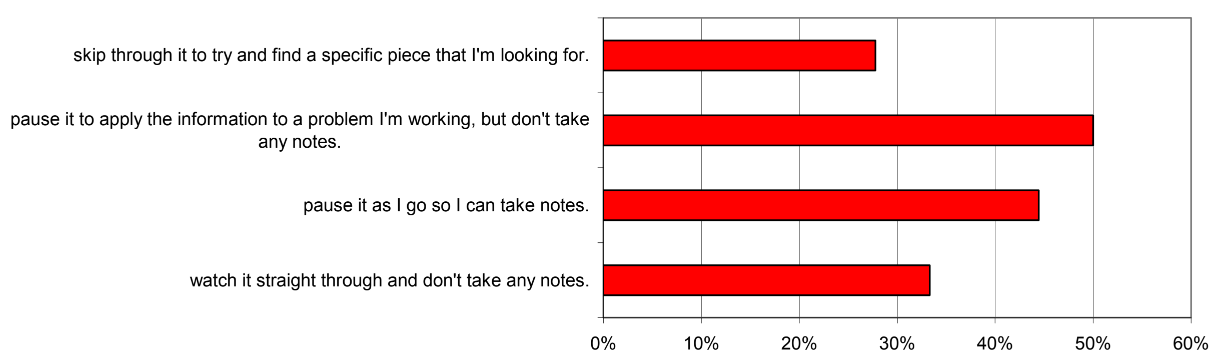


Figure 7 How Students use Video AI

Concerning their perceptions of the videos, the students "strongly agree" (average 4.72 out of 5 on the Likert scale) that the videos improve their understanding of the subject. They "agree" (average 4.40 out of 5 on the Likert scale) that a video helped them get unstuck on a problem set.

And they "strongly agree" (average 4.78 out of 5 on the Likert scale) that they would like to see Video AI on other topics in CE300. The leading topics desired were truss analysis and axial design.

The videos were created in two formats: one supported by Windows Media Player, the other supported by a video-equipped iPod. 100% of the students used the Windows Media Player format. Not a single student used a video iPod. Given the prevalence of Media Player on personal computers and the knowledge that students used the videos when completing homework and preparing for exams (and thus had their laptops accessible), this is not surprising.

Best Practices

The following principles guided the creation of our videos:

- Short
- Focused on a specific topic
- Address common problem areas or topics
- Walk through example problems
- Keep them "real"
- Don't add to the instructor's workload

We used the following resources to create the videos:

- Tablet PC
- Windows Journal Writer (program included in the purchase of a Tablet PC)
- Desk microphone (we used one that is included with the purchase of a desktop PC)
- Camtasia 4.0 software (can be purchased for less than $200; a free 30-day trial can be downloaded at http://www.techsmith.com/download/camtasiatrial.asp)

Camtasia is a simple program to use. Creation of the video requires the user to select the portion of the screen to be recorded, perform a quick audio check to ensure microphone functionality, and press the record button to begin screen and audio capture. When capture is complete, the user presses the stop button, and Camtasia opens the editing window, in which other videos, PowerPoint, or audio files can be added and edited similarly to typical digital movie editing software. Once the user is satisfied with the product, the video is "produced" into formats of the user's choosing. Professors at other institutions have produced similar videos by videotaping working problems on a chalkboard[9] or Tablet PC[10].

We have not found any need for editing. If there are minor errors that the instructor corrects while making the video, we do not believe the time necessary to edit them out is warranted. We have approached this project with the idea that the videos need to remain "real" and not "sterile." Using the instructor's own handwriting and retaining minor mistakes maintains some of the "realness" of the video and makes it more interesting to watch.

Some of the videos were made by writing on a blank piece of virtual paper, which resulted in a viewing experience similar to watching a problem unfold in class on the chalkboard. Other videos were made by capturing the instructor using more "finished" products like PowerPoint or

Word documents to create the solutions. As time is always limited, there are no pedagogical reasons to use PowerPoint or Word over a blank screen for most applications.

Effort was made to ensure that each video was less than ten minutes long. The primary reason for this limit was to keep videos short enough that students will be willing to use them: too long, and the student is less likely to take the time to find needed content in the video. The time constraint also forced the instructor to whittle the information down to the absolute essentials, reducing the extraneous details often included in classroom discussion. Another reason for this limit is that these videos are intended to supplement typical classroom activities. We do not want the videos to replace the need for active participation in class.

To enable and encourage working ahead on problem sets, videos should be posted as early as possible in the semester. As long as the videos do not show the same problems that are worked in class, there is no pressing pedagogical reason not to post all of the videos at the beginning of the semester. This allows students to see the resources that are available, gives a preview of what is to come, and may satisfy global learners' desires to see the big picture earlier. Of course, as the semester progresses, other content areas may appear that could easily be addressed by a quick video. In that case, create the video, post it, and announce it to the students. This demonstrates a number of positive principles to the students: the instructors are receptive to student needs, the instructor cares about student learning, and every group of students is different (what may not have been a problem for some students is a challenge for others).

Conclusion

The use of short, simple, focused videos improves student perception of learning and academic performance in an engineering course. These videos are resources that students like to use: the videos make use of technology which students use in other aspects of their lives and are, therefore, very comfortable with. Students appreciate Video AI because they can get help when it best suits their schedules and because it demonstrates that their instructors are willing to use new technology to improve student learning. Its immediacy helps to reduce the "Digital Immigrant accent" that most instructors have[11].

The concept was expanded during the most recent academic term. More videos, covering a broader range of topics, were prepared and offered for student access. After the positive response from the Spring 2007 implementation in CE300, several other instructors implemented Video AI in their courses within the department and across the institution. Additionally, this concept is perfectly suited to enhance distance learning; the Thermodynamics and Fluid Mechanics course (ME311) in our department used it in such a manner this past term. The feedback from all additional use was very similar to that presented in this paper. Video AI is positively regarded by students: they like having the resource available, and it improves their learning. We are excited to see how it continues to evolve and improve the education of future engineers.

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APPENDIX A: Survey Administered to Students via Blackboard

Question Which Video AI(s) have you watched?

Answers LSN 27 Quiz - Shear and Moment Diagram explanation
LSN 30 Beam Design (Step 1) - shear and moment diagram and design for flexure
LSN 30 Beam Design (Step 2) - checking the design for shear and deflection
Calculating Q

Question For what reason, or reasons, did you use the Video AI?

Answers To help on a problem set.
To prepare for the WPR.
Just to get a better understanding of the material.
To clarify something from class.

Question When watching Video AI, I typically:

Answers watch it straight through and don't take any notes.
pause it as I go so I can take notes.
pause it to apply the information to a problem I'm working, but don't take any notes.
skip through it to try and find a specific piece that I'm looking for.

Question The Video AI improved my understanding of the subject.

Answers

1. Strongly Agree
2. Agree
3. Neither Agree nor Disagree
4. Disagree
5. Strongly Disagree

Question The Video AI helped me get "unstuck" on a problem set.

Answers

1. Strongly Agree
2. Agree
3. Neither Agree nor Disagree
4. Disagree
5. Strongly Disagree
6. Not Applicable

Question I would like Video AI available for other topics in CE300.

Answers

1. Strongly Agree
2. Agree
3. Neither Agree nor Disagree
4. Disagree
5. Strongly Disagree

Question What other topics in CE300 would you like to see Video AI available for?
(You can also use this space for any general comments you have about the Video AI resource.)