AC 2011-2144: INCORPORATING SCREENCASTS INTO CHEMICAL ENGINEERING COURSES

Garret Nicodemus, University of Colorado-Boulder Department of Chemical & Biological Engineering


Dr. John L. Falconer P.E., University of Colorado, Boulder
Dr. Will Medlin, University of Colorado, Boulder

©American Society for Engineering Education, 2011
Incorporating Screencasts into Chemical Engineering Courses: Online Videos as Course Supplements and Student Feedback

Abstract

An online inventory of screencasts covering topics in six core chemical engineering courses has been created to provide learning resources for undergraduate students. Screencasts are recordings with accompanying narration, and are mostly made by screen captures of Tablet PC screens. They are designed to supplement courses, rather than replace the experience in the classroom. In contrast to video lectures, where a professor is recorded during class, these screencasts are shorter (~10 min) videos that present solutions to solving example problems, explain important concepts, provide instructional tutorials on using software, or reinforce key topics in more detail than afforded in the classroom. Screencasts provide a way for students to use course materials at their own pace, time, and location. Student feedback from anonymous surveys suggests that the majority of students find them “useful”, “very useful”, or “one of the best features of the course”. Currently more than 225 screencasts are available at www.learncheme.com. They are designed to be used in six chemical engineering courses: materials and energy balances, thermodynamics, fluid dynamics, kinetics, heat transfer, and separations. Since the site went online in August 2010, these screencasts have been watched over 16,000 times.

Why Screencasts?

The average K-12 student spends more than seven and a half hours a day using electronic devices to access media content. More than 2 billion YouTube videos are watched daily, but the vast majority is not for educating students. The non-profit Khan Academy, however, has prepared screencasts (short screen captures of a Tablet PC screen with narration by the instructor) specifically focused on tutoring in math, business, and science courses, and has become one of the most globally-accessed resources for educational screencasts. Both K-12 schools and universities have adopted a similar pedagogical approach involving supplementary screencasts to better engage students and improve their learning. Students in an entry-level freshmen chemistry course showed significant improvements in performance and conceptual understanding when screencasts were used. College physics students provided with screencasts have been shown to significantly outperform students receiving equivalent textbook instruction in class, and when screencasts were used as pre-lectures, student’s performance significantly increased. The Open Learning Initiative at Carnegie Mellon University has shown that a hybrid approach to learning, using two instructor-guided classes along with online course materials, resulted in students performing as well as or better than those taught by three traditional lecture style classes. The hybrid learning students also finished the course in half the time of the traditional lecture students.

The Value of a Screencast

Screencasts allow the instructor to provide an expert’s explanation on solving a problem, so that students can observe how to set up and step through the problem and how the problem-
solving techniques relate to the underlying principles (Fig. 1). Providing these videos as supplemental material allows the instructor to dedicate a significant fraction of class time to focusing on concepts and more active learning methods rather than lecture and mathematical solutions. These are not polished videos, but instead are similar to what would be done in class on a board. The advantage of not trying to prepare polished videos is that preparation time is minimized—generally less than that needed to prepare for a lecture of similar length—without sacrificing value to the students.

Students do not have to be stenographers during lecture, trying to capture everything the instructor is saying and writing on the board. Instead, students can stop and replay videos at their own pace. Furthermore, they can work through example problems on their own time and get many of the questions answered that might arise during office hours; thus watching the screencasts can be more efficient. A significant advantage of making screencasts is that once a screencast is produced and posted online, future courses taught can use these videos with no additional effort. Students can watch them using a variety of devices that connect to the internet.

We have utilized screencasts in a number of chemical engineering courses over the past few years, including: freshmen-level general chemistry for engineers; sophomore-level materials and energy balances and fluid dynamics courses; junior-level thermodynamics, heat transfer, and separations course; and graduate-level reaction engineering courses. They were made to accomplish the following goals:

- Clarify a difficult topic: Allows instructor to further discuss material not covered sufficiently in class and provide alternate explanations.
- Explain a conceptual problem: Work through a multiple choice conceptual question (ConcepTest) and provide reasoning behind student’s misconceptions and incorrect answers.
- Solve an example problem: Allows instructor to clearly explain setup and step-by-step solution and strategies to an example problem.
- **Provide explanations to homework, quiz, or test problems**: Students can benefit from a worked out explanation with narration instead of just a copy.
- **Review for exams**: Worked out solutions to previous exams.
- **Provide tutorials on software use**: Software programs, including spreadsheet programs, are used in many engineering courses, and screencasts can be used to show step-by-step procedures for using these programs.

Getting Started

Making a screencast is relatively simple. We have mostly prepared them on a tablet PC, but a few have been prepared on an interactive Smartboard. In either case, a stylus pen was used to input text, drawings, or annotations. A headset microphone is recommended over the integrated PC microphones, because of their improved audio clarity and quality, and their ability to remove background noise. Although a number of software packages can be used for screen capture and recording audio, TechSmith’s Camtasia Studio 7 was used for the screencasts on www.learncheme.com. This software is simple to learn and user-friendly, and it provides editing tools for both video and audio that can enhance the quality of the screencast. Freeware such as TechSmith’s Jing can also be used for screen capture and voice recording but does not allow editing.

Most of our screencasts were prepared using Windows Journal, which is software that is included on Tablet PCs. It is simple to use and provides lined paper and basic tools for drawing and writing. Microsoft OneNote can also be used and it has similar capabilities. We have also used Microsoft PowerPoint; Camtasia provides an add-in that simplifies the recording of PowerPoint presentations. PowerPoint is useful when going through multiple pre-formatted slides, but OneNote or Journal are easier when the majority of the screencast is instructor input. The following suggestions may improve the quality and reception of screencasts.

- **Start with a clear goal** matching specific learning objectives. Tell students the purpose of the video up front.
- **Keep screencasts short**. Surveyed students were more likely to watch a 10 minute or shorter video. Avoid long-winded number crunching.
- **Clear your environment**. Shut the door to prevent external interruptions.
- **Speak freely** and fix it later if really necessary. Mistakes, dead-time, extraneous work, and external noises can be removed later, but most things can be left in without comprising the screencast.
- **Follow a problem-solving outline**. Go through a problem solution in a methodical manner, starting with diagrams, labeling known variables and unknowns, using units throughout, make assumptions explicit, checking solutions at the end, and so forth.
- **Use highlights and annotations** post-recording to focus a student’s attention. Although these are not necessary, highlighting can help minimize confusion, and callouts can provide alternate explanations, definitions or cross-references to other materials.

Disseminating Screencasts

The Camtasia software allows screencasts to be prepared in a variety of formats, although some formats cannot be viewed on certain devices. The most ubiquitous format is .mpeg or
.mp4, which can be played on both PC and Mac computers and the majority of smart phones and handheld devices. Typical screens support the 4:3 aspect ratio, and recording in 800 x 600 or 1024 x 768 can be viewed effectively on most devices.

We have prepared more than 225 screencasts for chemical engineering courses, and they are available on www.learncheme.com. We use www.vimeo.com and iTunesU to host screencasts rather than other sites considered, because both services allows larger file sizes, a longer length of video, removal of ads, and the ability for users to download the video. Both Vimeo and iTunesU also provide a number of tools making uploading, linking, searching and organizing videos easy. Further information on preparing screencasts and resources on using screencasts for courses is on the learncheme.com website.

Usage and Feedback

In the first eight months of making screencasts available, these screencasts combined for more than 16,000 plays (Fig. 2), and the viewers were from 100 countries. More than 120 videos have been watched at least 50 times each, and 60 videos have been watched at least 100 times each. Tracking usage helps direct future efforts on making screencasts by identifying specific concepts/examples that are most watched. During the first semester videos were made available, spikes in weekly numbers appeared to correlate with exam weeks at the University of Colorado, where the majority of the screencasts had been watched. This indicates their significant use as studying materials. Currently the number of visits to the website averages 2,000 visits per month and 80% of those visits come from outside the institution.

Over 98% of the students in the thermodynamics course at the University of Colorado, when surveyed at the end of the semester, found the screencasts “useful” or “very useful”. Of the 80 posted screencasts during the semester, 50% of the class said they watched at least 20 different screencasts, and 80% watched 10 or more. Towards the end of the course, five screencasts were created of worked out solutions to previous final exam questions in lieu of a review session. Each video was viewed more than 75 times, and two of the five were watched over 100 times each. Not a single student complained about not having a review session, although they had been presented in the previous years for this course. Feedback at the end of the semester in multiple classes indicated that screencasts were considered the most important component for studying. Some student comments about the screencasts:

“Screencasts were extremely helpful. I think people would watch more if there were more.”

“Screencasts are much better than trying to figure out what is going on in the textbook examples.”

“I think the screencasts were great. My only suggestion would be to make more.”

Fig. 2. Usage of screencasts since website was made available.
“Screencasts are fantastic. I watched some of them twice.”
“I learned a lot from the videos. It’s hard learning at such a rapid pace in class, so it’s really nice to be able to rewind and replay the videos as many times as needed.”
“When I do a screencast I try to solve the problem myself and then watch the video.”
“I liked on some of the screencasts where you would define the entire problem and then pause to let the viewer solve it on their own first.”

Students also provided suggestions on improving screencasts that mainly focused on providing more example problems related to homework and exam questions, organizing them online by different formats (alphabetically, by textbook topic, by date posted), providing clearer descriptions of the screencasts, and simply making more of them. Screencasts are currently being prepared with the goal of at least 75 screencasts for each of the six core chemical engineering courses that are the focus of this project: thermodynamics, material and energy balances, separations, heat transfer, fluids, and kinetics. Screencasts will be organized according to dominant textbooks used in those courses, and more detailed descriptions will be added to help direct viewers.

Acknowledgements

We gratefully acknowledge support by NSF-CCLI grant DUE-0920640, by Shell Oil, and by the College of Engineering and Applied Sciences, Engineering Excellence Fund at the University of Colorado.

References