VIDEO MICROLECTURES: SIMPLE TO MAKE; VALUED BY STUDENTS

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ABSTRACT

A MicroLecture is a short video on an important element in a subject area, a format inspired by the work of Salman Khan at khanacademy.org and others. MicroLectures in fluid mechanics were developed on a just in time basis during the delivery of a first course in fluid mechanics in 2012 and made generally available on YouTube. Students were surveyed at the conclusion of the course and marks compared to past instances of the course delivered by the same instructor. The process and survey was repeated in 2014. Students responded very positively to the videos and found them useful in their learning. Low production values did not present an obstacle. A faster pace than typical lectures and the ability to control pace / repetition were valued. Some students preferred having the course instructor delivering the video instruction rather than a stranger. Student course marks were substantially higher than in past offerings. This paper has been updated from a poster presentation at CDIO 2013 [1] to include more recent developments.

KEYWORDS

Video, MicroLecture, YouTube, Fluid Mechanics, CDIO Standards 3, 8, 10

INTRODUCTION

Although there are a small number of truly compelling lecturers, I personally have found very few full-length video lectures that I can sit through without losing interest. Classroom lectures, for a variety of good reasons, often follow a slow pace. This makes videos taken in the classroom drag when viewed online. I find shorter, faster paced material more viewable and valuable in my own on-line learning. Based on those observations and the extraordinary popular success of Salman Khan at khanacademy.org, I set out to create a collection of short video MicroLectures to support learning in MECH 241, our first course in fluid mechanics. Many others (e.g. the edX initiative (www.edx.org)) are following similar paths.

There is still limited evidence of the relative effectiveness of modern video lectures, beyond the obvious practical advantages and student perceptions of learning. Lyons et al. [2] and Giannakos [3,4] provide current reviews of the literature to the extent possible in a very rapidly changing field. Lloyd [5] shows that screencasts shorter than a normal lecture session can enhance student learning of statistics and discusses appropriate lengths — the parallels in mathematical intensity suggest these results should extend to fluid mechanics. The present work concentrates on the practical delivery of short video lectures in a CDIO curriculum and their value will be assumed demonstrated by these others and by student and public opinion.

A MicroLecture is a short video on an important element in a subject area, or on solving a particular problem. Although it probably includes much the same material one might deliver in a lecture, the format is different and definitely not scaled to the 50 minute academic hour length chunks dictated by the typical bricks and mortar timetable. Mine are simple pencil and paper notes, with a developmental description of what's going on in those notes. They were made available to my students and the rest of the world by posting them to YouTube with an organizational list at: https://sites.google.com/site/rwsfluids/home/fluids-microlectures.

Modern video production covers a huge range of quality, all of which is visible on YouTube and other on-line sources. Meeting the high quality standards to which we might aspire as faculty members requires considerable time, skill, and often, additional personnel. The budgetary constraints on the offering of regular lecture courses make it difficult to support such quality. The current work results from the observation that students value faculty thinking and explanations of ideas, even delivered on a poor quality chalkboard in a draughty, badly lit classroom. Thoughts and content matter to students, and so does getting them from the person who will be setting the final exam. Based on that thinking I set out to make MicroLectures of the things I really wanted students to know and the thinking processes I wanted them to be able use, completing them on a just in time basis and accepting that the production values would be sacrificed to timely delivery within a very limited budget.

This paper will first address the practical aspects of the video production and distribution methods, followed by measurements of student perceptions through a survey and conclusions based on anecdotal experience and those measurements. The practical elements are intentionally specific, where relevant, about commercial products I found useful. There are certainly other options and other platforms that may be as good or better, however the products mentioned provided me with practical solutions in the Apple environment I am accustomed to.

MECH 241: A TYPICAL ENGINEERING SCIENCE LECTURE COURSE

MECH 241 is the first course in fluid mechanics for students in mechanical engineering and several smaller programs. It has been delivered as a traditional lecture / text book course (12 week term, 36 one hour lectures, 12 one hour tutorials, midterm quizzes and a final exam) for many years by a variety of instructors. As part of our integrated curriculum [6] it supports students who are simultaneously engaged with the APSC 200 design project process.

In teaching MECH 241 in Winter 2012 I was following content and delivery I had used in previous successful offerings. That content is CDIO focused with a context of professional practice. What are the basic physical principles? What are the reasonable assumptions for practical situations encountered in practice? How will you use these principles to make good design decisions and answer practical operational questions? Delivering content on video at student chosen times frees up some of the traditional lecture contact hours. They can then be used for active learning exercises and other less traditional activities that can enhance the student learning experience.

PRODUCING AND DISTRIBUTING MICROLECTURES

To develop MicroLectures without a substantial infrastructure and budget, I needed to leverage facilities I already had available as well as capabilities available for free on the Internet. Queen's policy on creator ownership of intellectual property left me free to post my instructional materials publicly and I took advantage of this freedom to reduce obstacles and make these materials as widely available to students as possible. This section details things I found to work well for my workflow. There are bound to be other options that may work better in your application environment.

Video Capture

I tried several techniques to grab video via the computer and found them cumbersome. They interrupted the flow and distracted me from the task at hand, explaining something about engineering. I tried with an inexpensive Bamboo digitizing tablet like Khan initially used (http://www.wacom.com/en/products/pen-tablets/bamboo) and found the results almost illegible. I have never written clearly while looking away from the paper. I tried with my iPad and stylus, but found the capture area too small. A large, pen enabled display might have worked as smoothly for me as my accustomed blackboard or quad pad, but was beyond the budget target for this exercise. Eventually I settled on pen, pencil and paper as my medium, with HD video recording to capture it in a readable form. That allowed me to focus on message rather than technology while recording, although it required that I develop the video camera and post processing technique to be as fast and simple as possible while dealing with some quite large digital video files.

Lighting: Soft natural light from a north-facing window is ideal for working and for good images with minimal shadowing, but weather and working hours don't always cooperate. After considerable experimentation I got good results with a strip of warm white multi-element LED task lighting (Figure 1) mounted to a wall shelf about ½ metre above my desk. Self adhesive 12 volt LED strip light tape can be installed to light your work area from above and left (or right) to reduce hand shadows.

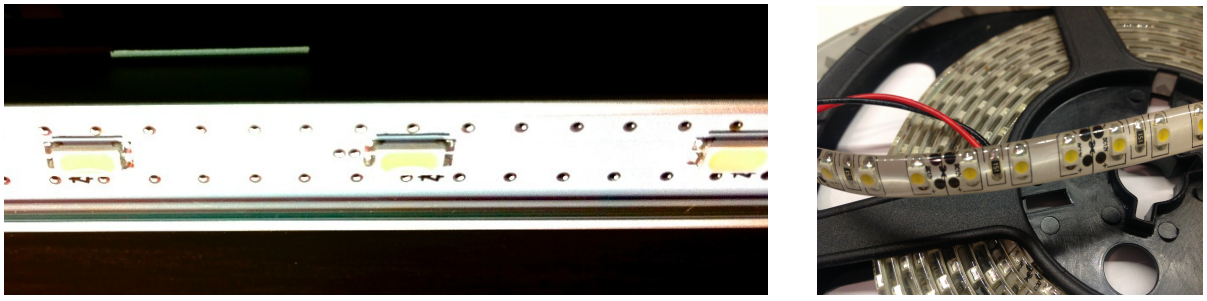

Figure 1. Warm white LED task lighting is effective, cool and energy efficient in hard mounted units or self-adhesive strips.

Camera and Positioning: I've used a GoPro HD Hero with a headband mount for lab videos. It is very versatile, with great resolution, but with the wide-angle lens it needs to be relatively close to the subject, making it difficult to write on the pages. A current DSLR (Digital Single Lens Reflex [camera]) takes great video in 720p or 1080p HD, but anything with lower resolution does not capture an A4 page in enough detail to read my pencil writing. The huge files from the DSLR can take quite a while to move from the camera to a computer for post

processing and upload. Current phones and tablets provide very good HD video capture capabilities and can be used to do basic editing of the results and post directly to YouTube. They represent a compromise that many academics have immediate access to.

Fix the Focus on the Page: Continuous auto-focus during a video can be distracting. Avoid it by using third party apps that let you hold a fixed focus on the page from the start of the video, by using a DSLR or other full-featured camera, or by using more recent tablet / phone native apps that manage the focus better.

Avoid Jittering: Many desks shake a little when I write on them. Flexible supports attached to the desk will vibrate and produce an annoyingly jumpy image. One simple solution is to support the camera from wall hung shelves.

Use Correct Orientation: Avoid portrait orientation video – turn your A4 page to landscape and use the format everybody expects from video. Make sure the camera orientation matches the page orientation before you start taking the video (probably by holding your phone / tablet right way up before pressing the button), otherwise you'll have to rotate it which may be both difficult and time consuming depending on your software. A jig with stops can help get the camera into the same location every time, but isn't essential.

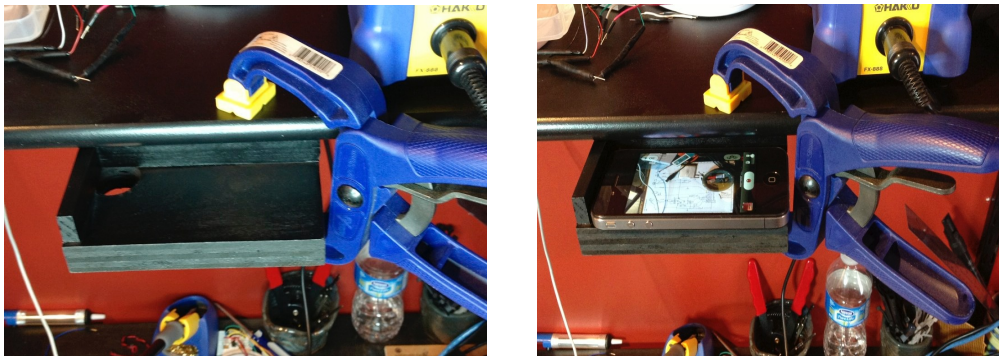

Figure 2. A simple wooden jig for suspending an iPhone from an overhead shelf. The hole at the back left allows visual access for the camera while the edge blocks assure consistent placement.

Natural Pace: I found the results flowed better when I explained at a relaxed pace, as I would with one or two students in a tutorial environment. That also included taking a few seconds at the start of the explanation to shift my mind from the technical issues of camera setup to the technical content issues I was about to explain. That dead air is easy to remove in editing. The results were not as pleasing when I rushed to get through things quickly, just as I have experienced with in-person lectures. The pace was still substantially faster than my classroom lectures. In some instances I presented the same lesson both in class and as a MicroLecture, from exactly the same text notes. The finished video versions were typically about half as long (clock time) but delivered all the same material. Students also reported positive results running them at one-and-a-half or double speed, allowing them to review in 12 minutes what I might have taken 50 minutes to present as an in-person lecture.

Sound Quality is important. Good results were achieved in my relatively quiet home office with all of the camera options I tried. Occasional traffic noise or interruptions did not interfere with the quality and may have contributed to a friendly informality.

The overall results achieved with the iPhone and iPad cameras were entirely satisfactory and allowed convenient and immediate uploading to YouTube with iMovie. Videos were shot with a custom support bracket (Figure 2) or with the device simply resting on the edge of a shelf with the camera lens overhanging. (Figure 3)

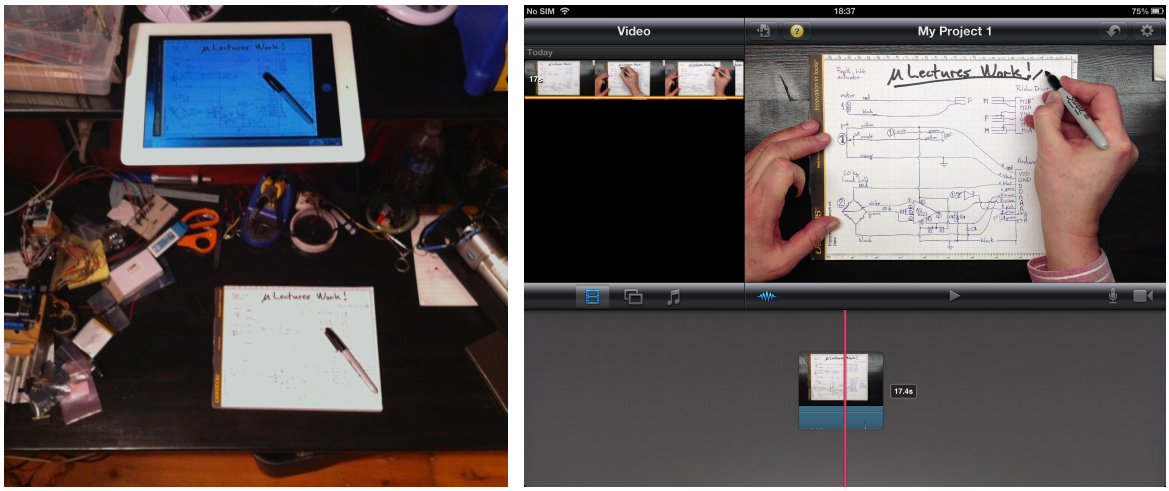

Figure 3. The iPad resting on a shelf with the camera lens overhanging provides a simple and effective recording arrangement, even in a cluttered multi-purpose space. Post processing can start immediately in iMovie and yield an HD video much more readable than these images.

Post Processing

A typical post-production workflow in video would be from a camera into a computer either over a cable connection or on an SD card, then importing the raw video into an editing program such as iMovie or Final Cut on a Macintosh. That enables professional quality video editing that far exceeds MicroLecture requirements. The final product can be uploaded directly to YouTube from the editor. Similar products are available on other platforms. This flexibility comes at the penalty of time required to move the video in uncompressed form from the camera to the computer and into the editor.

Mobile device apps like iMovie on the iPhone / iPad allow one to capture video, perform relatively rudimentary edits, and upload the results directly to YouTube. The editing of the current MicroLectures generally did not extend further than clipping the excess from the start and finish of the video. The compression and upload still requires considerable time, however that time is all in the final posting step and doesn't require supervision or interaction, although it will fail if the iPad / iPhone auto locks or otherwise shifts application focus while the upload is taking place.

More recently, Google provides a free app named "YouTube Capture" for IOS and Android, which can provide faster uploads (sometimes **much** faster), apparently by shooting initially at lower resolution and doing more of the preprocessing on the device. Experiment to find what works best for you in this changing market.

Streaming Video Service and Student Access

Like other universities, Queen's provides a course management system (Moodle and more recently Desire2Learn) and video streaming services that allow faculty to control who sees what and when. This offers considerable advantages in staging a course, for example not

making solutions available before an exam or an assignment deadline and restricting access to students actually registered in the course. It also introduces obstacles to casual access to materials and may make it difficult for students to go back to materials after the class or even the degree is complete. It locks out the public, students not registered and other faculty unless their access is explicitly enabled. In this instance I chose to make this part of the course fully accessible on YouTube. The edX initiative also uses YouTube to host their video content. At the same time I also used a course management system and textbook publisher's proprietary site for collecting student work with identity validation.

YouTube generally restricts the length of uploaded videos to 15 minutes, but may automatically upgrade privileges to allow longer postings. Your experience may, of course, differ as the on-line landscape continues to evolve. Some practical design elements for YouTube video emerged:

Embed the videos or display them full frame in the browser: Just browsing YouTube and watching videos will result in a link format that is uninformative like http://www.youtube.com/watch?v=CFpZb6lXqos where the last sequence "CFpZb6lXqos" specifies the video you are watching. That link reaches the video with the usual YouTube page with lots of distractions towards other videos.
http://www.youtube.com/v/CFpZb6lXqos&autoplay=1 uses the same identifier and will play the video to fill the browser window without distractions (Figure 4). The same distraction reducing advantages are provided by embedding the video within a web page or course management system. Alternately, display an image of the completed page of notes for easy review, with a link to the video that develops that page for further explanation.

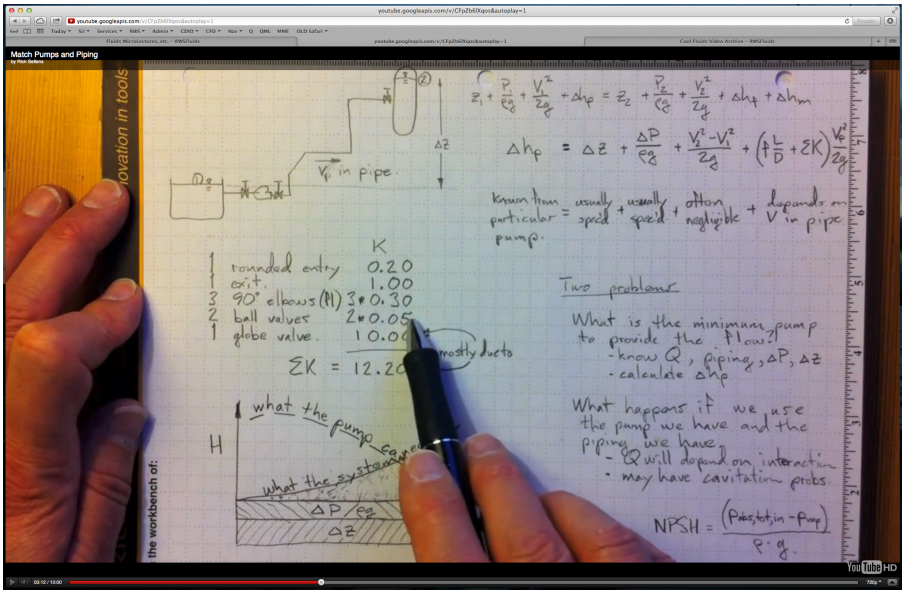

Figure 4. The /v/ format in a YouTube link with &autoplay=1 will open and start the video to fit the full browser window. This avoids the distractions usually found while surfing YouTube.

Google Sites (https://sites.google.com) provides a simple yet powerful interface for generating basic web sites at no cost to the user. It took only a few minutes to create the skeleton of a site at https://sites.google.com/site/rwsfluids/home. I added content as it became available with a total of 49 MicroLectures produced during the 2012 offering of the course. This approach with a text index of links to video and graphic content did not provide

enough graphic cues for return navigation. Both the students and I had difficulty remembering which video a text link pointed to when returning to the list.

For Winter 2014, the video content was integrated in our course management system (D2L) to provide better tracking and embedding capabilities, and 44 additional MicroLectures were produced to complete the topic coverage. Embedded graphics and or video frames provided much better mnemonic links for return navigation of the site.

Configure the links on your index page to open videos in a new tab/window: Help your students keep track of where they are by making sure the index of your materials doesn't disappear while they are watching your videos or exploring other content. Most authoring systems make it easy for you to have a link open in a new tab by default.

Summary Page: A by-product of completing the MicroLecture with pencil and paper is a finished page of notes that exactly matches what students saw in the video. Scan that page and make the image available through the same channels for review, or for advanced students to read instead of watching the full video development.

STUDENT FEEDBACK PROCESSES

Very few students used the YouTube comment process. More of them volunteered comments before and after the in-person lectures, or by email. This enabled some refinement during the course of the term.

Student Survey

I surveyed the class near the end of 2012 term, using the Moodle system for automatic validation and tabulation, with the promise that I would not review the survey results before submitting final course marks. There were 164 responses from a class of nominally 211 students. The survey collected information on several innovations introduced in course delivery, including the MicroLectures. Student responses on the other topics ranged considerably from positive to negative, suggesting that they were being candid in their responses. Students provided over 10,000 words in more than 300 separate written comments on the survey, demonstrating significant engagement in the process. Of course student opinions may not tell the entire story about where learning is taking place, however positive responses indicate a positive experience and engagement, both of which are bound to help with their learning. The survey process was repeated with the same questions in the winter 2014 offering, and received 150 responses from a class of nominally 192 students. This report provides student responses in the aggregate to protect individual privacy and in accord with Queen's ethics policy.

Device Usage: Although many students reported access to devices such as tablets and smart phones, the vast majority did not view MicroLectures more than once on such devices. Almost all viewing took place on notebook computers or desktops.

MicroLectures: Response was overwhelmingly positive, with the vast majority of students watching all, or nearly all of the videos. Most students watched some of the videos more than once. (Figure 5) MicroLectures were posted on YouTube and indexed on my web page in 2012. Many of the MicroLectures got over 300 views, consistent with the survey reports. Reported viewing was down slightly in the 2014 offering, not surprising given the number of MicroLectures available to students was almost doubled.

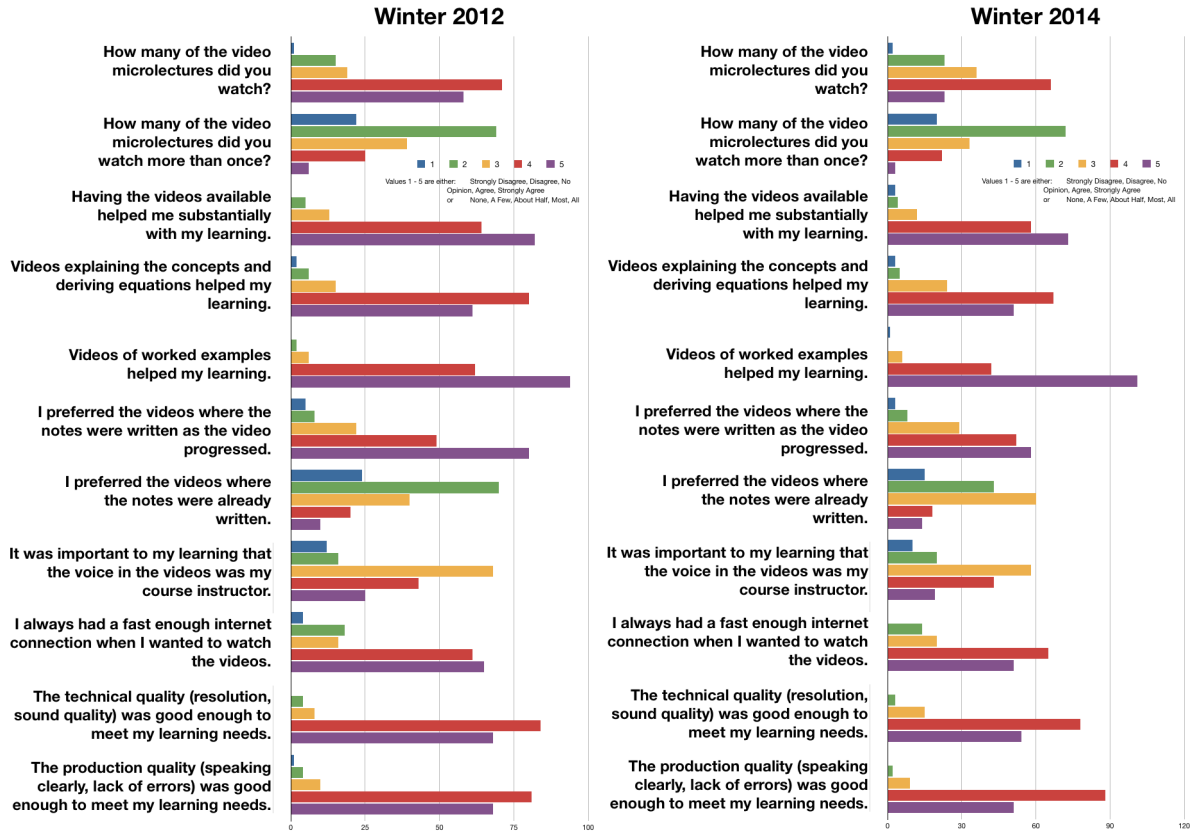

Figure 5. Student survey responses on MicroLectures included in the course offering.

A significant fraction thought it was important that I was the voice on the videos. Those students might not be as successful in a fully on-line course where they did not have any direct interaction with the instructor.

There was a strong preference for my writing the notes as the presentation went forward, mimicking the progress of a standard chalk and talk lesson. Students were not as positive for notes written in advance and pointed to during the presentation, similar to a PowerPoint style lecture. Several comments suggested that diagrams could be pre-drawn, but equations should be written during the recording, an approach that was incorporated in the 2014 production. More post-production might accelerate the appearance of the writing as is done in e.g. Minute Physics (http://www.youtube.com/user/minutephysics) although this would substantially increase the production time and effort.

Many of the 2012 videos were crude as I experimented with different cameras, lighting, etc. and most were shot in a single take with minimal editing. I was positively surprised at the student acceptance for this level of quality. I will be aiming for better in the future, although these results suggest that is more a matter of personal pride than necessity. The level of satisfaction with the production quality did not drop significantly between 2012 and 2014, even as the broader quality of online video went up substantially.

In response to a new question in the 2014 survey, 79% of students agreed that “The handwritten format was a positive contrast to the textbook.” Only 8.5% agreed that with the

summary sheets and MicroLectures available online, “I still used my textbook quite often.” The online content seems to have displaced the textbook as a student study aid.

YOUTUBE ANALYTICS

YouTube provides analytical tracking of viewers, Figure 6. Although these videos were generally available, the peaks linked to the quizzes and the exam, and less so to assignment due dates, indicate that the vast majority of viewers were MECH 241 students. This data makes it clear that the video resources got heavy use, consistent with student reports. The pattern of usage matches the widely observed tendency of engineering students to cram immediately before tests and exams, rather than engage in a continuous learning process. Improved access to lecture style explanations during this cramming process can reasonably be expected to improve that mode of learning.

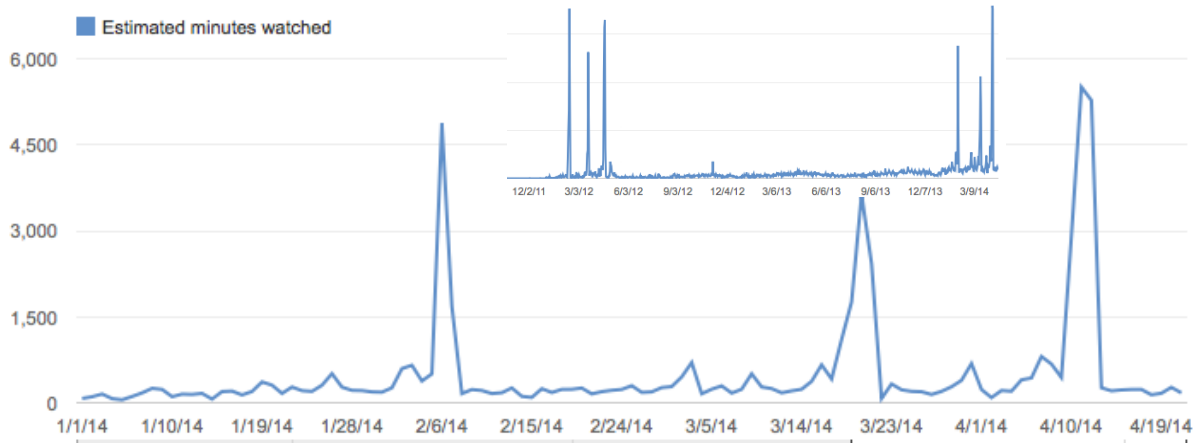

Figure 6. Data from the 2014 offering shows three distinct peaks corresponding directly to the two quizzes and the final exam for the course. YouTube estimates the integrated total viewing at 16,296 views for a total of 55,655 minutes during this period. The inset shows similar peaks in numbers of views from the 2012 offering, when YouTube’s analytics did not yet provide minutes watched.

STUDENT COURSE MARKS

In past offerings of this course by the author and others the averages have typically been around 65% +/- 3% (from C- to C+) and the failure rate has been around 10% +/- 5%. In 2012 the average and the median were both B- and the failure rate was less than 3%. The positive changes could result from:

- the class being significantly brighter than the usual class (unlikely with n = 211)
- my teaching, including the MicroLectures, being considerably more effective than my usual teaching
- the new letter grade marking system being considerably more forgiving of incorrect answers

The third one is mathematically true due to the non-linear change in the scaling from percentages to letter grades and probably accounts for most of the change. The MicroLectures may account for some of the improvement, or there may be additional confounding factors. The marks in the 2014 offering are consistent with those in 2012.

CONCLUSIONS

Video MicroLectures can be created in tandem with a course offering while consuming minimal resources beyond those already available to faculty at most CDIO schools.

MicroLectures produced using this minimalist approach provide production values that the vast majority of students find “good enough”.

Students find considerable value in the MicroLectures and report enhanced learning outcomes in two successive surveys.

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BIOGRAPHICAL INFORMATION

Rick Sellens is an Associate Professor in the Department of Mechanical and Materials Engineering at Queen’s University. His research background is in Fluid Mechanics and more recently in Biomechanics. He has been actively involved in facilities and curriculum development to support active learning, including the Integrated Learning Centre at Queen’s.

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