Use of Online Videos Developed for a MOOC in the MIT Introductory Physics Classes

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The introductory physics courses at MIT, 8.01 Physics I (Newtonian Mechanics) and 8.02 Physics II (Electricity and Magnetism) are taught using the studio physics pedagogy called Technology Enabled Active Learning (TEAL). The TEAL pedagogical model represents an attempt to incorporate a variety of research-based teaching models and technologies into the first-year physics subjects. The course is a non-lecture based course with an emphasis on active learning. The two physics courses are General Institute Requirements (GIR) and have large enrollments (around 600 students in Fall 8.01 and over 700 students in Spring 8.02). Approximately 95% of the students in either class are first-year students. The classroom space consists of twelve tables seating nine students (Figure 1), which requires seven sections in the Fall 8.01 and eight sections in the Spring 8.02. Each section is led by a different instructor. The content is coordinated through a common set of Powerpoint slides for lectures and online resources for students. The students work together in groups of three, using tabletop experiments and computer-based visualizations to develop their conceptual and analytic understanding of mechanics, electricity, and magnetism. The syllabus is designed to integrate concepts, labs, and problem-solving skills in an interactive learning environment in which students regularly discuss concepts and problems in class with their teachers.

Figure 1:
TEAL classroom

For the online recourses, the students use the MITx platform. Many of the features that are available on the platform are the standard LMS tools – such as a place to organize all the weekly materials, post readings, assignments, a calendar of office hours, and links to discussions, grades, and other topics. The students are expected to answer short questions (Prepset) once a week as part of their graded work. The Prepsets are graded automatically online. The labs are hosted on the MITx platform – the instructions and follow-up questions. All of the problem sets are distributed on the platform along with ungraded answer checkers for all the problems and detailed written solutions after the deadline.

This last feature - the online problem answer checker feature has earned the most positive responses on end of term student reviews. Specifically, this feature, which we have been using since 2012, allows an unlimited number of attempts to check answers to long and difficult problems. Students submit handwritten solutions for grading, but now they have access to immediate feedback while working on the problems. Most of the problems have an average of 5-10 answer checker attempts per student, but some of the harder problems have a much higher rate.

Over the past few years we have developed a set of short videos (5 -10 minutes each) using a Lightboard (much like the one originally developed by Michael Peshkin at Northwestern University). These videos present a wide range of topics: theoretical introductions, derivations, problem-solving methodologies, worked examples, mathematical summaries, homework hints, and deeper investigations of concepts (these tended to be longer). The addition of these videos to the course has provided the students with an alternative to the online textbooks. The majority of the video-watching occurs right before exams. This can be seen in Figure 2, where the video use during the 8.02 Spring 2018 semester is shown in green. The two midterm exams took place on March 8 and April 19 and the final was May 21. The other place where students use the videos at a high rate occurs while they are working on their weekly problem sets. There are a few homework problems that are directly related to video worked examples, and students will refer to those worked examples when asking questions about the problems during office hours.

On average, it appears that about a quarter of the students are watching the videos in the second semester of physics – each video has an average of just under 200 views out of a class of around 715 students. This is higher rate of watching compared to the 8.01 Fall 2017 course, during which there was an average of 120 views per video out of a class of 585 students. This increase in rate may be due to the fact that more students were aware of the existence of the videos in the second semester, and that the content of mechanics is considered to be more familiar and less abstract and mathematical than electricity and magnetism. The students who do use the videos praise their usefulness and continually send in topic requests for new videos. In both semesters, the videos with the highest number of views tend to be problem-solving videos instead of the more theoretical introductions to concepts. Compared to the online answer checker, which practically all of the students use and most students highly approve of, the videos are a less well-known and utilized resource. However, those who do use the videos generally report having a positive experience.

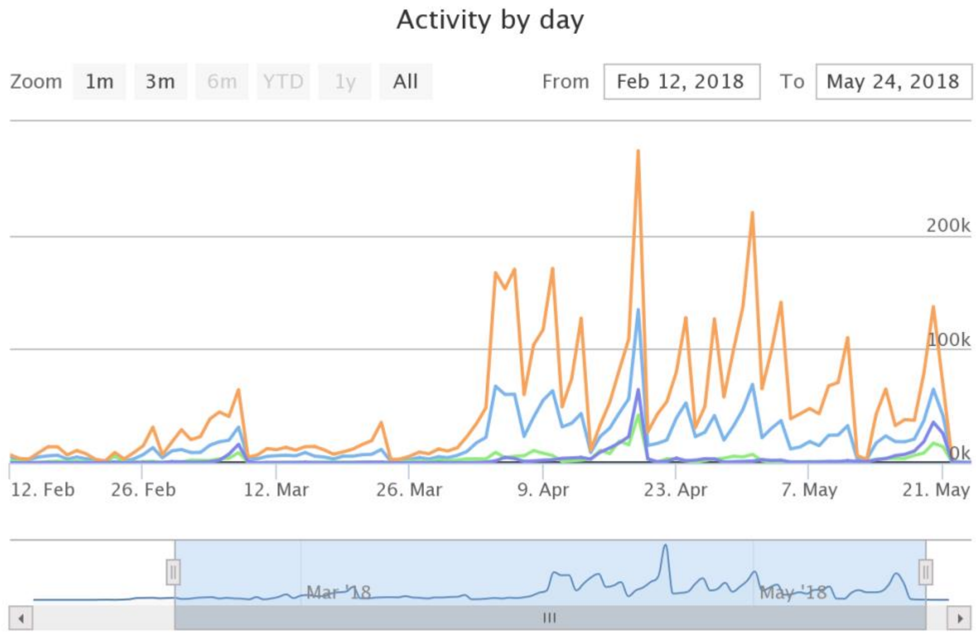

Figure 2. This graph is from a tool created by Isaac Chuang at MIT. It shows the number of different types of events on the MITx platform for the spring semester as a function of time. The important dates are March 8 and April 19, which were exam dates. The final was May 21.

Over the past few years, we have developed a set of online classes for global students on edX based on our introductory physics sequence at MIT. Because these edX classes have no in-person component, we expanded our set of short videos and embedded the videos in learning sequences that consist of multiple choice conceptual questions and short analytic problems. We are now in the process of introducing these video-based learning sequences into the residential 8.01 and 8.02 courses replacing our pre-class Prepset assignments. We plan to analyze if introducing the video-based learning sequences leads to more students using the videos and to better learning outcomes.

In conclusion, students generally respond very positively to our online resources, but we still need to refine how we use these resources in our residential classes. Because of the positive responses from the students who do use the videos, we would classify the introduction of the videos as a partial success. However, we conjecture that better organization of our content may lead to even more students using the videos in ways that may help their learning.