MLMs Improve Learning in Physics
Recent research provides evidence that the integration of multimedia learning modules (MLMs) into introductory courses improves learning and retention of physics content1-3,4. Yet, it is not fully clear how students use MLMs for learning. Making a MLM available for students to learn from does not guarantee that students will take advantage of the opportunity, even if it is a required course assignment. In this study, we investigate the nature and extent of students’ use of MLMs by analyzing clickstream data from student interactions with SMART Physics.

Research questions
1. Is there a credible difference in exam performance between viewers and nonviewers of MLMs?
2. Is there a credible difference in course performance between viewers and nonviewers of MLMs?

Course Context
• Physics 251 is the first semester of a two-semester sequence on introductory calculus-based physics focusing on Newtonian mechanics and its applications. It constitutes four one-hour lectures per week and has a typical enrollment of between 80 and 100 students.
• Instructor assigned 24 prelectures (a type of MLM) to be viewed before attending face-to-face lecture classes over the course of the semester.
• Figure 1 provides an example of a scene viewed by students.

Data Collection
• We obtained clickstream data for all students from SMART Physics.
• Clickstream data contained timestamps for each click that advanced a student to the next scene.
• We calculated each student’s viewing time for specific scenes based on elapsed time between successive timestamps.

Classifying Students
• Identified a student as viewer, nonviewer, or nonaccess for each prelecture
  - Nonaccess: did not attempt to access the prelecture
  - Nonviewer: spent less than 75% of the scene duration for 3 or more scenes
  - Viewer: all remaining students
• Next, we separated students into viewer and nonviewer groups. The viewer group included students who were identified as a viewer for at least 75% of the prelectures, while the nonviewer group included all other students.

Bayesian estimation of the difference between two groups based on exam performance
• Our analysis revealed a credible non-zero difference in exam performance between viewers and nonviewers for Exam 2. Viewers earned a higher average exam grade than nonviewers. The posterior distribution for the difference of means yielded a mean difference of 15.8% with a 95% HDI ranging from 6.1% to 26.1% (Figure 3). The posterior distribution for effect size indicated a mode of .77 with a 95% HDI ranging from 0.28 to 1.22 (Figure 4).
• Our analysis did not identify a credible difference in exam performance between viewers and nonviewers for Exams 1 and 3 (Figures 2 and 5). The 95% HDI included 0, which means that 0 is a credible value for the difference between means.

Conclusion
• Our research provides evidence that students exhibit different patterns of accessing prelectures.
• We observed some evidence that viewers performed better than nonviewers. We did not identify a difference between the groups for all performance measures.
• Since there is evidence for a difference in course performance between viewers and nonviewers, it may be possible to design an early warning system based on the extent to which students view prelectures (or other MLMs).

Graph 1. Percentage of students viewing online prelectures

Differences in course performance
1. University of Wisconsin-River Falls, 2. North Dakota State University

MLMs: multimedia learning modules; HDI: highest density interval.