“Mechanics ReView presents a college-level introductory mechanics class using a strategic problem-solving approach.” – edx.org

**Introduction.** Mechanics ReView (8.MReV) is a second look at introductory Newtonian Mechanics. In contrast to the typical edX course, it was aimed at secondary school teachers. The course is designed to give a unified overview of mechanics that will dramatically increase students' problem-solving ability. It is especially designed for teachers and those who want to improve their existing understanding of mechanics. Newtonian mechanics is the study of how forces change the motion of objects. This course begins with force, and moves on to straight-line motion, momentum, mechanical energy, rotational motion, and angular momentum. Optional units include oscillations, planetary orbits, and a review of multi-concept problems.

8.MReV was offered as an MITx on edX course in the Summer of 2013, taught by Professor David Pritchard and Dr. Colin Fredericks.

Many participants in MITx on edX courses come with different intentions and levels of interest and many resemble shoppers and auditors in their course activity. This report identifies four subpopulations of participants (numbers below): those who registered, viewed some course content, explored the course, and were certified.

<table>
<thead>
<tr>
<th>Important Dates</th>
<th></th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 27, 2013</td>
<td>Registration Open</td>
<td>Registered: 16,787</td>
</tr>
<tr>
<td>June 1, 2013</td>
<td>Course Launch</td>
<td>Viewed: 12,047</td>
</tr>
<tr>
<td>September 15, 2013</td>
<td>Course Close</td>
<td>Explored: 1,268</td>
</tr>
<tr>
<td>September 8, 2013</td>
<td>Date of Report Data Collection</td>
<td>Certified: 1,033</td>
</tr>
</tbody>
</table>

1 See page 4 for definitions

Course structure refers to the type, frequency, and order of resources in a given course. Within an MITx course on edX\(^2\), course structure is composed of a few base resource types (problems, videos, html pages), each categorized under a specific course component. Figure 1 visualizes the 1143 base resources of 8.MReV in terms of their course component categories, where each line indicates a separate resource, and the length approximates the weight of the component toward final course grade (lecture sequences do not count). Text labels indicate selected chapters, which are the highest level on the “courseware” menu that houses the course content.

For 8.MReV, there were eleven required and three optional chapters (units). Learning Sequences formed the base learning material released in a given chapter, each centered around an interactive eText emphasizing a modeling pedagogy developed by Professor Pritchard and his RELATE group\(^3\). Each learning sequence comprised a number of html pages (orange) interspersed with checkpoint questions (black). Graded assessment included a combination of Homework (silver) and Quizzes (red) made of mainly numerical and formula response problems, each labeled with a point value correlated to problem difficulty. Supplemental learning components (not pictured in Figure 1) included a threaded discussion forum for students and staff, a staff and student wiki aimed at course resources, and weekly online office hours addressing student questions voted on in the discussion forum (see page 7).

The release of chapters in 8.MReV occurred over roughly 15 calendar weeks, with the final exam ending on August 25, 2013.

\(^{2}\) Often colloquially referred to as a Massive Open Online Course (MOOC)

\(^{3}\) http://relate.mit.edu
(and only optional material afterwards). Final course grades were determined by performance on checkpoint questions (10%), eleven homework sets (55%), and eleven quizzes (35%). Certification was granted to students whose final grades were 59% or greater.

To date, MITx courses on edX have had similar schedules of regularly released resources and periodic due dates. Like 8.MReV, courses have used quantitative assessment supported by lecture sequences and textual material, as well as a few special learning components (see end of this report). In the figures that follow, we compare 8.MReV data with those from other MITx courses on edX, from Fall 2012 to Summer 2013.

**Demographics.** For 8.MReV, we have records of 16,787 students who registered for the course by the cutoff date of this report, September 8, 2013. According to self-reported demographics, registrants were 82.7% men, and as a group, highly educated: 30.6% have earned bachelor’s degrees, 18.6% have masters or professional degrees, and 4.6% of registrants had earned a doctorate (for certified students, percentages are 20.3%, 23.8%, and 9.6%, respectively). Distributions of level of education and gender are plotted below in the top half of Figure 2, along with the average distributions for all MITx courses. Note, roughly 8% of 8.MReV registrants did not self-report one or more of the demographic categories.

![Figure 2](image.png)

**Figure 2:** Distributions of demographic variables collected at registration for all registrants reporting data, with MITx-wide comparisons for reference: (top left) education attainment, (top-right) gender, (bottom left) age, and (bottom right) geolocation via IP look-up.

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As with other MITx courses on edX, 8.MReV students came from all over the world. Based on geolocation of student IP addresses, 25.3% of registrants came from the United States, but many students also came from over 150 other countries around the world. Consistent with other MITx courses on edX, the median age of registrants and certified students was higher than typical MIT undergraduates; namely, 25 and 27 years, respectively. Distributions of geolocated country and age are plotted in Figure 2 for 8.MReV, alongside the average distributions for all MITx courses.

Participants in 8.MReV. Who are the students taking this course, and how much did they participate? The degree and kind of participation in the course varied considerably among those who signed up for 8.MReV. Furthermore, like many MOOCs, this course remained open to new registrants, so that enrollment continued to rise through the semester. This asynchronicity is a key feature of open online courses. One feature of low barriers to registration, for example, is a large number of students who registered but never actually viewed any course material.

To illustrate the considerable variability in participants by their actions, we identify four subpopulations of interest within this course: those who (1) only registered, and never accessed the courseware, (2) only viewed, i.e. non-certified registrants who accessed at least one chapter but less than half of chapters, (3) only explored, i.e. non-certified registrants who accessed half or more of the chapters, and those who were (4) certified, by earning a final grade at or higher than the cutoff.

Certificate earners are the most conventional subpopulation, defined by crossing a certain threshold of achievement on quantitative assessments (well defined for 8.MReV). The “only explored” subpopulation seeks to represent students having interacted with a considerable amount of course material, while the “only viewed” subpopulation seeks to highlight participants having only sampled the course. Both the “only explored” and “only viewed” subpopulations contain participants with highly varying levels of activity (as highlighted in the following two sections on persistence and activity). The fourth sub-population of "only registered" contains users that registered, but never accessed the courseware. This is a substantial number in 8.MReV and many of the MITx courses on edX.

For 8.MReV, the numbers of students who only registered, only viewed, only explored, or were certified, are shown in Fig. 3. The categories are defined as disjoint sets by using the “only” terminology, but the figure highlights the nested nature of registration, viewing, exploring, and certification. Students who were certified
certainly viewed the course, but not all viewers were certified. Similarly, “explored” and “certified” are both subsets of viewed.

**Activity in 8.MReV.** The activity of students in MITx courses on edX is logged; activity level can provide perspective into which courseware components are of interest to students, and which specific activities students are undertaking in a course, e.g. to earn certification.

How diverse is the activity students in 8.MReV? Consider the grade earned by students, which is determined in 8.MReV by quantitative assessment with regular due dates and periodic exams. A scatter plot (Figure 4) depicting earned grade versus the number of chapters visited, for each registered student, illustrates the distinctions between the sub-populations of students who only viewed, only explored, or became certified in the course. This plot also illuminates some possible registrant types: “completionists” (perfect grade, viewed all chapters), “optimizers” (occasional registrants that view minimal chapters but earn a certificate), and “listeners” (viewed all chapters, zero grade – submitted no work for credit).

**Figure 4:** Scatter plot of grade versus chapters viewed (left), highlighting student sub-populations; certified students are red points and all points are jittered. Histograms of grades and number of chapters viewed (right) distinguished by student certification status.

**Figure 5:** Distribution of clicks (total course interactions) and active days, distinguished by certificate status.
For 8.MReV, edX recorded 14,940,915 events in its tracking logs, relating to students interacting with the course contents, through the cutoff date of this report. These events included interactions indicating when students played videos, attempted problems, browsed through text pages, read or posted entries in the forum, and other activities. Figure 5 gives a glimpse into these data, presenting a histogram of the total number of events (“clicks”) recorded for all registrants with at least one event, and highlighting the population of students who earned a certificate in comparison with all other students. The figure also presents a histogram of the number of active days, where “active days” represents any day where a course interaction was logged. The distribution of active days for certificate earners is broad, further reflecting the variety of approaches by which a participant can earn a certificate.

**Figure 6:** Daily number of unique participants accessing courseware or course-site (pre-launch) via our described participant categories. Vertical dashed lines indicate the start and end of the course.

**Persistence in 8.MReV.** How does the activity of students change as the course progresses, particularly with students who persist to earn certification? Figure 6 highlights courseware and course-site (pre-launch) interactions for three of the disjoint participant types: only viewed, only explored, and certified. In 8.MReV, there is a noticeable periodicity in each curve that is highly correlated with content release and due dates. Certified students show a relatively stable weekly periodicity, while the periodicity of the viewed and explored curves disappears after about one-third and two-thirds of the course, respectively. It is important to note that these curves do not account for registration date or for large times between user interactions. However, they do provide insight into the collective behavior of our defined populations. It is particularly interesting to formulate hypotheses about behavior early in the course, e.g., attempting to target struggling students that may benefit from intervention.

**Figure 7:** Certification fraction versus registration week relative to course launch. Bubble size represents the number of unique users registering each week.
Do students who register early have a higher likelihood of earning a certificate than students who register late? Figure 7 depicts the certification fraction versus registration week relative to course launch (bubbles indicate total enrollment each week). Across MITx courses, certification rates do not depend greatly on registration dates prior to launch, although some courses have higher registration rates very early as well as just prior to launch. For 8.MReV, a relatively flat pre-launch distribution is seen, where roughly 10% of the users registering prior to launch earn a certificate regardless of enrollment week. After launch, the rate drops dramatically. Because of the highly structured due dates in 8.MReV, it is reasonable to attribute most of the post-launch drop in certification rates to registrants who have missed due dates and find it difficult or impossible to catch up.

Special Features
Each MITx on edX course includes atypical features unique to the course. 8.MReV had several features:

- **Concept Map.** 8.MReV was designed from the ground up using learning-sciences oriented pedagogy, aimed at teaching students how to think like and become experts at a subject. It was specifically designed to be helpful in preparing students for AP or advanced standing exams.

- **Pre-test and Post-test.** Unique among all the first-year MITx on edX courses, 8.MReV asked its students to take a test about the subject material, at the very start of the course, before any learning sequences were provided. Data from this pre-test, combined with data from the final quizzes in each module of the course, provided Professor Pritchard’s team with the data to compute and study quantitative learning gains.

- **For Teachers.** Professor Pritchard arranged with the American Association of Physics Teachers to offer formal continuing education units to any teacher who earned a certificate in 8.MReV. In addition, the course was specifically designed to demonstrate a methodology of approach to the subject, Mechanics, which is modular and particularly well suited to structured teaching.