

## MasteringEngineering

School Name University of Colorado Boulder, Boulder, CO

Course Name Dynamics

Course Format Lecture and lab

**Key Results** Students who used MasteringEngineering for homework attempted more homework assignments and were more likely to earn an A in the course than students who did paper-and-pencil homework assignments.

### Submitted by

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### Course materials

*Engineering Mechanics: Dynamics*, Hibbeler

### About the Course

The University of Colorado Boulder is a public university serving nearly 32,000 students a year. In fall 2013, its mechanical engineering program was the largest in the College of Engineering and Applied Science. Approximately 24 percent of the college's undergraduate students are female, and 12 percent are underrepresented minorities.<sup>1</sup>

Dynamics is the second course for mechanical engineering majors. It covers dynamic behavior of particle systems and rigid bodies; 2D and 3D kinematics and kinetics; impulse, momentum, potential, and kinetic energy; and work, collision, and vibration. Both lecture and homework assignments involve computers, hands-on laboratory work, and written reports.

### Challenges and Goals

Instructor Jeffrey Knutsen alternates teaching Dynamics in the fall and spring semesters. Course skills build upon prior physics courses and use key calculus skills. Success in the course is critical, as its content is essential for some mechanical engineering careers, and potential employers expect proficiency with the material.

Developing good problem-solving techniques is essential for success both in the course and in future careers. An online system that can provide automatic grading is one way to provide students in large-enrollment courses with additional problem-solving practice.

Previously, Knutsen had encountered issues with another online program, so he decided to test MasteringEngineering. He hypothesized that because the program is able to randomly generate problems, student copying—from one another and from the solutions manual—would decrease.

### Implementation

In spring 2012, Knutsen asked students to select a homework format: online in MasteringEngineering or paper and pencil. So that all students would be assigned the same level of homework, he assigned the end-of-section problems, which can be assigned as paper-and-pencil homework from the textbook or electronically in MasteringEngineering. Homework was due at the end of each week.

Knutsen's goal was to compare the performance of students who used MasteringEngineering with that of students who completed paper-and-pencil homework. Although they selected only one option, early in the semester some students did both formats. Of the students who selected paper-and-pencil homework in spring 2012, none did work in MasteringEngineering. Of the students who selected MasteringEngineering, however, some did both formats or paper-and-pencil work in lieu of MasteringEngineering for some of the assignments.

### Assessments

45 percent	Midterms (three)
20 percent	Final exam
15 percent	Homework
10 percent	Reading, quizzes, and clicker questions
10 percent	Workshops and labs

<sup>1</sup><http://www.colorado.edu/engineering/about/facts>.

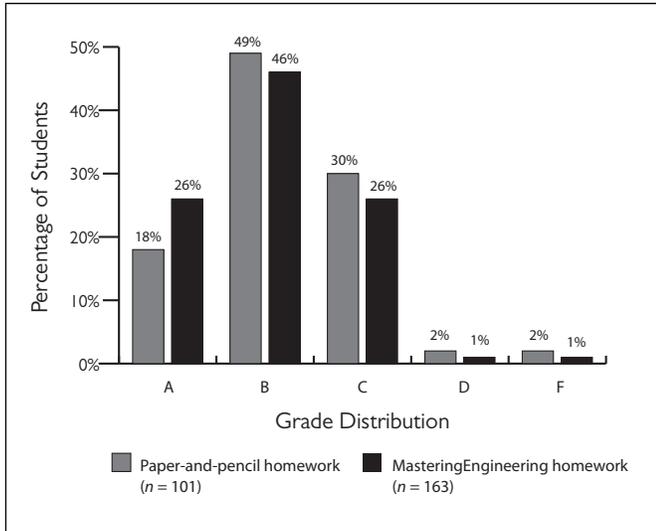


Figure 1. Grade Distribution for Students Completing MasteringEngineering and Paper-and-Pencil Homework, Spring 2012–Fall 2013

## Results and Data

Combined data for two semesters that Knutsen taught the course indicate that students who used MasteringEngineering as their homework format earned more As in the course than students who did paper-and-pencil homework (Figure 1). More students who completed paper-and-pencil homework earned a B or C in the course. There was a slight difference in the number of Ds and Fs.

The results for students who selected MasteringEngineering for homework but who did some assignments as paper and pencil or did some assignments in both formats were evaluated in more detail for spring 2012 because the enrollment of 206 facilitated a better analysis than fall 2013's enrollment of 58.

Of the students who selected MasteringEngineering, 38 percent did the first assignment on paper, and 22 percent of those students used both formats. Knutsen then asked students to select a format and continue with it. On the second assignment, 8 percent of students who selected MasteringEngineering did paper-and-pencil homework, and 42 percent of those students did both. For the fourth and remaining assignments, less than 3 percent of the MasteringEngineering students did the assignment on paper.

Of the group who selected MasteringEngineering homework, students who did only MasteringEngineering received more As and fewer Ds and Fs than students who went back and forth between paper and MasteringEngineering or who elected to do only paper-and-pencil homework (Figure 2).

In addition, the results show the following:

- In spring 2012, 75 percent of students who selected MasteringEngineering attempted all homework;

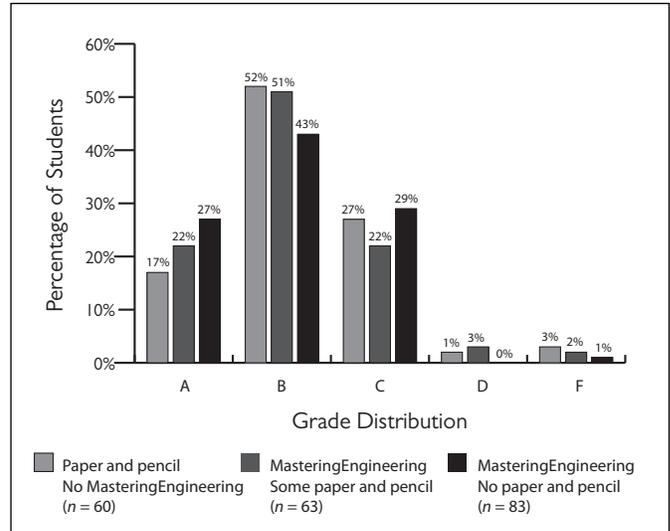


Figure 2. Grade Distribution by Homework Format, Spring 2012

58 percent of students selecting paper and pencil attempted all assignments.

- In fall 2013, 59 percent of students who selected MasteringEngineering attempted all homework; 37 percent of students who selected paper and pencil attempted all assignments.

Although other variables, such as student self-selection, may have impacted results, preliminary results show that students who used MasteringEngineering completed more homework—a critical factor to mastering necessary problem-solving skills.

## The Student Experience

Students appreciated MasteringEngineering's immediate feedback—they knew right away if their calculations were correct. They also liked that MasteringEngineering recognized common mistakes, such as sign errors and significant figures, which helped them correct their mistakes and move forward. As can happen with automated grading, students also got frustrated if their solutions were incorrect and their full problems were marked incorrect. Also, although they were allowed multiple attempts to solve problems, it was sometimes difficult for students to identify what part of their problems was incorrect.

## Conclusion

Preliminary results show that students who selected MasteringEngineering for homework attempted more homework and were more likely to earn an A in the course than students who selected paper-and-pencil homework. Because other variables could have impacted the outcome of the study, Knutsen believes additional research is needed to gather more data and collect more qualitative feedback from students.