

Students' Grasp of Thermodynamics in Online Course

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Abstract

During the fall semester of 2020, Thermodynamics I was taught online at North Carolina State University due to the coronavirus pandemic. It is the first thermal/fluids course that students take in the Mechanical and Aerospace Department and has a reputation of being challenging. During the semester, students were regularly asked to rate how well they understood the material being taught and to predict their next test grade based on that understanding. These results are used to determine when students struggle with the material when learning in an online environment. Analysis shows that students consistently felt that they understood the material fairly well regardless of the difficulty of the topics or previous test average.

Keywords

Thermodynamics, undergraduate, perception, online instruction

Introduction

Thermodynamics I can be a challenging course for undergraduate students. It is taught in the Mechanical and Aerospace Engineering (MAE) department at North Carolina State University for sophomore MAE students. Students from other engineering disciplines at NC State and distance education students from two other schools were also enrolled in the semester used for this study.

The current study analyzes student perception of their own knowledge and test performance throughout the semester. Perception can be indicative of the attitude a student has for a course^{1,2} but also a gauge of a student's understanding. The online environment makes it more difficult for instructors to gauge student learning without the visible cues in the classroom³. These self-reported perceptions are compared to predictions of test grades and the actual class performance.

Student Perception

The course was taught synchronously online via Zoom with posted recordings available to the students. A participation quiz was assigned weekly to test student understanding of the previous week's lectures. These quizzes also included the following ungraded questions:

On a scale from 1 to 5, how well do you think you understand the material in this course thus far?

- a) Not well at all – 1
- b) 2
- c) Fairly well – 3
- d) 4

e) Extremely well – 5

If a test on the material were given today, what grade do you think you would earn?

- a) A
- b) B
- c) C
- d) D
- e) F

The course included three tests during the semester with about 4 weeks between each. For this study, each four week period is called a unit with the last week in each unit including the test. Thus, the participation quiz assigned immediately following each test (and during the last week of the unit) replaced the second question above with the following:

Now that you've taken the test, what grade do you think you earned on the test?

- a) A
- b) B
- c) C
- d) D
- e) F

Analysis

All enrolled students who answered the survey questions for each week in the unit are included in the analysis below. For Unit 1, there are 127 students included, for Unit 2 117 students included, and for Unit 3 113 students included. There was no participation quiz for the first week of the semester to allow students to get comfortable with the course structure.

Figure 1 shows the results for Unit 1 which starts with the 2nd week of the semester. The majority of students reported that they understood the material “fairly well” at that point in the semester compared to the other options each week. The percentage of students who reported “fairly well” peaked in week 4, which was prior to the test. Week 5 shows that after taking the test fewer students reported “fairly well”, and more students reported “4” which is better than “fairly well”.

Each week students were asked to predict their grade if a test were given that day. The results for Unit 1 are shown in Figure 2. Less than 10% of students predicted an A each week. Most students predicted a B, with C being second-most popular. Week 5 data is the grade predicted after taking the test. The number of students predicting B was lowest for week 5 compared to the earlier weeks but still the most popular answer. The last column for each grade shows the percentage of students who actually earned that grade on the test. The test average for this unit was 74%. All test averages for this semester were near the average of the past several semesters taught face-to-face. Students were provided with the test average of the class when grades were posted. More students earned an A, D, and F than predicted it. The largest discrepancy between predicted grades and actual grades was for B.

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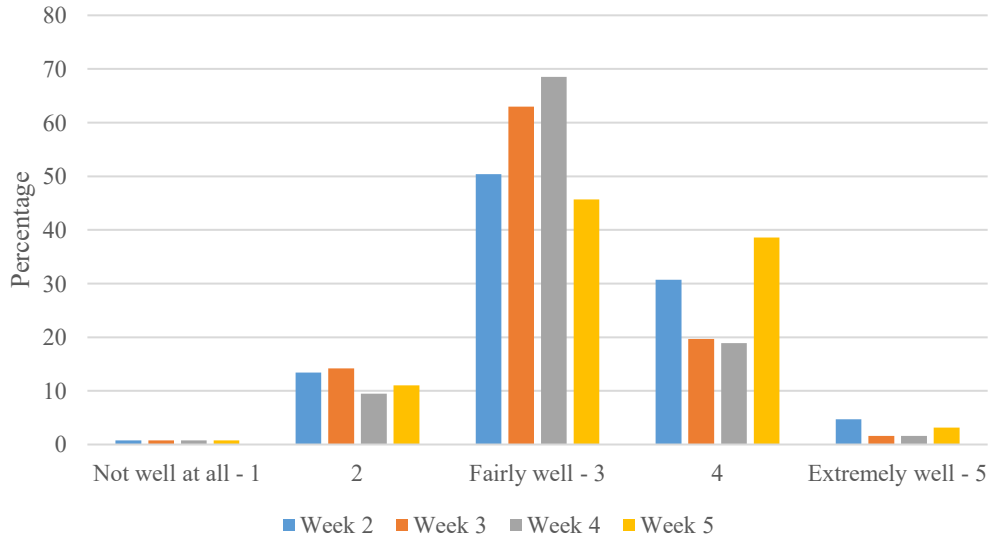


Figure 1. Unit 1: How well do you think you understand the material in this course thus far?

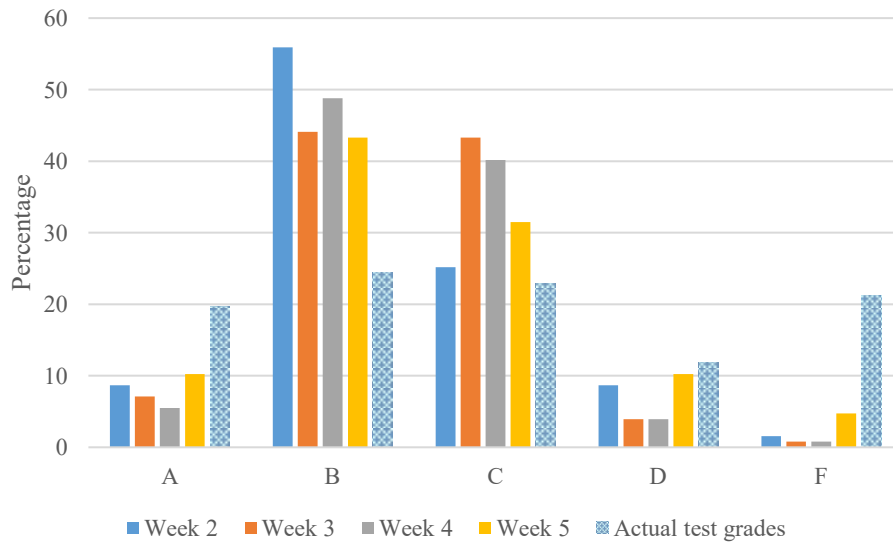


Figure 2. Predicted Test Grades for Unit 1.

Unit 2 covered weeks 6-9 with the test being administered prior to week 9. The trends in the understanding of material for Unit 1 are seen again in Unit 2 (shown in Figure 3). Most students reported that they understood the material “fairly well” more than any other category, but that number decreased each week before the test. As with Unit 1, more students reported “4” after the test than for any week prior.

Figure 4 shows the predicted grades for the test and the actual grades that resulted in a 77% average. Twenty percent more students predicted a B after taking the second test than predicted a C but an almost equal number of students scored a B and a C. For units 1 and 2, more students predicted an A on the test than reported knowing the material “extremely well”.

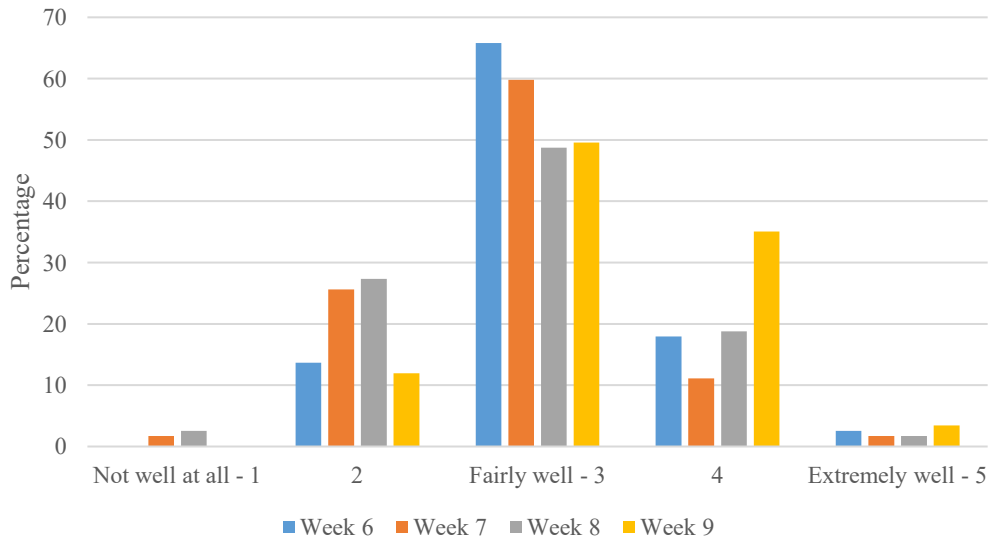


Figure 3. Unit 2: How well do you think you understand the material in this course thus far?

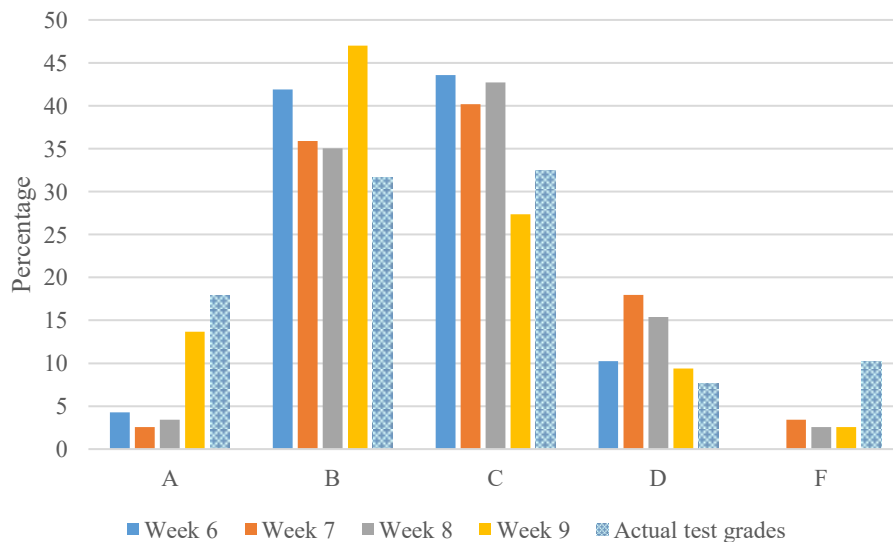


Figure 4. Predicted Test Grades for Unit 2.

For the last unit, there was more consistency week-to-week with the reported understanding of the material (see Figure 5). This consistency suggests that students’ perceived understanding was based on their work in the semester to date as much as or more than their work during the week. Figure 6 shows that most students predicted a C grade both before (week 12) and after (week 13) the test. Several students earned an A on the test but none reported understanding the material “extremely well” after taking the test. The average for the third test was 78%.

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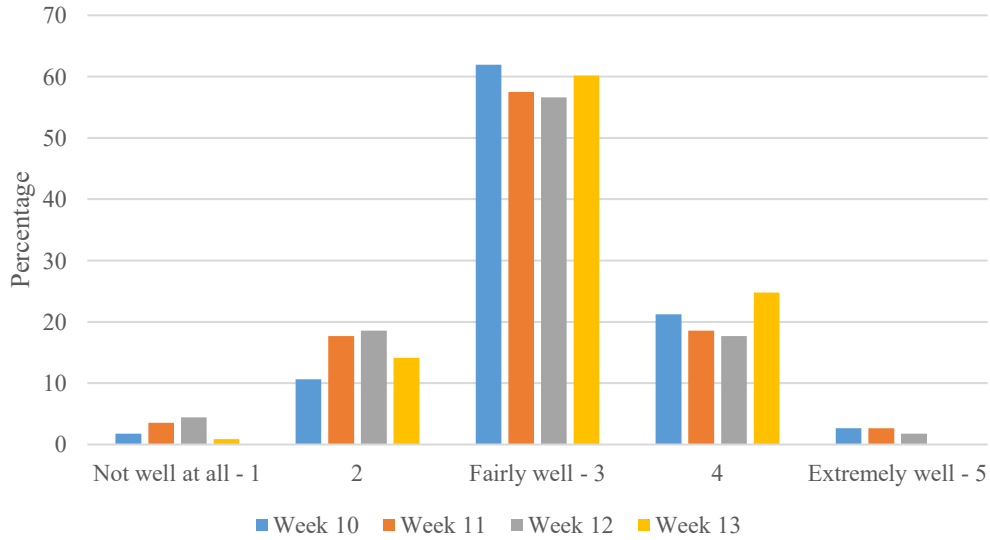


Figure 5. Unit 3: How well do you think you understand the material in this course thus far?

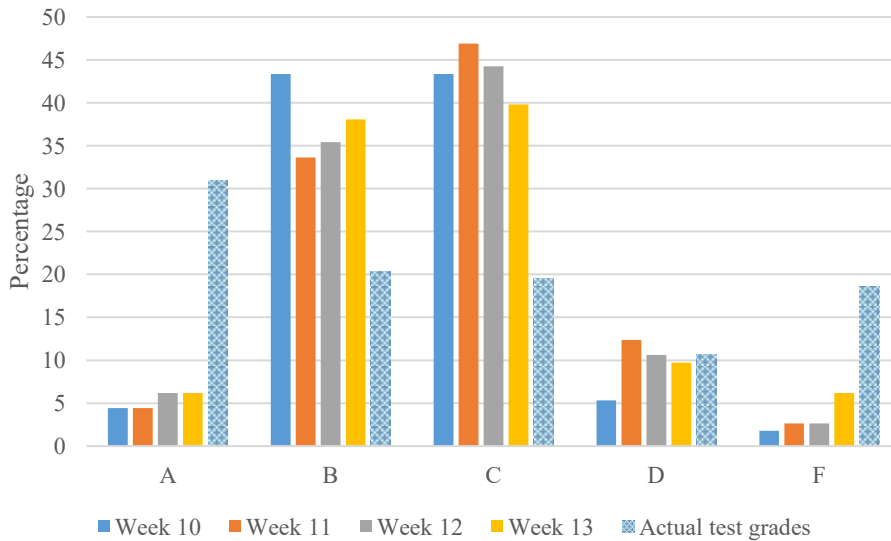


Figure 6. Predicted Test Grades for Unit 3.

Figure 7 shows the accuracy of the predicted test grades throughout the semester. After the first week of Unit 1, 31% of students correctly predicted the grade that they earned. The percentage rose to 36% after the first test. For each unit, the percentages were lowest in the second week and peaked in the week after the test.

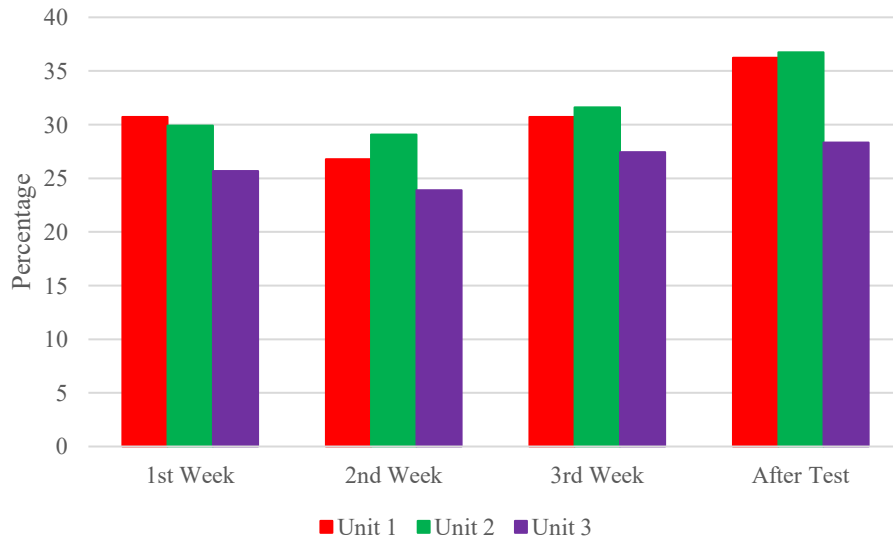


Figure 7. Accuracy of Grade Prediction.

Conclusions

Students were asked to assess their understanding of the material and predict their test grade. Results show that students most often report their understanding as “fairly well”, or 3 on a 5 point scale. More students earned an F than reported that they didn’t understand the material. Alternatively, more students earned an A than reported that they knew the material “extremely well”. This indicates that students need more practice assessing their own knowledge, which may lead to seeking help from the professor or tutors improving overall performance. Future work could include having assignments that students self-grade to improve their awareness of gaps in their knowledge. A promising outcome is that the accuracy of students’ grade predictions increased after taking the test indicating that at the end of each unit more of them understood their results.

These survey questions continue to be asked in the current semester. So far, this study has not yet been done in a face-to-face setting but that should be possible in the future. With more data, the author will be able to analyze the perceptions of underrepresented students in engineering and gain a better understanding of the reasons for disparities in perception versus reality.

References

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