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Work-in-Progress: Student Perceptions of Specifications Grading in Mechanical Engineering Design Courses

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Abstract

Alternative grading methods have continued to receive attention within engineering education. This paper focuses on two undergraduate courses: a second-year introduction to the mechanical design process and a capstone design course. Both courses were built around semester-long team design projects and included individual and group assignments. Students were able to revise and resubmit most types of assignments after receiving feedback. At the end of the semester, anonymous surveys were conducted to assess the students' perceptions of the grading method in each course. Most of the students who responded to the survey agreed that the grading method increased their ability to implement the design process in engineering design projects and preferred this grading method over those in their other courses. In the open response portion of the survey, students reported aspects of the grading system that worked well, for example the ability to resubmit assignments and the feedback received. This paper will describe the course assignments, student course performance data, and survey results.

Introduction

Issues with traditional grading methods are increasingly being discussed [1] - [3]. Some concerns with grades include being an ineffective way to provide constructive feedback and demotivating students [4]. Alternative grading strategies, including specifications grading, are gaining popularity in higher education. Benefits of alternative grading methods include reduced student text anxiety [5], increased student self-efficacy [6], [7], similar or higher learning outputs [8], and higher grades in a subsequent course [9]. Many examples of alternative grading methods in engineering courses have recently been reported [10] - [15].

In specifications grading, student work is scored pass/fail according to whether the assignment submission meets the provided requirements, and the final grade is determined by how many assignments were successfully completed. The instructor may set a high bar for what is considered work at the "pass" level.

The purpose of this paper is to describe how specifications grading was used in two undergraduate mechanical engineering design courses and report on preliminary student perceptions of this grading method.

Pedagogical approach

Two undergraduate courses are the focus of this study: a second-year introduction to the mechanical design process and a mechanical engineering capstone design course. This paper builds on previously published preliminary data from one offering of each course, which provides additional details about course assignments and grading schemes [16]. Both courses involved semester-long team design projects with team sizes between 3 and 5 students. Both courses included individual and group assignments, which were scored as "Pass" or "No Pass", based on whether all the specified requirements were met. The instructor provided feedback for

most assignments. Students were able to revise and resubmit most types of assignments if a "No Pass" score was earned.

In the second-year course, the major assignments in the course were project deliverables and an engineering ethics case study assignment. There were two types of smaller assignments that were graded on completion: guided practice assignments, meant to prepare students in a flipped classroom for the group activities [17], [18], and individual homework assignments. The course syllabus specified which major assignments were required for each final course letter grade, with "Pass" scores on more assignments required for higher grades. The letter grade could be modified by a "+" (plus) or "–" (minus) based on how many guided practice and homework assignments were successfully completed.

More assignments were required in the capstone course, including final project deliverables, weekly team assignments, a midterm report, and individual assignments. Like the second-year course, "Pass" scores on more assignments were required for higher grades. The letter grade could be modified by a "+" or "–" based on how many individual assignments received "Pass" scores.

Anonymous online surveys were conducted at the end of the course to assess the students' perceptions of the grading method used in the course. The survey consisted of Likert-type and open-response questions based on other work examining student perceptions of grading [15], [19] - [21]. This work was determined to be exempt from further review by the Indiana University IRB.

Results and discussion

The surveys were made available to a total of 34 students; 20 completed the survey (59% response rate). The enrollment of each course and the number of survey respondents is given in Table 1.

Table 1. Course enrollment and survey response rate summary.

Course	Year	Number of Students Enrolled	Number of Survey Responses	Response Rate
2nd year	2023	7	4	57%
	2024	9	8	89%
Capstone	2023	12	6	50%
	2024	6	2	33%
Total		34	20	59%

The surveys for both courses included the six statements shown in Table 2. Possible responses were strongly disagree (1), somewhat disagree (2), neither agree nor disagree (3), somewhat agree (4), and strongly agree (5). Most students agreed that the course grading method increased their ability to implement the design process, complete an engineering design project,

communicate effectively, and write organized project reports. Overall, students also liked the learning environment in the course and preferred the grading system to the ones in other courses.

Table 2. Average agreement with each statement (n = 20). (1 = strongly disagree; 5 = strongly agree)

The method in which the course was graded increased my ability to implement the design process in engineering design projects.	4.8
The method in which the course was graded increased my ability to complete an engineering design project.	4.6
The method in which the course was graded increased my ability to communicate effectively.	4.3
The method in which the course was graded increased my ability to write organized project reports.	4.3
I prefer the grading system in this course to the ones in my other courses.	4.6
I liked the learning environment in this course.	4.7

The survey for the second-year course contained three additional questions about components of the course, listed in Table 3. Most students found the homework assignments and in-class activities helpful. Fewer students agreed that the guided practice assignments helped them learn.

Table 3. Average agreement with each statement (n = 12). (1 = strongly disagree; 5 = strongly agree)

The Homework assignments helped me learn.	4.6
The Guided Practice assignments helped me learn.	3.9
The in-class exercises/problems and discussions helped me learn.	4.8

In addition to the quantitative questions, the survey contained three open-response items. Fourteen responses were given to the question “What aspects of the grading method used in this course did you think worked well?” The aspects reported most frequently were revising and resubmitting assignments (5 responses) and the feedback received (4 responses). Other aspects reported by multiple students included perceived improved learning (3 responses), criteria that helped in producing successful assignments (2 responses), and less stress (2 responses).

Fifteen responses were received for the item “What aspects of the grading method used in this course would you change and why?” Nine students indicated that no changes should be made. The only change suggested by more than one student was more than two levels (pass or no pass) on the proficiency scale (2 responses).

Only six responses were given for the prompt “Please provide any additional feedback about the grading method used in this course.” Three responses mentioned enjoyment of the class or grading system.

The number of individual assignments available in the capstone course varied during the two course offerings (4 or 5 assignments). In both cases, most of the students completed all the individual assignments. In the second-year course, 11 students earned a "Pass" score on the ethics case study assignment. All 16 students earned a "Pass" score on the design notebook. Summaries of successful completion of guided practice and homework assignments are given in Table 4 and Table 5.

Table 4. Second-year course guided practice assignment summary.

"Pass" Scores Earned on Guided Practice Assignments (out of 16)	Number of Students
15 or more (requirement for "+" grade modification)	12
Between 8 and 14	1
Fewer than 8 (requirement for "–" grade modification)	3

Table 5. Second-year course homework assignment summary.

"Pass" Scores Earned on Homework Assignments (out of 12)	Number of Students
11 or more (requirement for "+" grade modification)	11
Between 6 and 10	3
Fewer than 6 (requirement for "–" grade modification)	2

The instructor did not track time spent grading and giving feedback, but the workload for these courses did not feel onerous. This is likely because the courses were built around students working toward the final project. Throughout the design process, students received feedback from the instructor, project sponsors, and peers and were expected to incorporate that feedback into their project. The other contributing factor was the small class sizes.

Future work

This work will be expanded to survey students in mechanical engineering technology courses taught by the author using alternative grading methods, including courses with laboratory components. The next phase will be a qualitative study of how alternative grading methods, such as specifications grading, affect student perceptions of learning. This will likely involve focus groups. Based on the results of the design course surveys, some questions for future study include how students use feedback and how grades affect a student's enjoyment of the course.

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