Awarding Failing Grades in a Senior Capstone Design Course

Gregory Watkins
California State University Chico

Assigning individual grades to students who work in teams on year-long capstone design projects poses many challenges. Each student's performance and contribution to project success are difficult to assess. It is not unusual for a member of a student design team to fail to do his or her "fair share" of the project work. In extreme cases, a student's contribution may be so lacking that a failing grade is warranted.

But failing a student in a senior capstone design course is problematic for a number of reasons. Unlike a traditional course where poor performance on exams, homework, or projects can fully justify a failing grade, it is difficult to be certain that a student's performance is sufficiently lacking to warrant a failing grade. The burden of proof typically falls on the instructor to demonstrate that the student "deserves" to fail the class rather than the student demonstrating that sufficient work was done to earn a passing grade. The decision also has a significant impact on the student, likely delaying their graduation by a semester or more.

For many reasons, it is not uncommon to award passing grades to students that have not in fact earned them. This paper addresses severe student performance issues, offers strategies to motivate student performance, and details a mechanism for awarding a failing grade when warranted.

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Corresponding Author: Greg Watkins, gkwatkins@csuchico.edu

Background

The mechanical and mechatronic engineering programs at California State University Chico conclude with a two-semester course sequence in Capstone Design. The courses include students from both majors who work in multidisciplinary teams on year-long design projects that are predominantly externally sponsored. The first semester is spent in design activities while the second encompasses prototype building and testing. Each group is assigned a faculty advisor[1] and self selects a student project manager[2]. Students are required to maintain design log books for the duration of the project. The course sequence concludes with the Design Expo event.

Students are assigned to projects by the instructor; they are not allowed to self-select projects or teammates. Projects are recruited before the semester begins and are presented to the class at the beginning of the term. Students rank their project choices and also complete a self-assessment of their team role preference[3]. Priority is given to the student's choice of project, with team role preference used as a secondary criterion. The goal is to form teams whose members are interested in the project and also share a range of talents and personalities, hopefully resulting in a cohesive, high performing group.

While many teams perform well with all members making significant contributions, there are inevitably others that have a member or two who underperform, do not do their "fair share," and/or undermine dynamics within the team. Many strategies exist for assessing and aiding the performance of student teams[4] and the poor performance of individual members[5]. However there does not appear to be significant prior research specific to the issue of determining when failing grades are justified and the recommended strategies and implications of awarding them.

Student Assessment Model

As is done in the majority of similar programs at other institutions[6], students receive individual grades for each class in the sequence rather than awarding the same grade to all group members. Grades are determined by a combination of individual (I) and group (G) assessments. The grading schemes for the first and second courses are shown in Tables 1 and 2 respectively.

Table 1 – First Semester Grading Scheme

Topic	%	I/G
Project Proposal Presentation	10%	I
Prelim. Design Review Presentation	15%	I
Final Design Review Presentation	20%	I
Draft Design Report	5%	G
Final Design Report	25%	G
Contribution to the Project	25%	I

Table 2 – Second Semester Grading Scheme

Topic	%	I/G
Test Procedure Assignment	10%	I
Testing	10%	G
Final Project Presentation	15%	I
Poster	5%	G
Design Report	20%	G
Overall Project Quality	20%	G
Contribution to the Project	20%	I

It should be noted that presentation grades, while identified as individual, actually have elements of both. Presentations are graded in three areas using the following metrics:

- Content: 25% (G)
- Visuals: 25% (G)
- Delivery: 50% (I)

Each student is assigned a grade for "Contribution to the Project" by the group's faculty advisor. The grade is based on end-of-semester peer evaluations, the advisor's observations throughout the term, and examination of the students' design log books. Rubrics utilized for many of the student assessments can be made available to interested parties.

A Student Can't Fail?

Strictly adhering to the grade schemes above, it is virtually impossible for a student to receive a failing grade based on a lack of contribution to the project. Presuming that the rest of his/her group is doing at least adequate work, the group elements such as design reports and project quality will significantly lift a poor performing student's average. Additionally, 50% of the presentation grades are the same for all group members, and the delivery portion assesses only presentation skills and not actual contribution. The only mechanism for lowering the grade of an under-performing student is in the area of "Contribution to the Project." In both classes, even if a 0% is awarded, the final average will almost certainly result in a passing score.

A potential solution would be to increase the weighting factor for the contribution grade. But the subjectivity of the grade and its reliance on peer evaluations make that approach problematic. The recommended alternative is a simple statement in the syllabus, such as: "*If warranted, the course instructor, with input from the faculty advisor, may issue a failing grade regardless of a student's computed final average*."

The syllabus language actually provides an important first step in this process, which is to inform the class, on the very first day, this it is indeed possible to fail the course, regardless of how grades are computed or what they may have heard through the student grapevine.

Early Detection

The goal here is not to fail students, but to identify poor performers early enough to take corrective action. But in so doing, also prepare for the eventuality should it be the appropriate course of action. By far the most important element is early detection of an underperforming student.

As mentioned, confidential peer evaluations are performed at the end of the term and are one factor considered in the individual contribution grade of the student. Team members evaluate all other members and also themselves. They are asked if they *Strongly Agree, Agree,* are *Neutral, Disagree,* or *Strongly Disagree* with a series of statements. Students are also encouraged to provide written comments. The statements (and a final question) used for evaluation are:

- The group member did his/her "fair share" of the project work
- The group member attended scheduled group meetings
- The group member was a "team player" and worked well with other group members
- The group member contributed significantly to the overall success of the project
- If had $1000 to award to the team, and was told to distribute it to the members based on their overall contribution, I would award this team member $_____

Several years ago, (at the suggestion of a fellow conference attendee whose identity is unfortunately forgotten), we began administering peer evaluations at about the half-way point of the first semester. This has a two-fold benefit. First is that the students get a "practice run" at the evaluation, and know how they will be evaluated by their peers at the end of the term. The second and more important benefit is that the faculty advisor learns of any potential performance issues (or personality conflicts, etc...) early enough in the term to help correct any that have occurred.

Industry Style Performance Review

Once a poor performing student has been identified through midterm peer evaluations or other means, it is critical that some corrective action take place and that it be documented. The student needs to be appraised of his standing and be made aware of specific actions that can be taken to improve his/her performance. Documenting this process is extremely important in the event that a failing grade is ultimately awarded. The hope, of course, is that the student will respond to the meeting positively

and will make the necessary changes in his/her participation on the project team. However, in the event that they do not, documentation of this meeting is of the utmost importance if the student eventually appeals a failing grade.

The student should be called in to meet with the project's faculty advisor, and the course instructor if desired. Before the meeting, the advisor should review the peer evaluations and be familiar with the general observations, such as the student always being late to group meetings, missing meetings without notice, missing deadlines, poor quality work, not coming to class, etc. However, care should be taken to not mention any personably identifiable comments to maintain the confidentiality of the other team members. The student should be told to bring his/her design log book to the meeting.

A suggestion is that the meeting begin with a review of the student's log book. Where possible, specific references should be sought out that may corroborate specific items mentioned in the peer evaluations, such as an absence of notes from a meeting that was missed. It is also suggested that students be made plainly aware at the beginning of the semester that their log books document many things, including their individual contribution to the project. A final recommendation is that a copy of the log book be made for future reference.

The meeting should proceed with an industry-style performance review, of which there are numerous examples freely available on the Internet. While the general topic of assessing student performance in capstone is well explored[7-11], the educational literature is lacking on specific examples of industry-style performance reviews utilized in capstone courses. While space does not allow complete details, our review consists of the following metrics:

- Quality of Work
- Initiative
- Teamwork
- Timely Delivery on Commitments
- Effective Communication
- Customer/Sponsor focus

The student should be made aware that his/her performance to date is unsatisfactory in identified areas, with details documented during the review. It should be made clear that the student's performance needs to improve in specific, measureable ways in order to receive a passing grade in the class. The performance review should be dated and signed by all parties with a copy maintained for future reference.

Outcomes

There have been many instances of underperforming students in the ten year history of the program in its current structure. Most cases have not reached the threshold for at least considering the awarding of a failing grade. But there are three instances worth mentioning.

The Student that Didn't Fail

The genesis of this model occurred early in the development of this now mature program. A four-person design team working on an externally sponsored project had a severely underperforming member. Midterm peer evaluations had not yet been implemented in the program and the team's faculty advisor was not fully aware of the issue until final peer evaluations were received after the semester.

In addition to the performance issues of the individual student, the evaluations also revealed serious personality conflicts within the team. Much discussion ensued about the best way to handle the situation, and whether or not the student should receive a passing grade. At the time, capstone design was taught only in a fall-spring sequence, meaning a failing grade would delay the student's graduation not just for a semester, but by an entire year.

A decision was reached to pass the student with a very low score for contribution, and for the advisor to work more closely with the student, and the team, going forward. During the second semester, the issues went from bad to worse, the team disintegrated, and the project was completed with no contribution from the student in question. In hindsight, failing the student after the first semester may have been the right thing to do. But it would have been unfair to the student to do so without having identified and documented the issues early in the semester and given him an opportunity to improve. Another alternative, not considered at the time, would have been to award an Incomplete with clear guidelines of what would be required going forward to earn a passing grade.

The Student that Did Fail

Several years later, and after implementing the midterm peer evaluation process, another case of a severely underperforming student arose. Once the magnitude of the problem was identified, the group's faculty advisor met one on one with the student. The student's log book was copied, and the gist of the meeting was as described here, except that a formal industry-style performance review was not accomplished. And more importantly, not documented.

The student's performance barely improved over the course of the semester and the decision was made to

award a failing grade. As is their right, the student filed a grievance and a hearing was held. A great deal of time and effort for both the faculty advisor and the instructor went into preparing for the hearing. The student's log book was ultimately the clearest evidence of performance and the failing grade was upheld. But the experience clearly dictated the need for additional documentation, leading to the performance review model presented here.

The Student that Withdrew

Perhaps two years later was the next instance of a severely underperforming student on a capstone design team. Midterm peer evaluations identified the problem and (coincidently) the same faculty advisor from the previous case took immediate action. A meeting was initiated with the student and a formal, industry-style performance review was conducted. The review included a clear list of measureable actions required by the student to achieve a passing grade in the class. Ultimately, the student withdrew from the class and the team continued successfully without him.

Not mentioned in the above anecdotes are the many students that have been identified as underperforming, improved their performance, and were ultimately successful in the class.

Conclusion

Though conjecture, the author presumes that no professor *wants* to fail a student. But every experienced educator either has faced, or will face, the situation where it is the appropriate course of action. Most engineering programs have very high rates of attrition (this one included), and it is assumed that by the time a student reaches their senior year in the program, and enrollment in the capstone design course, that they are serious students, well prepared and dedicated to perform at a high level. Personal experience shows this to be overwhelmingly true, where students clearly embrace the opportunity to work on an industry-sponsored project and show their sponsor, and the rest of the class, what they are capable of as engineers.

But experience has also shown that occasionally students come along that have somehow managed to pass all the prerequisite courses and enter the capstone program with the apparent goal of doing the bare minimum required to graduate. The method presented here should not be thought of just as a means to deal with underperforming students, but as a mechanism to calibrate them to the expectations of the program, and to promote and encourage their success in it.

References

1. Watkins, G. (2009, June), *Defining The Role Of The Faculty Advisor In A Mechanical Engineering Capstone Design Course* Paper presented at 2009 Annual Conference & Exposition, Austin, Texas. https://peer.asee.org/5627
2. Watkins, G. (2018, June), *Peer Project Management for Capstone Design Teams* Paper accepted for presentation at 2018 Annual Conference & Exposition, Salt Lake City, Utah
3. Watkins, G. (2008, June), *Group Selection Techniques For A Mechanical Engineering Senior Design Project Course* Paper presented at 2008 Annual Conference & Exposition, Pittsburgh, Pennsylvania. https://peer.asee.org/4300
4. Davis, D. C., & Ulseth, R. R. (2013, June), *Building Student Capacity for High Performance Teamwork* Paper presented at 2013 ASEE Annual Conference & Exposition, Atlanta, Georgia. https://peer.asee.org/19274
5. Cheville, A., & Co, C., & Turner, B. (2007, June), *Improving Team Performance In A Capstone Design Course Using The Jigsaw Technique And Electronic Peer Evaluation* Paper presented at 2007 Annual Conference & Exposition, Honolulu, Hawaii. https://peer.asee.org/1891
6. Howe, S., Rosenbauer L., & Poulos, S., *The 2015 Capstone Design Survey Results: Current Practices and Changes over Time*, International Journal of Engineering Education 2017, Vol 33, No. 5
7. Davis, D., Beyerlein, S., Harrison, O., Thompson, P., & Trevisan, M., *Assessments For Three Performance Areas In Capstone Engineering Design* Paper presented at 2007 Annual Conference & Exposition, Honolulu, Hawaii. https://peer.asee.org/2759
8. Kremer, G., & Burnette, D. (2008, June), *Using Performance Reviews In Capstone Design Courses For Development And Assessment Of Professional Skills* Paper presented at 2008 Annual Conference & Exposition, Pittsburgh, Pennsylvania. https://peer.asee.org/3640
9. Cooley, L., *Individual Student Assessment in Team-Based Capstone Design Projects*, 34th Annual IEEE Frontiers in Education Conference, 2004
10. Jones, D., Tadros, A., *Successful Use Of Rubrics To Assess Student Performance In Capstone Projects* Paper presented at 2010 Annual Conference & Exposition, Louisville, Kentucky. https://peer.asee.org/15865
11. Kiefer, S., Ericson, T., *Capstone Design Assessment and Student Motivation*, Paper presented at 2015 ASEE Annual Conference & Exposition, Seattle, Washington. https://peer.asee.org/23663