

Encouraging Entrepreneurial Habits and Value Creation through Mastery-Based Learning in Project Courses

Dr. Mark Brinton, Elizabethtown College

Dr. Mark Brinton currently teaches electrical and biomedical engineering courses at Elizabethtown College. Prior to joining Elizabethtown College, he studied advanced prosthetic limbs at the University of Utah (postdoc, Biomedical Engineering) and electro-neural stimulation at Stanford University (PhD, Electrical Engineering).

Dr. Shannon M. Clancy, Elizabethtown College

Dr. Shannon M. Clancy (she/they) is an Assistant Professor of Engineering at Elizabethtown College in Pennsylvania. She earned all of her degrees in Mechanical Engineering: B.S. from the University of Maryland, Baltimore County (UMBC), M.S. from the University of Michigan, and her Ph.D. from the University of Michigan (U-M). They also received an Engineering Education Research Certificate during their time at U-M.

Her research interests include front-end design practices, sociotechnical knowledge and skills, and queer student experiences in engineering. They use qualitative methods and fields across engineering design, psychology, learning sciences, education, and STEM education to dive deeply into these topics, understanding the how's and why's of engineers' experiences, decision-making, and sharing their stories.

Dr. Clancy is motivated by their passion for and experiences with equity-minded teaching and holistic mentorship of students as people and professionals. She particularly enjoys intertwining engineering technical practices and social implications to prepare students to become socially responsible engineers. She seeks to reimagine who can be an engineer, what engineering is, and the impact engineering has on society for a more equitable world.

Dr. Kurt M DeGoede, Elizabethtown College

Professor of Engineering and Physics, Elizabethtown College. His research interests in biomechanics include developing clinical instruments for rehabilitation. Dr. DeGoede teaches upper-level undergraduate mechanical engineering using a Mastery-Based assessment model and design courses and first-year multidisciplinary courses.

Dr. Tomas Estrada, Elizabethtown College

Dr. Tomas Estrada is an Associate Professor in the Department of Engineering and Physics at Elizabethtown College, in Elizabethtown, PA. He received his B.S. in Electrical Engineering from Universidad de Costa Rica in 2002 and his M.S. and Ph.D. (both in

Dr. Sara A. Atwood, Elizabethtown College

Dr. Sara A. Atwood is the Dean of the School of Engineering and Computer Science and Professor of Engineering at Elizabethtown College in Pennsylvania. She holds a BA and MS in Engineering Sciences from Dartmouth College, and PhD in Mechanical Engineering from the University of California at Berkeley.

Dr. Judson Wagner, Elizabethtown College

Judson Wagner is an Assistant Teaching Professor in the Department of Engineering and Physics at Elizabethtown College. His research focuses on neurodivergent-inclusive engineering education, AI-supported learning, and entrepreneurial mindset development. He holds a doctorate in Educational Leadership and brings expertise in STEM pedagogy, having served as a STEM supervisor and state-level STEM initiative advisor. His current work explores how emerging technologies can create scalable, inclusive pathways for developing strategic thinking capabilities in engineering students.

Gwenyth Michelle Lottero, Elizabethtown College
Munia Kamal, Elizabethtown College
Emmanuel Attah, Elizabethtown College

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Mark R. Brinton, Shannon M. Clancy, Kurt M. DeGoede, Tomas Estrada, Sara A. Atwood, Judson Wagner, Gwentyth M. Lottero, Munia Kamal, Emmanuel Attah

Department of Engineering, Elizabethtown College, Elizabethtown, PA

Abstract:

Engineering students often meet technical requirements but struggle to consistently demonstrate the entrepreneurial habits of mind that distinguish innovative, value-adding engineers. To address this gap, we redesigned sophomore through senior project-based courses to incorporate mastery-based resubmission policies and entrepreneurially minded (EM) grading rubrics. These interventions were intended to focus student assignments on value-creation and the development of EM habits such as persistence, resilience, initiative, and growth mindset.

Two main strategies guided our work. First, a mastery-based resubmission policy allowed students to revise assignments after targeted feedback, reinforcing habits of persistence and growth mindset. Second, a four-point rubric required students to move beyond checklist completion toward demonstrating unique value for stakeholders.

We evaluated these interventions across sophomore, junior and senior project courses using surveys and analysis of student comments. Results indicate that students valued the resubmission process and felt it helped them do quality work. Students resubmitted about 60% of their assignments, improving scores by about 1 point on a 4-point scale. Student comments about the resubmission policy referenced EM habits about 70-75% of the time, frequently referencing growth mindset, persistence, and resilience. In contrast, student responses to the EM rubric were mixed, and very few referred to EM habits. While some reported increased initiative and motivation, others struggled with the ambiguity of going beyond a list of stated requirements, suggesting a need for scaffolding, examples, and coaching to support development.

Our findings suggest that mastery-based resubmission policies are effective at reinforcing entrepreneurial habits, while EM-focused rubrics require refinement to balance motivation with clarity. This paper will share examples of our assignment designs, rubric structure, and student outcomes, and discuss lessons learned for faculty integrating mastery-based learning and the entrepreneurial mindset into engineering project courses.

Introduction:

Engineering instructors can spend a lot of time giving feedback on summative engineering reports, but if the report is never reevaluated, we never know if students even read comments, and if they did, whether they tried to learn and improve (and for some students there is no incentive to do so). Faculty should play the role of a coach, encouraging students to develop and meet higher standards—unfortunately, we can feel more like referees, constantly identifying mistakes and calculating a final grade to reflect the aggregation of a student’s good work, minus any mistakes or missing information. Faculty may also spend a lot of time developing intricate and explicit rubrics, only to find that some student work justifiably deviates from the prescribed rubric—perhaps even more common among project-based learning where students are expected to create unique value for stakeholders. If the rubric is too prescriptive and does not expect critical thinking, as performance-based rubrics should [1], students can become conditioned to look at the rubric as a checklist for an ‘A’ (or whatever grade they are comfortable with). To break holistic judgments down into smaller, more manageable parts, overly prescriptive rubrics can actually lead to distorted grading [2] and encourage students to focus more on their grade than the actual learning [3]. While assignment clarity is important and students should know what is expected of them, the reality is that as soon as they enter graduate school or land their first job, they will quickly be expected to wrestle with ambiguity, ill-defined problems, and differentiate themselves from artificial intelligence tools.

One way to foster an environment for ambiguity is to avoid using overly prescriptive rubrics so that problems are more open-ended and less close-looped like textbook problems or projects. In a 2006 study by Mohammed et al., an industry-sponsored open-ended project was used to introduce ambiguity in a first-year engineering design class [4]. Surveys showed students grappling with ambiguity; students left comments commonly asking for “better defined problems” and not know “what needed to be done”. The study suggested that embracing ambiguity was correlated with other important features of engineering design: students with a higher tolerance for ambiguity showed higher levels of collective efficacy, team satisfaction, and conflict resolution than students who have a low tolerance for ambiguity [4].

Resubmission and relearning are not remedial practices but central mechanisms through which learning and mastery occur. As both Bloom and Guskey argue, students often require multiple opportunities, supported by targeted feedback, to reach a clearly defined standard [5] [6]. In many real-life scenarios, such as a typical driver’s license examination or the fundamentals of engineering exam administered by the National Council of Examiners for Engineering and Surveying, the number of attempts is irrelevant—once the

standard is met an individual receives the associated privileges and opportunities. Allowing resubmission accommodates differences in students' learning rates, styles, and modalities by providing alternative pathways to mastery rather than penalizing initial misunderstanding [6]. Frequent, instructor feedback further reduces wasted effort by clarifying specific errors and guiding corrective action, which increases students' perseverance and efficiency in reaching mastery [5]. Mastery-Based Learning (MBL) provides the structural conditions that make this process possible by emphasizing fixed standards, iterative feedback, clear instruction, and reassessment that is not penalized, thereby enabling students to learn at an appropriate pace, address areas of weakness, and ultimately demonstrate deep, verifiable achievement.

Mastery-Based Learning (MBL) (also referred to as Competency-Based Learning (CBL)) applied to traditional courses boosts student learning and success [6][5][7][8][9][10][11][12][13]. This structure allows students to learn at their own pace by breaking up a traditional course into subskills that can be attempted more than once with same credit given to a successful attempt no matter the number of attempts. MBL courses give students the room to master core foundational concepts. And because engineering topics build on each other, students are better prepared and more likely to master advanced skills as well.

MBL applied to a 300-level dynamics class showed that 93% of students demonstrated mastery on required core topics in the MBL version compared to only 50% in the traditional version [9]. Another study on MBL in a foundational Statics class showed that lower academic achieving students benefitted from MBL and performed better compared to their peers in traditional offerings [8]. Students commented that mastery-based learning "forced them to understand the material" [8]. This emphasizes how mastery-based courses encourage lower-performing students to gain depth through reassessments on core topics, rather than acquiring shallow knowledge across many of the course topics.

Increasingly MBL has been applied to project-based courses across several programs. In a civil engineering senior design course at Angelo State University, key learning objectives were separated into three skill categories: required Skills, major Skills, and minor Skills [7]. With letter grades assigned to individual skills and varying modes of reassessment, students in the course enjoyed the new learning model with some saying, "I can see one specific topic and improve on it, while as on a test I need to rush on multiple topics at the same time." Others mentioned being more prepared for the engineering industry and the instructor observed an increase in the number of A-level students. At Embry-Riddle Aeronautical University, specifications grading was applied to aerospace and communications capstone courses [11]. This course maintained a pass/fail structure,

mapped distinct learning outcomes to assessment activities, required students to focus on all learning outcomes to pass the class (instead of being graded on how many learning outcomes students chose to master), and provided flexible reassessment opportunities like submitting work within a timeframe without consequence. Not only did students perform better, but team satisfaction and cohesion increased in comparison to the traditional method and students demonstrated a shift in focus from earning grades to actual learning. Students began working on projects early, sought formative feedback, and engaged more deeply with course content [11]. In other project-based courses with mastery-based learning, students preferred the assessment and reassessment policy [13] and left the course with greater belief in their ability to perform design tasks [12].

The aim of this study was to explore student mindset in response to the application of mastery-based learning in project-based courses—particularly how they view the opportunity to incorporate feedback and persist beyond a checklist of requirements to create value. We implemented mastery-based resubmission policies and a simplified 4-point entrepreneurially minded grading rubric to encourage entrepreneurial mindsets such as persistence, resilience, and growth mindset in our students. This study suggests that students see value in, engage with and persist through the feedback and resubmission process. It also reveals tensions and challenges that arise when students are asked to move beyond checklist completion toward value creation.

Methods

Data Collection and Courses Sampled

Interventions were implemented across the project-based curriculum: Community Based Project (EGR 201), Junior Design (EGR 301), Senior Capstone (EGR 401 and 402). As part of the institution's standard end-of-semester course surveys, we collected survey data (5-pt Likert scale and open-ended responses) about the resubmission process and the 4-point entrepreneurially minded rubric. After receiving an initial assessment and specific feedback from faculty, teams were allowed to resubmit engineering design assignments in each course (unless an assignment was due at the end of the semester where no time was available for resubmission). In Junior Design (EGR 301), teams were allowed to resubmit twice. We tracked the percentage of assignments resubmitted, and any changes in assignment grade due to resubmission.

Each assignment in the course was graded on a 4-pt rubric where a '4' (corresponding to an A) required students to describe and create unique value for their stakeholders in that assignment. Students were provided with a list of EM habits [14] and encouraged to

consider and apply a habit to the assignment at hand. A ‘3’ (corresponding to a B) was awarded to students who successfully completed the list of requirements provided for each assignment. A ‘2’ (corresponding to a C) was awarded to students who were generally successful but failed to meet all the criteria stated to an acceptable level. Everything else was awarded a ‘0’ (corresponding to an ‘F’) and encouraged to resubmit (see Appendix A – Resources for Capstone Students for the template rubric).

Regarding assessment, students were told that fulfilling the stated requirements leads to a “ ‘3’, a strong grade, and a good position to be in”, but “we want to encourage you to be an engineer that creates and adds unique value to your project... [the] type of work that might catch the eye of a future employer and lead to unique opportunities and promotions”.

Students were told that working at the ‘4’ level means that you (1) “...ask questions and demonstrate curiosity at a deeper level...[which] fuels exploration, challenges assumptions, and reveals new opportunities.”; (2) “...demonstrate ability to connect and integrate different perspectives, ideas, systems, resources or opportunities that increase innovation or magnify the impact of your work”; or (3) “... create and communicate added value to others (including those assessing your work).” Students were not given specific details on how to achieve a ‘4’ on each assignment, but students were provided with a list of questions (capstone students in EGR 301, 401 and 402) or more specific suggestions (sophomore students in EGR 201) to consider when seeking to go beyond the stated requirements. Assignment examples, rubrics, course syllabi, and the list of questions provided to students are available online [14].

Classes sampled were our sophomore, junior and senior level project courses (Table 1) during the semesters when the mastery-based learning (MBL) and entrepreneurially minded rubrics were introduced.

Likert-scale survey questions included the following (rated from ‘Strongly agree’ to ‘Strongly disagree’):

To what extent do you agree with the following statements:

The resubmission process helped me to do quality work.

The 4-point rubric (e.g., Entrepreneurially Minded (4), Entry-Level (3), Intern-Level (2), Unacceptable (0)) motivated us do our best work.

For two courses, our sophomore (EGR 201) and junior-level (EGR 301) courses, we collected and analyzed student open-ended responses (“Why? Or Why Not?”) used to justify their Likert survey ratings. A student author conducted an initial round of coding, followed by a faculty author who reviewed and refined the classifications. Responses were

qualitatively interpreted and categorized into a priori codes using the definitions described in Appendix A, with one additional theme (embracing ambiguity) incorporated during coding based on the student comments. The faculty author made the final coding determinations. While responses could align with multiple themes, each was assigned a single category based on the dominant theme.

This study was reviewed and approved by the Elizabethtown College IRB as exempt research involving normal educational practices; the requirement for informed consent was waived as data were collected as part of standard course activities and analyzed in de-identified form.

Table 1-Courses surveyed and number of students in each course

Course Name	Number of Students Enrolled	Number of Students Completing Survey	Student Level
EGR 201 – Community Based Project	51	26	2 nd – year
EGR 301 – Junior Design	47	46	3 rd – year
EGR 401 – Senior Project I	35*	25	4 th – year
EGR 402 – Senior Project II	35*	32	4 th – year

*Note: the same students enrolled in EGR 401 and EGR 402.

Results

Mastery-Based Resubmission Policy

Across the curriculum, students agreed or strongly agreed that the opportunity to resubmit helped them do quality work: the median response for each course from the sophomore to senior courses were ‘5-strongly agree’, ‘4-agree’, ‘5-strongly agree’, and ‘4-agree’ (respectively; Figure 1). Students resubmitted 71% out of 5, 57% out of 7, 60% out of 7 and 50% out of 2 eligible assignments (Figure 2, median; for EGR 201 (n = 51), 301 (n = 47), 401 (n = 35), and 402 (n = 35)). These resulted in median assignment grade improvements of 1.5, 1, 1.25 and 1.5 (median; on a scale of 0 to 4), respectively (Figure 3).

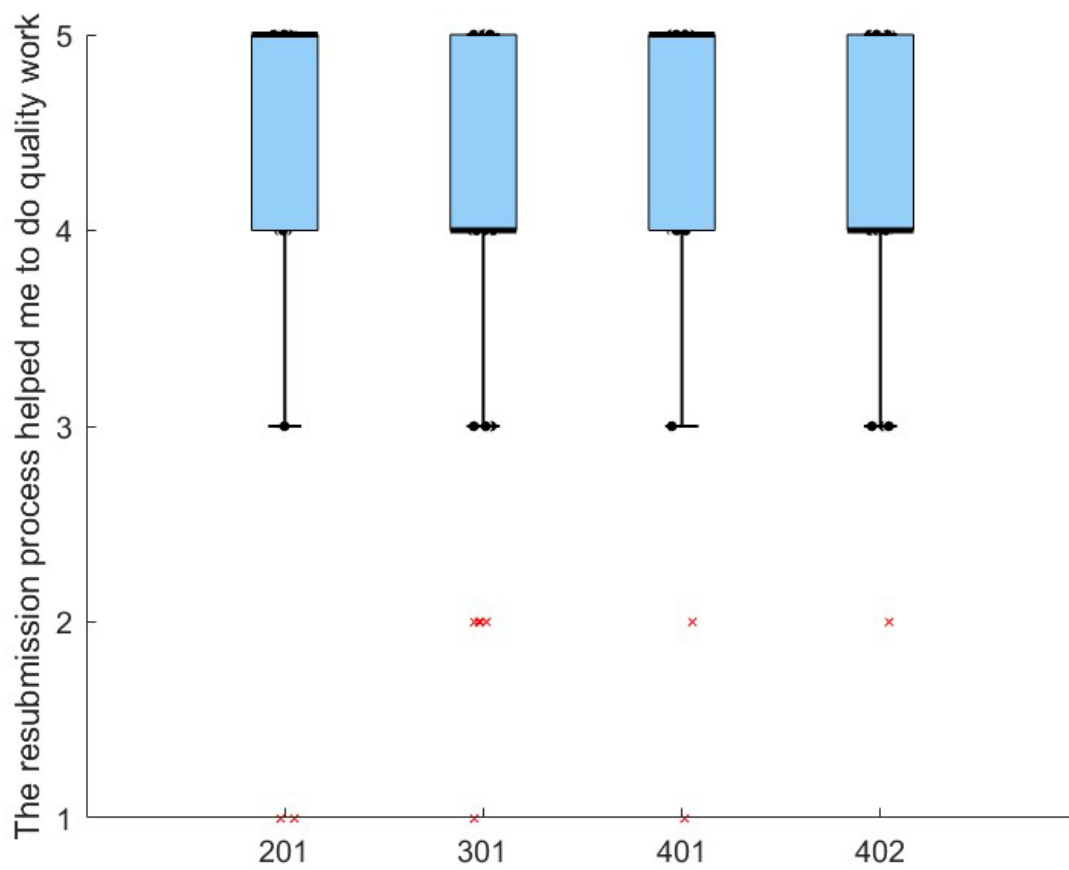


Figure 1 - Likert data (5-pt scale: 1 - strongly disagree, 5 - strongly agree) for whether the resubmission process helped students do quality work. Black line is the median for each class, box the interquartile range (IQR), whiskers are at $1.5 \times \text{IQR}$, and each red 'x' represents an outlier. Response rates for the survey were 51%, 98%, 71% and 91%, respectively.

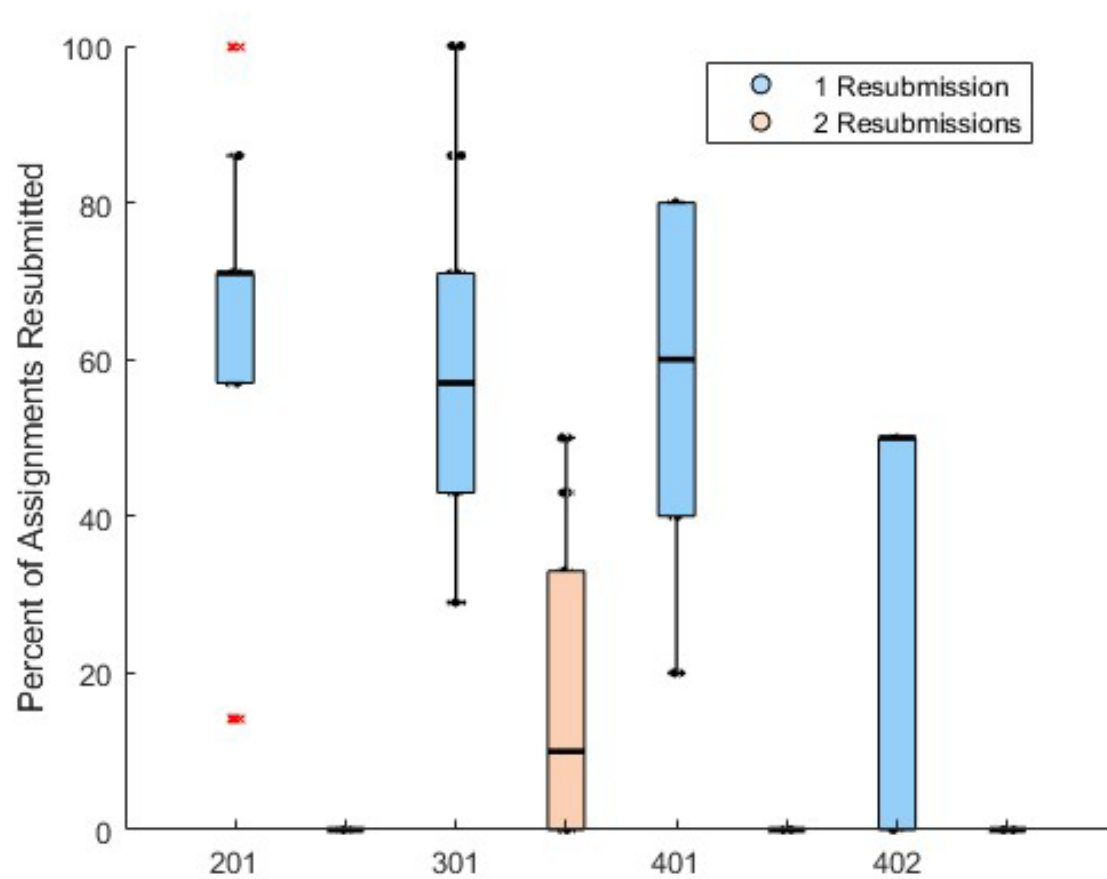


Figure 2 – Percent of assignments resubmitted. Plotted data are the median percentage for each student. Black line is the median for each class, box the interquartile range (IQR), whiskers are at $1.5 \times \text{IQR}$, and each red 'x' represents an outlier. EGR 301 students were allowed to resubmit all eligible assignments twice, though most did not take advantage of that opportunity (opportunity was not provided in other courses).

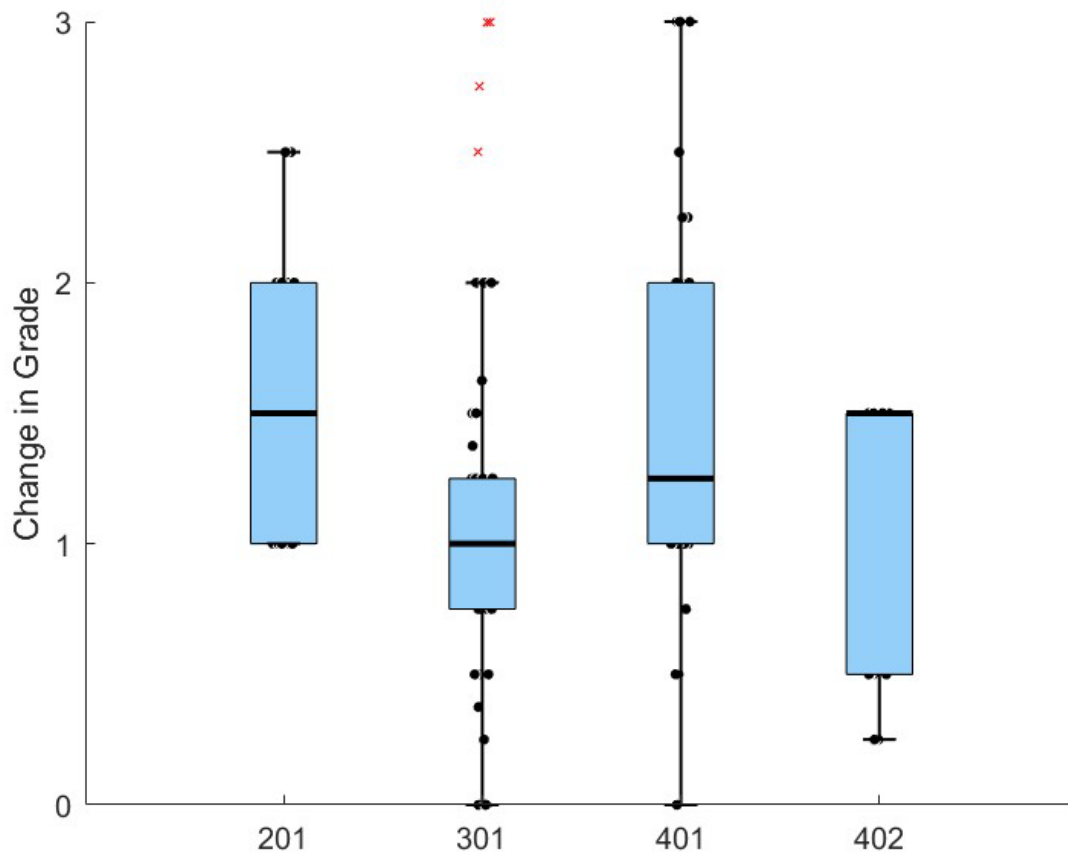


Figure 3 – Change in assignments grades after students resubmit their work. Each data point is the median grade change for an individual student across all resubmitted assignments. The black line is the median for each class, box the interquartile range (IQR), whiskers are at 1.5 x IQR, and each red 'x' represents an outlier.

When justifying their Likert rating, we found 21 student comments reflecting the entrepreneurial habits, while only 4 comments indicating a lack of entrepreneurial mindset for the EGR 201. Similarly, we found 19 comments supporting, and 8 lacking evidence of these habits in EGR 301.

Table 2- Summary of student comments showing, or showing opposite of, EM habits when justifying their resubmission Likert score. All comments and categories are displayed in Appendix B.

Mindset	EGR 201 – Community Project		EGR 301 – Junior Design	
	Comments showing	Comments lacking	Comments showing	Comments lacking
Growth Mindset	10	-	9	1
Persistence	8	2	7	3
Resilience	3	1	2	-
Initiative	-	1	1	4

Most comments reflecting the growth mindset were focused on doing better work and overcoming weaknesses or mistakes (see Appendix B for a complete list). For example:

"It gives us a chance to use feedback to perfect our work, which is how it works in a real engineering job" (EGR 201 student)

"Being able to resubmit helped me to improve my weaknesses more effectively" (EGR 201 student)

"While this process did seem a little frustrating due to the feeling that it was difficult to get a 4/4, it did help me to go back and see errors that I now know to look for or stay away from in my writing or calculations." (EGR 301 student)

Comments related to the persistence mindset focused largely on the role that resubmitting played in reaching success:

"...the resubmissions allowed us to refine our previously submitted work to make it the best that we could possibly have" (EGR 201 student)

"Because of how the course changed, some of the assignments weren't worded/described in ways that helped us get a 4. The resubmission process allowed for that grace period and allowed me to continually elevate my work." (EGR 301 student)

A few comments indicating a lack of persistence or initiative, while acknowledging the benefit of resubmissions, also reflected a misunderstanding of the role of feedback and the necessity for individual effort:

"We would get poor grades, and the resubmission definitely helped our grade. I sometimes think the feedback was just for us to do more work because some of the time it didn't even matter" (EGR 201 student)

"It was nice being able to get feedback on resubmissions, but it was a lot of work on us and also the professors to try and give feedback on the assignments. I think having a little more specific rubric for just one submission might take pressure off the professors and students." (EGR 301 student)

Entrepreneurially Minded Rubric

Students reported medians of 4, 4, and 3.5 (for the EGR 201, 401 and 402 courses, respectively) in response to a survey about whether the EM focused rubric motivated them to do their best work—these scores suggest they were generally motivated by the rubric

(Figure 4). However, students in the junior design course (EGR 301) were neutral (median of 3) as to whether the rubric provided motivation.

Table 3 summarizes the categorization of student comments about the EM rubric. In the sophomore level course (EGR 201) fewer students left comments indicating EM: only 4 comments for and 1 against. For the junior design course, only 2 comments revealed EM whereas 14 showed mindsets in contradiction of EM (e.g., lack of persistence; see Appendix C).

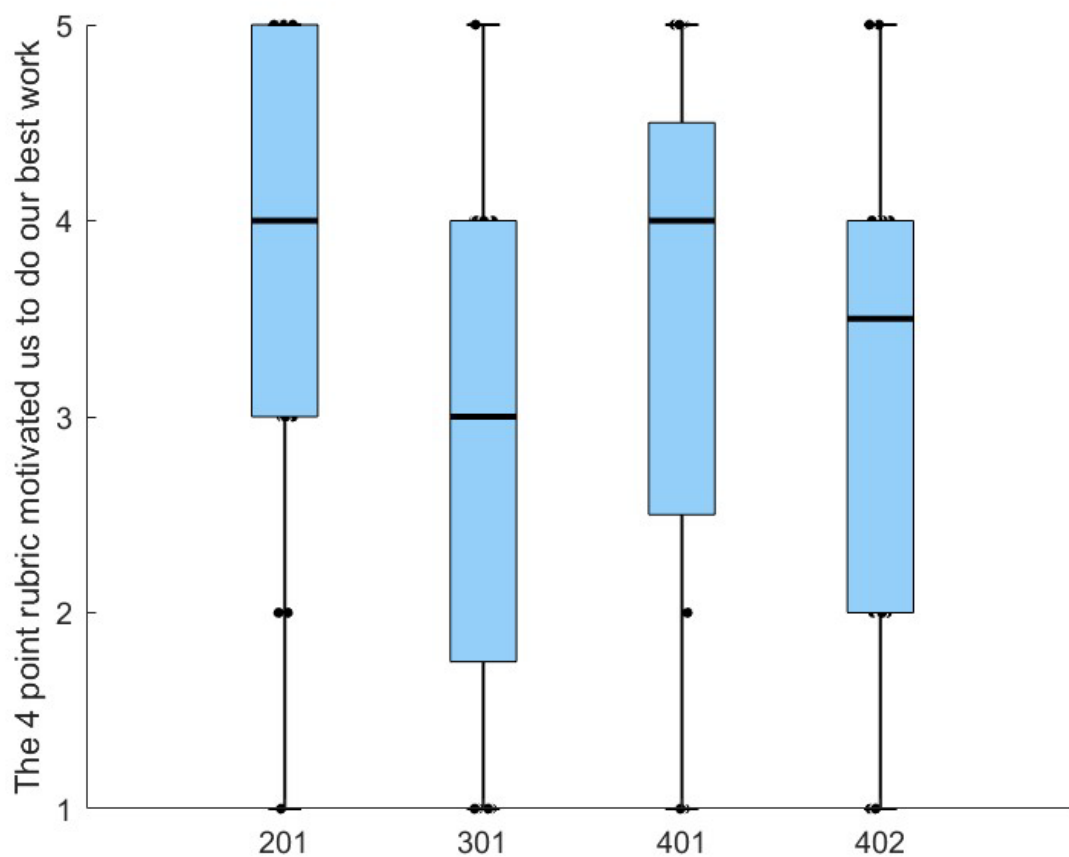


Figure 4 - Likert data (5-pt scale: 1 - strongly disagree, 5 - strongly agree) for whether the 4-pt, EM focused rubric motivated students to do their best work. Black line is the median for each class, box the interquartile range (IQR), whiskers are at 1.5 x IQR, and each red 'x' represents an outlier. Response rates for the survey were 51%, 98%, 71% and 91%, respectively.

Table 3- Summary of student comments justifying their Likert score for the 4-pt EM focused rubric. All comments and categories are shown in Appendix C.

Mindset	EGR 201 – Community Project		EGR 301 – Junior Design	
	Evidence for	Evidence against	Evidence for	Evidence against
Growth Mindset	1	1	-	1
Persistence	-	-	-	5
Resilience	-	-	-	2
Initiative	3	-	2	3
Embracing Ambiguity	-	-	-	3

Compared with EGR 201, where only one student provided a comment suggesting a lack of EM, in EGR 301 fourteen comments demonstrated a lack of EM habits (Table 3, and Appendix C). Several of these categorized as lack of persistence or resilience revealed students strongly attached to the idea that to earn a perfect grade, they should only be required to meet prescribed expectations. Examples include:

"I disagree with the use of the 4-point grading scale. I don't think it's fair that completing all parts of an assignment correctly only earns a 3 out of 4, and that we are expected to go "above and beyond" just to achieve a full score. It's extremely discouraging to spend so much time and effort making sure we thoroughly follow the instructions, only to be told that meeting expectations isn't enough for a perfect grade. It feels like our hard work isn't being fully recognized.... That inconsistency makes the grading system feel even more unfair and demotivating." (EGR 301 student)

"The fact that a 4 required going above and beyond what was asked for in the instructions made it feel a bit vague in what was really wanted for an assignment. I sometimes felt discouraged knowing that all the hard work I put into an assignment would only get me a ¾, or 75%, on it. I'm used to that being a C, which I feel is below what I consider an acceptable grade for myself. I felt forced into a no-win situation." (EGR 301 student)

"I would get a ¾ on an assignment which meant we worked very hard and did what the assignment asked for. This is a 75% in the grade book which seems unreasonable." (EGR 301 student)

Multiple comments also demonstrate lack of initiative and some emotional discouragement, that could also impact their resilience or persistence, as seen in these responses:

"Knowing that we could fill every checkbox and still get a mediocre grade removes the sense of reward from completing quality assignments." (EGR 301 student)

"Getting a 4/4 was particularly difficult, especially when it isn't necessarily outline what is expected or wanted. Sometimes it felt unclear or unmotivating to get that 4/4, and I found myself settling for a 3/4 a lot of times." (EGR 301)

Interestingly, in EGR 201 students (15%, 4 out of 26) focused on misunderstandings with grade sensitivity, whereas EGR 301 students (17%, 8 out of 48) instead challenged the expectation that completing the specified tasks only resulted in a 3 out of 4, and pushed against the need to create value unique to their project to earn full points (as seen in several of the comments provided earlier). EGR 201 students mistakenly thought a 2 out of 4 was a 50% (Failing), or a 3 of 4 a 75% (C grade), not realizing how to use letter-grade system we adapted where 3 is a B and 2 out of 4 is a C. For example,

"Difference of quality between 3/4 to 4/4 is slim, yet the difference in grade is 25%. This is a bit too big of a jump in my opinion." (EGR 201 student)

"I personally don't like the point-based system because the tiniest thing would give us a 3/4 and bring our grade down tremendously" (EGR 201 student)

Use of the rubric appears to have motivated students to take initiative, albeit most referred to the rubric affecting their grade as opposed to identifying and creating value:

"Everyone wants to get the best grade, but to do that you must go above and beyond, therefore it made me want to do the best." (EGR 301 student)

Discussion

We found that students felt the opportunity to resubmit was valuable and most teams resubmitted more than half of their assignments, except during EGR 402 (Figure 2) which was perhaps a result of decreased motivation due to pending graduation—though it could also reflect student growth and requiring fewer resubmissions to succeed. With resubmission, assignment grades generally improved by at least 1 point. Interestingly, the median improvement trended upward from 1, to 1.25 to 1.5 for the capstone sequence (EGR 301 through EGR 402). It may be that as students complete the capstone sequence, they are more adept at responding to targeted feedback once given, although this may not be true as the course instructors also changed each semester. A few students were able to improve their scores by as much as 3 points, though this was rare.

Overall, earlier-year students in EGR 201 seemed to take the most advantage of the resubmission opportunities and comment most positively about mindset development as a result of the EM-aligned rubric. This may be a result of the faculty team providing more

scaffolding and explanation or might be due to their having less experience in the design sequence prior to this course. Upper-year students, particularly the seniors, had previously been given more defined rubrics in earlier project courses and could have been conditioned to receiving an 'A' for 'checking all the boxes'.

We found that while some students were motivated by the EM rubric, some were not, particularly in our junior design course (EGR 301). This is likely due to the ambiguity involved in identifying how to create value beyond the stated list of assignment requirements. This led some students to push against the expectation to add unique value, unspecified by faculty instructors, to their work. Comments also suggest that this led to some emotional discouragement and lack of initiative.

There could be a few reasons why we did not see the same struggle with ambiguity in the sophomore level course (EGR 201). First, the junior design course already asks students to wrestle with ambiguity as part of the human-centered, front-end design and needs finding curriculum—wading through this process already challenges many students and evokes emotional reactions and tests resilience, adding more uncertainty certainly will as well. In contrast the sophomore students are given predefined and appropriately scoped needs that they immediately begin designing around. Second, the EM rubrics for the sophomore students, suggesting general ways (not specific tasks) that value might be added for each unique assignment in the design process. We had hoped that providing the junior design class with a list of EM related questions would help them think independently and identify ways to add value. However, several student responses demonstrated a lack of an EM, including some comments specifically demonstrating inability to embrace the ambiguity associated with earning a '4'.

Students struggling with the ambiguity of a task is not unexpected and it is also what others have found when giving students open-ended, ill-defined problems to solve [15]. We recognize that when a challenge evokes too much emotion or too high expectations, it can lead to disengagement and loss of effort and learning. However, as we include more scaffolding in the earlier courses, we hope students learn what we mean by creating value in their project tasks, and we are optimistic that this will carry over into their project classes later in the curriculum.

In this study, we did not measure whether student mindset changed, rather just whether these mindsets were reflected by student comments in the course. These interventions (resubmissions and an EM focused rubric) created a learning environment where students can engage with and develop habits of an EM. Further studies are needed to show whether the student mindset changes because of these interventions.

This study has several limitations. First, coding of student comments was performed without independent validation, the coding was interpretive and several themes (e.g., persistence, resilience, and growth mindset) overlap, which could lead to both bias and variability in classification. Second, survey responses were voluntary and participation varied across courses, potentially introducing response bias. Differences in response rates may reflect variation in instructor implementation (e.g., time allocated in class) as well as self-selection by students with particularly positive or negative experiences. Third, both the course materials and most of the course instructors differed across courses, making comparisons across sections difficult. Fourth, the study relies primarily on self-reported perceptions and behavioral proxies (e.g., resubmissions) rather than direct measures of mindset development or value creation. Finally, this work was conducted within a single program and institutional context with relatively small sample sizes, which may limit generalizability to other engineering programs.

Conclusion

This study explored student mindset in response to the application of mastery-based learning in project-based courses, particularly how students engage with feedback and persist beyond checklist completion to create value. Findings suggest that students see value in, engage with, and act on opportunities to revise their work, with most teams taking advantage of resubmission to improve their project outcomes. At the same time, the results highlight tensions that arise when students are asked to move beyond prescribed requirements to create value—particularly with how such work should be defined and assessed within the rubric. While mastery-based resubmission policies appear to support persistence and iterative improvement, the entrepreneurially minded rubric requires further refinement to balance motivation with clarity. With targeted adjustments and clearer scaffolding, these approaches have the potential to create learning environments where students can more effectively practice and develop entrepreneurial mindsets in engineering project courses.

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Appendix A: Definitions of the Habits of the Entrepreneurial Mindset

There are many habits of the entrepreneurial mindset. We initially identified the habits we expected to see reflected in the student feedback comments (#1-4), but also allowed for additional habits for thematic grouping based on the student comments themselves (e.g., hence #5 was also included).

1. Persistence: develops resilience against setbacks, recognizes that setbacks and failures are a natural part of all success.
2. Initiative: takes proactive steps to make progress.
3. Resilience: bounces back from setbacks and recovers from failures.
4. Growth Mindset: embraces learning and feedback for development.
5. Embracing Ambiguity: develop comfort with uncertainty and decision-making when there is limited information.

Appendix B: Student Comments Justifying their Likert Scale Rating for the Resubmission Policy

EGR 201 – Community Project

Growth Mindset: Embraces learning and feedback for development.

"We were able to learn from our mistakes"

"Some assignments we didn't fully understand, so the chance to get feedback and resubmit was very helpful in us learning and getting better grades"

"It was worth it for improving grades, but also to better understand the instructors' expectations for the assignment"

"Since we could resubmit after receiving feedback, we were able to learn what we did wrong, and resubmit a document that consisted of much more quality work. This also helped us learn on other documents what we had to do."

"It gives us a chance to use feedback to perfect our work, which is how it works in a real engineering job"

"It helped me to see what was wrong and provide better work"

"Resubmissions allowed us to clearly understand the expectations and to complete the best work"

"It helped me better understand the instructors' expectations and improve my work if need be"

"Being able to resubmit helped me to improve my weaknesses more effectively"

"It helped me to correct small mistakes that I may have overlooked the first time"

Resilience: Bounces back from setbacks and recovers from failures.

"Resubmitting work saved our grade, since a lot of the time there was not example or clear explanation set for the assignments. This caused low scores for the first submissions. It also helped since different professors had different expectations and depending on who graded your assignment would give you a higher or lower grade for the same thing"

"Allowed us to gain points back"

"It allowed us to gain more points back"

Persistence: develops resilience against setbacks, recognizes that setbacks and failures are a natural part of all success.

"It was nice to see what we could improve on in our assignments and get a better grade"

"Getting feedback allowed me to turn in my best work"

"The resubmissions allowed us to give the best work we possibly could"

"If the assignments were confusing, we were able to read the comments and fix it"

"If the assignment was confusion, I was able to read the comments and fix it which made me work harder to get the better grade"

"It was valuable to see what should be put in each specific document to ensure it is professionally written."

"It allowed for groups to put the best product forward after some feedback"

"Much like I answered in the previous question, the resubmissions allowed us to refine our previously submitted work to make it the best that we could possibly have"

Positive but not directly EM related:

"We get more time to do it"

Lack of Initiative:

"We would get not quality grades for quality work. Some of the comments didn't make sense"

Lack of Persistence:

"We still lost points, should have been more of a grace period especially with our specific situation"

"We would get poor grades, and the resubmission definitely helped our grade. I sometimes think the feedback was just for us to do more work because some of the time it didn't even matter"

Lack of Resilience:

"Not everything is going to be perfect and there is always room for interpretation. There were times I thought I did my best work and spent a lot of time on something, but it just wasn't what the assignment was intended for"

Negative but not directly EM related:

"No, it just stressed us out more"

"Many times, the instructors made mistakes when explaining what to do with the assignments"

EGR 301 – Junior Design

Growth Mindset: Embraces learning and feedback for development.

"It forced me to go back to my work and look at what I did wrong."

"Resubmissions helped me better understand learning objectives that weren't as clear to me initially"

"I think it helps us to see what quality work is and how we can get our work to that point"

"Being able to resubmit helped me identify the flaws in our team's work and improve"

"It gave us a chance to reflect on our feedback and create a higher quality submission from it."

"While this process did seem a little frustrating due to the feeling that it was difficult to get a 4/4, it did help me to go back and see errors that I now know to look for or stay away from in my writing or calculations."

"Being able to resubmit helped me identify the flaws in our team's work and improve. The feedback also helped me for future assignments as well."

"It allowed for me to see where I can be better in writing documents."

"It is crucial to get feedback and have a chance to improve without getting penalized."

Persistence: develops resilience against setbacks, recognizes that setbacks and failures are a natural part of all success.

"My resubmission attempts gave me a second opinion which I could use to polish up my work."

"If I did not understand what I needed in the original submission, I was able to get feedback and try again."

"Resubmissions allowed us to gather feedback and better revise our work instead of blindly submitting and accepting the grade."

"You get to make it the best it can be."

"Because of how the course changed, some of the assignments weren't worded/described in ways that helped us get a 4. The resubmission process allowed for that grace period and allowed me to continually elevate my work."

"We had a chance to fix our submission"

"Sometimes I felt like we were able to just submit something to get graded and then receive feedback. So the first submission might not have been the best work but the second or third was based on the feedback."

Resilience: Bounces back from setbacks and recovers from failures.

"It provided us with an opportunity to learn from our mistakes without harshly impacting our grades."

"We wanted to do good work on the first go around, but because we could resubmit there was the general mindset of "we don't need to go all in on the first draft so lets just submit now and rework later"

Initiative: Takes proactive steps to make progress.

"I like that we can resubmit because if somebody on the team is slacking and not putting in quality work, it allows those that actually care about their grade to revise it so we are submitting quality work."

Lack of Initiative:

"I definitely enjoyed having the resubmission option, however I do think that the quality of our first submission was worse because we knew we could resubmit. AND I like that we can resubmit them"

"I felt that there was a guarantee that no matter how hard we worked on the first submission there would be comments telling us to do more or we did something incorrect. I felt towards the end of the year it was better to not try as hard on the first submission just to find out what was actually wanted in the assignment."

"Revisiting work is helpful, but finding time to do so while there are so many other assignments to do at once can harm our quality sometimes."

"It was nice being able to get feedback on resubmissions, but it was a lot of work on us and also the professors to try and give feedback on the assignments. I think having a little more specific rubric for just one submission might take pressure off the professors and students."

Lack of Persistence:

"I felt that our first submission usually wasn't the best because the due dates came up too fast. I didn't like how we basically had to rush our first submission and I felt like we weren't able to submit quality work. Then when we needed to resubmit we had more assignments to work on and we started to get swamped with work, causing us again to not submit the best quality work."

"Allowed us to receive a better grade on poorly done assignments, but I feel like it raised the bar for what is expected in a single assignment. Made it difficult to receive a 4/4."

"I like the idea, but one of my teammates made all these changes and additions and got the same grade with no comments added so that makes it seem useless."

Lack of Growth Mindset

"It seems grades were based on the number of resubmissions not the quality of work."

Appendix C: Student Comments Justifying their Likert Scale Rating for the 4pt EM Focused Rubric

EGR 201 – Community Project

Growth Mindset: Embraces learning and feedback for development.

"It lets you know exactly where your skills are at"

Initiative: Takes proactive steps to make progress.

"The 4 point system motivated use because we did not want a ¾ to bring our grade down."

"It meant that even small errors took 25% off the assignment grade, motivating us to be perfect."
"Having higher amounts of points was motivating"

Positive but not directly EM related:

"I like the 4 point system. I think it worked well."
"It felt like a simple, straight-forward way to get graded on assignments"
"Not all quality of work should boil down to a grade, but a strict outline definitely ensures we have the essentials in our reports. The grading also allows interpretation so each group can have their own style."
"Everybody wants a 4"

Indifferent comments:

"I feel that it was okay. I think some more guidance would help and what they would like."
"It was an adequate way of grading, but did not allow for much "in between" grades. If you did not do an assignment perfectly, your grade was impacted significantly."

Lack of Growth Mindset:

"It made me stress more to do the work, and we put in so much time. We did not earn a good grade like we deserved for how much time and effort we put into the work we did."

Negative but not directly EM related:

"I feel like this system leads to only wanting a 3 or 4. Although this is what should be targeted, I feel like saying a 2 is adequate isn't a strong choice of word as if every assignment was adequate, then you would have a 50% (not adequate in most applications)"
"I think it limits the assignments down so they don't have different importances and all mean the same."
"Difference of quality between $\frac{3}{4}$ to $\frac{4}{4}$ is slim, yet the difference in grade is 25%. This is a bit too big of a jump in my opinion."
"I personally don't like the point based system because the tiniest thing would give us a $\frac{3}{4}$ and bring our grade down tremendously"

EGR 301 – Junior Design

Initiative: Takes proactive steps to make progress.

"Achieving a 4 was seen more as a nice to have rather than a necessity but it did encourage us to put forth more effort in assignments."
"Everyone wants to get the best grade, but to do that you must go above and beyond, therefore it made me want to do the best."

Positive not categorized:

"I do agree with but i don't have a reasoning"

Indifferent:

"It doesn't matter much to me how you grade assignments. As long as the expectations are defined, I can't complain."

"I think the 4-point system is good, but it feels like there's a glass ceiling at $\frac{3}{4}$. It's different enough from other classes where full effort gets me full marks. Overall, I was ok with the grading."

"The scale didn't motivate or demotivate our team. It just feels like another grading standard."

Lack of Persistence:

"Sure it is a motivating factor, but I think it is implemented poorly. I understand trying to motivate people to do better work with the fours, but I feel like it is borderline unfair. There are times where I believe that the only way to get a four is to use all of your resubmission attempts"

"I don't like that if we submit exactly what is asked for in the assignment, we don't get a 4. I think that is we submit exactly what is asked for and we do it well, we should get a 4. and if a team goes above and beyond, maybe that's an extra credit opportunity or something. I've done my best and tried hard on these assignments only to get a max 3.5."

"I would get a $\frac{3}{4}$ on an assignment which meant we worked very hard and did what the assignment asked for. This is a 75% in the grade book which seems unreasonable."

"This gave us poor judgement and minimal room for error. If anything I wish the score gap could be a little more forgiving."

"I disagree with the use of the 4-point grading scale. I don't think it's fair that completing all parts of an assignment correctly only earns a 3 out of 4, and that we are expected to go "above and beyond" just to achieve a full score. It's extremely discouraging to spend so much time and effort making sure we thoroughly follow the instructions, only to be told that meeting expectations isn't enough for a perfect grade. It feels like our hard work isn't being fully recognized.....That inconsistency makes the grading system feel even more unfair and demotivating."

Lack of Resilience:

"We felt like we received a lot of 3's and that it was almost impossible to get a 4. Therefore, it made it difficult sometimes to get motivation to do our best work."

"The fact that a 4 required going above and beyond what was asked for in the instructions made it feel a bit vague in what was really wanted for an assignment. I sometimes felt discouraged knowing that all the hard work I put into an assignment would only get me a $\frac{3}{4}$, or 75%, on it. I'm used to that being a C, which I feel is below what I consider an acceptable grade for myself. I felt forced into a no win situation."

Lack of Initiative:

"Knowing that we could fill every checkbox and still get a mediocre grade removes the sense of reward from completing quality assignments."

"As a college student, we are going to be doing work that is intern work, so with that in mind, I should be getting a 50% on all my assignments? This is not fair at all and that is why we are in college, to learn. Going above and beyond to get a 4 would take me more time than I should be putting into a 2 credit class. The grading in this class really upset me and made me like engineering less."

"Getting a 4/4 was particularly difficult, especially when it isn't necessarily outline what is expected or wanted. Sometimes it felt unclear or unmotivating to get that 4/4, and I found myself settling for a $\frac{3}{4}$ a lot of times."

Lack of Embracing Ambiguity:

"I think it is very hard to know you are getting a 4 since the rubric is only a 3"

"As long as the goal is clearly detailed, the 4 point system works. It is when the conditions are not stated that it becomes unfair to ask more of students without guidelines to follow."

"I understand the whole point of it and the motivating factor it should have, however I feel as if there were more examples of how to get a 4/4, then I feel like I would be more in favor of it. Right now it seems as if it is very rare to get a 4/4 on an assignment."

Lack of Growth Mindset:

"The definitions that each professor gives on what constitutes a "4" is completely different and they all grade on a scale that isn't strict to the 1-4 system."

Negative but not directly EM related:

"I like the idea that each assignment is worth the same, but I think it was a bit confusing to when I would get a 4 on one assignment and then a 3 on another, when I felt the quality of work was about the same for each"

"With this format there shouldn't be partial points like 2.5, 3.75. Establish a system and stick to it."

"Because of how canvas stores grades, this rubric means it's nearly impossible to determine how we are actually doing in the class, and the syllabus isn't very helpful as to calculating our current grade."

"I believe there should be half points in this level because it sometimes when just one thing is wrong it drops the grade to a 2."

"Also, it's frustrating that grading can vary so much depending on which professor is evaluating the work. At this point, it feels like we can almost predict the grade we're going to receive just based on who is grading, not necessarily the quality of our work"

"Earning the 4 doesn't make sense to me completely because to earn it one of the requirements is to explain what extra was added. I'm not sure why grading should rely on the person telling you what they added. I think it should be determined on the work they produce and they shouldn't have to tell you where they added more. It should be noticeable if it's better than other submissions."