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Exploring engineering students' self-reported feedback needs in an art in engineering Class

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WIP: Exploring engineering students' self-reported feedback needs in an Art in Engineering Class

Introduction & Background

An important component to student learning and growth in educational environments is feedback. Feedback is broadly defined as any information given to a learner on their performance or understanding [1]. While there is ample evidence in research regarding feedback's effectiveness related to student learning at all ages and across many topics [1], significantly less research has been done exploring students' perspectives on feedback and its utility in their learning. Gaining and understanding of student perspectives on feedback is important, as it can help instructors develop more strategic and student-centered ways to implement effective feedback practices in our classroom environments.

In any of the numerous variations of the engineering design process that have been published, illustrated, and taught in engineering classrooms, one step is consistent across them all - "improve" "iterate" "refine" - a step that is dedicated to making changes to a design based on the inclusion of additional information. In many engineering design processes this additional information comes from the preceding step of "test" or "evaluate" or "gather feedback". The purpose of the 'change your design' step is to make improvements such that it performs to better meet the needs and criteria of the design and its stakeholders. The skill of gathering additional information in one or more ways to make adjustments and improvements to designs is an important skill to develop for engineers, one that students have been shown to lack compared to practicing engineers [2].

This idea of gathering additional information to make improvements to one's design functions similarly to the purpose feedback serves in learning environments. The functional purpose of feedback is to provide learners with additional information that allows them to reflect upon and make improvements to their own knowledge or performance, ultimately helping them close the gap between where they are and where our course learning outcomes require them to be [3]. The purpose of this WIP paper is to report on students' self-reported feedback needs and discuss how the students' self-identified feedback needs could inform future research and pedagogical decisions in how to give feedback to students in design-focused learning environments. The data presented in this paper provide insight into the types of feedback and additional information students seek when working through the engineering design process. We will close by connecting the results of students' self-identified feedback needs to both research opportunities and pedagogical recommendations.

Engineering Course & Context

The data come from the first iteration of a new course, “Art in Engineering”, taught in Fall 2022. This course was designed to help students connect artistic and creative principles to the engineering profession, and to use art projects to develop engineering skills. The course learning outcomes were to 1) Explain the utility of art in engineering; 2) Explain the uses of engineering principles in the creation of artistic works; 3) Apply engineering principles to the creation of artistic works; 4) Discuss the influences and interactions of the engineering profession and the art world; and 5) Explain ideas to both engineers and artists. Most of the 29 students enrolled were in their first semester of university studies and therefore had not yet declared their specific engineering disciplinary major, as this is done after the first year at the authors’ institution.

Class sessions typically followed the structure of a brief topic introduction, small group and class discussions on the topic, a creative activity exploring the topic, and a summative class discussion. In addition to the in-class activities, students were asked to create seven works of art outside of class of increasing scope, with one to four weeks to complete each. Most of these projects also had a loose organizing theme, such as physics, history, or engineering experiences. Students were able to choose any artistic materials or media they liked. As each piece of artwork was due, students brought their works to an in-class exhibition, where all students viewed and discussed each others’ work.

The instructor made the intentional decision to limit their own feedback to in-class appreciative or constructive comments, and instead focused on peer feedback processes, with lessons to students that were adapted from the Critical Response Process [4]. In this process, the artist has control and ownership of feedback delivery. Since there was such variability in skill, subject, media, emotional expression, and experience, the focus was meant to stay on intent and personal progress, and the instructor did not want to imply criticism or comparison. Instead, students asked for feedback from each other on the areas in which they felt comfortable asking for feedback. Students were also encouraged to offer compliments. This feedback was a major theme in in-class activities and as such saw participation from all students present, but was not reflected in their grades. During each feedback activity, the instructor provided guidance and help to increase the efficacy of the activity, both at the beginning of the activity, and dynamically in response to class discussion. Students were expected to apply the feedback and lessons from each other to their subsequent works of art..

One author was the instructor, who developed and facilitated the first iteration of the course. This author is a collegiate faculty member in engineering education, with a strong interest in the success of the course. They enjoy a wide variety of artistic and creative activities in their personal and professional lives, and seek to create opportunities for their students to do the same in all courses they facilitate, as well as in their various university service roles. The second

author is also a collegiate faculty member. While not affiliated with the art in engineering course one of the second author's research specializations is feedback in engineering classrooms.

Student Data

To collect students' responses related to their self-reported feedback needs/preferences as well as feedback they had for peers exit-ticket surveys were used [5]. While exit tickets were used in each class, questions explicitly asking about feedback were included in week 5 and week 10. The questions given each of these weeks are provided below.

> ***Week 5:*** What kinds of feedback would you like the teaching team to give you for your art?
> ***Week 10:*** What other kinds of feedback would you like from your peers about your creative work?

After IRB review, students' answers to these questions were reviewed at the end of the semester in a de-identified manner to gain insights into students' self-reported feedback needs with regards to their designs. All student responses were read and commonalities amongst responses were identified in an effort to identify what was salient across multiple students in the course. Then, instances of response commonalities were quantified and compared across each of the three weeks in which feedback was explicitly asked about in the exit ticket. The results of our high-level initial thematic analysis of student exit-ticket responses are expanded upon and discussed below.

Presentation & Brief Discussion of Initial Findings

Initial Finding 1 - Certainty & Specificity

The first notable characteristic of students' responses to week 5 and 10's questions asking what feedback they would like to receive was the apparent certainty (or lack of certainty) in their responses. In week 5, 10 out of 29 respondents said they weren't sure or started their responses with the word "maybe" or "probably" - words that are commonly associated with varying degrees of uncertainty [6], [7]. In week 10, this was only the case for 5 out of the 29 respondents.

The second notable characteristic of students' responses to week 5 and 10's questions was the presence of lack of specificity of their feedback requests. Students' self-reported feedback needs were considered specific if they identified an aspect of their project they wanted further feedback on. Examples of responses that were considered specific and not specific are shown on the next page.

Specific	"Feedback about if the art fits the given prompts." "Different approaches for the mediums that I used." "Did the concepts/ideas of inspiration come through?"
Not Specific	"What I can work on to better future projects." "I can't think of anything else that I would like to hear from my peers" "I would like some small improvements or other suggestions"

Overall, more students were able to specifically articulate the type of feedback they would like to receive over time. In week 5 only 13 out of 29 responses were classified as specific, whereas in week 10, a total of 17 out of 29 responses were classified as specific.

The increase in the number of responses that were both certain and specific are not surprising given that time in class was spent discussing feedback, its purpose and mechanisms, and how it is used in artistic and design spaces. Research has shown that both the clear communication of learning outcomes and continued and targeted practice leads to increased learning gains for students [8].Accordingly, in-class discussions and activities related to feedback built students' confidence and specificity when describing feedback they thought would be useful.

Initial Finding 2 - Critical vs Positive Feedback

An additional aspect of students' responses to week 5 and week 10's questions was the fact that many students self-reported looking for feedback with critical elements - specifically looking for "constructive criticism" or ways to "improve" or "make better". In week 5, 11 out of 29 responses claimed to seek critical feedback, whereas in week 10 only 7/29 responses indicated wanting this type of feedback. Only two responses on each date explicitly asked for "positive feedback" or "nice comments". We found it notable that so many students requested feedback that communicated possible shortcomings or less appealing aspects of their design. Research on students' reactions to feedback also indicate these mixed feelings of critical feedback, as students have been known and recognize that the feedback functions to improve the quality of their work and understanding [9], but also express that criticisms of the identification of shortcomings also cause negative emotions [10], [11]. What may have also caused this difference was the sources of the feedback in each question. Week 10's question asked what feedback they'd like from peers, while week 5's questions asked about the teaching team. While engaging in giving peer feedback has been shown to benefit student learning [12], students also have indicated in research that they find peer feedback less trustworthy than instructor feedback, given that peers are not as experienced in the content, nor do they ultimately score the assignment [13].

Implications for Practice & Future Work

These initial results have some implications for course administration in creativity- and design-based engineering courses. Firstly, as students practice their creativity skills and offer each other feedback, they may benefit from guidance and lessons in developing confidence and specificity in their requests. Based on the initial results of these exit surveys we recommend that more intentional opportunities for students to practice requesting and giving feedback that is clear, specific, direction, and actionable be incorporated into design classes. These opportunities are beneficial to students, giving them explicit chances to 1) practice reflecting on their design and the feedback they believe will be most beneficial (including details such as who the feedback should come from, how quickly the students need the feedback, what details should be included in the feedback, etc.) as well as 2) practice giving valuable feedback on peers' designs. As such, the second author will be adjusting the feedback practice process in the "Art in Engineering" course to incorporate more examples for the students and opportunities for practice.

Secondly, the instructor's concerns about how students who had not necessarily had much art education would respond to critical feedback on their artwork were not supported by these results. While support and kindness are important in assessing and critiquing student work, especially with a personal and emotional component, we found that it is still useful and desired by students to offer feedback that points to opportunities for improvement both in terms of technical proficiency and artistic intent. Based on the data in this paper we recommend making intentional time for class lessons and discussions related to the purpose of constructive feedback as well as integrating opportunities in the design process for students to receive, reflect, and act upon constructive feedback. By taking these steps we can create a learning environment that both rewards student work and growth, but also develops students' skills in viewing 'critical' feedback as opportunities for improvements. Based on our own results there are plans to revise the feedback process in the Art in Engineering class to include more of their own critiques and interpretations of the art, and scaffold that more clearly for peer feedback processes.

Avenues for future research in the area of feedback to engineering students in design-based learning environments include the explicit study of how students engage with feedback practices - both actions of giving others feedback and utilizing feedback they have received. We hope to pursue this line of inquiry in the "Art in Engineering" class, but we also encourage other researchers and educators to do so in their own design-based courses and projects. The more intentional integration of opportunities to offer and act on feedback in the design process offer us as researchers a chance to gain insights into how students request, give, and use feedback in their design processes.

Additionally, we also noted that the instructor's experience of developing creativity- and art-based courses and activities involved a variety of concerns about fit, disciplinary connection,

and the course content being seen as “not engineering”, although examples of art and creativity can be found in K-12 STEM education activities. We also believe that it would be worthwhile to study the motivation and experiences of instructors who develop and deploy activities that integrate engineering with subject areas or topics that are commonly seen as “not technical” or “not engineering” such as the second author did with his creativity- and art-based activities and course.

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