Pay It Forward: Use of a Course-Based Discussion Platform to Deepen Content and Professional Knowledge in an Engineering Project Course

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***Abstract*—This innovative practice paper describes how an implementation of a course contributions grade improved the learning experience and contributed insightful perspectives and knowledge that will also benefit future cohorts. Research shows that student participation during class can improve the learning experience, yet active participation remains a challenge given the limitations and preferences of everyone involved. Therefore, instructors continuously ideate tactics to allow students to feel motivated to participate, such as the opportunity to earn credit for their effort and describing how their effort will lead to developing skills in areas such as analysis and communication. The practice detailed in this paper applies tactics such as student communications are guided by a non-trivial grading requirement with instructions on what constitutes a contribution to the course, participants embrace inclusive and equitable opportunities for contributing during class meetings and through our online discussion platform, fostering a sense of community where informal positive interactions are not only allowed but actively encouraged, and course staff continuously participate and support the students' contributions providing context to the connection of their ideas with the professional skills they are developing. This practice was implemented in a multidisciplinary engineering senior design course, where for the most recent cohort of 92 students, over 80% contributed on three or more occasions per semester, improving the learning experience for all stakeholders, and to a greater extent and unbeknownst to the students, providing an enduring impact by shaping a comprehensive and insightful course knowledgebase of student perspectives that transcends their academic term. This paper describes the common challenges instructors face with students actively participating in the class, how the mix of innovations presented address these challenges, and includes example contributions and interactions with analysis of their impact towards the current and future course cohorts. The translation of this practice contributes to the educational goals of enabling students to have the ability to effectively communicate and work within a team, to exercise professionalism, and to apply their knowledge. This paper offers recommendations to inspire instructors to enable active contributors in their classes and advance the research of maximizing student course contributions.**

Keywords*—*Student-Participation, Student-perspectives, Active-learning, Interactive-learning, Student-contributions

I. Introduction

Most course instructors care about their students learning and therefore appreciate feedback from the students. If that feedback occurs during class, then the student can obtain an instant response to assist with their learning experience, plus the other participants can also learn from that exchange. Most educational research shows that active discussions during class improve the learning experience of the participants. Unfortunately, active participation during a class is a challenge for multiple reasons discussed in the literature below, including limitations and personal preferences of everyone involved. Therefore, active and engaged learning is an ongoing educational research topic.

This study describes an example where student participation was required, and it worked well. The goal is to share this experience, analyze what went right and discuss research questions to build from this experience. These results should help instructors with strategies to inspire contributing students.

II. Literature Review

Class participation denotes student involvement in class activities and is considered an integral activity within active and interactive learning, which are two of the cognitive engagement modes of the ICAP framework [1]. For example, active learning can include students interpreting the material and asking the instructors for confirmation, while interactive learning can include students asking questions that generate further questions and answers from their peers and the instructors. In practice, these learning activities can be immersed into any engagement mode to provide students with multiple levels of cognitive engagement. Hence, multiple studies on class participation have concluded that classes with active and engaged students participating during class meetings, enable higher academic achievement for participants [2]-[4].

In engineering and computer science education, the academic accreditation ABET includes as student outcomes the ability to communicate effectively with a range of audiences and the ability to function effectively on a team whose members together create a collaborative and inclusive environment [5]. Actively participating in class will help develop the skills for those outcomes. Other perceived benefits of class participation for students are exposure to a diversity of perspectives, increased motivation to take responsibility for their learning, encouragement for social interactions, development of respect for others' points of view, increased intellectual agility, improved capacity to critique peers in a supportive environment, and provides opportunities for instructor feedback [3],[6]. Participation can also help build collaborative thinking skills by

designing activities through a collaborative lens, which is the process of people coordinating their thoughts to negotiate shared understanding and accomplish shared goals [7].

Implementing active participation in a class is a challenge for multiple known reasons, including limitations and personal preferences of everyone involved. Multiple course reviews have shown cases where most of the students did not engage in participations [8],[9]. Researchers have also studied the factors that influence students' willingness to participate during class. One such paper concluded that the most influential factor is student proficiency, followed by the student's character, whereas grading was not a significant factor [4]. Nonetheless, given the multiple benefits of engaged learning, instructors continuously have utilized several tactics and leveraged technology to provide students with opportunities and resources that encourage their participation [3],[8]. These tactics must allow students to feel motivated to participate, which often entails being driven by the opportunity to earn credit for their effort (grades) and having the confidence that their effort will help develop skills in areas such as analysis and communication.

Multiple studies have explored how grading participation impacts the learning experience for their class and results have varied [2]-[4],[6],[8]-[11]. In one study, the instructor had environmental engineering students present relevant published articles to the class and generate discussions with their peers, then, and quantified the procedures to assess their participations [10]. While some students complained that tracking participation forced too many students into sharing low quality comments for the sake of scoring points, in general the students believed the grades assigned were fair and no student felt the process unfair. Still, grading participation can be hard to track, highly time-consuming and prone to subjective biases. Therefore, for everyone's benefit, when integrating grading into course participation instructors must make clear from the beginning of the course what are the expectations and criteria for these evaluations. Instructors should consider using a rubric for grading that clearly describes what is considered participation and providing periodic grading updates and feedback [2],[3],[7]. For example, in [12], participation was defined as taking part in the social dimensions of a class, while contribution implies participation with an intent to share intellectual knowledge. Therefore, instructors expecting contributions may consider providing students with content-specific examples of "contribution" and "participation" comments [9].

Other challenges regarding assessing student participation in class include subjectivity and consistency in assessing the quality of the participation, peer pressure, and personal preferences towards public speaking [3]. Similarly, instructor behavior is significant in encouraging student participation. For example, in [13], students reported being influenced by the instructor speech rate, eye and body language, reinforcing answers (versus rectifying, scolding or nitpicking their answers), and the provided time for reflection and discussions.

A. Tactics to Inspire Student Participation

Aside from the implementation challenges, perhaps the biggest challenge for enabling student participation is that a significant number of students do not appreciate applying these skills during class. While most studies of active learning implementations show positive results, there are concerns about engineering student resistance to these type of engagement modes [14]. One study comparing the ICAP learning modes found that student involvement in class activities was highest during passive instructional activities [15]. Naturally, every course will include students that are not prepared to participate verbally for reasons unrelated to the class such as anxiety, lack of confidence, introversion, cultural background, and previous negative experiences [6]. Furthermore, recent cohorts of students who are mostly Gen Z, have preferences and limitations that often mean avoiding synchronous verbal interactions during class, in favor of asynchronous text-based interactions through online channels [16]. Thus, research on aligning the expectations of academia and industry with the preferences of students will remain continuous with the understanding that as both sides evolve through generations, pedagogies must continually introduce innovative practices.

III. Synthesis and Extension

Inspired by the literature discussed above, this section provides a list of tactics to enable students to become active participants in class discussions.

- Instead of participation, students should be encouraged to contribute to the course, i.e., the success of the course experiences relies on their willingness to share their intellectual knowledge and challenges with their peers and instructors.
- Student contributions should be induced by a non-trivial grading requirement with clear instructions on what constitutes a contribution to the course, how these will be tracked and how they will be graded. Instructors must provide feedback periodically on their performance.
- Instructors must provide multiple modes for contributing, i.e., verbally and text-based channels.
- Course plans should include topics and time for discussions, plus time for student introduced topics.
- Verbal interactions during class should encourage intellectual exploration, expanding into conversations welcoming others in the class to join, rather than quick one-on-one, Q&A style recitation exchanges.
- Instructors should also actively participate in the online discussions and support the student contributions, providing context to their ideas with course content and the professional skills they are developing.
- Instructors should discuss during class time significant topics discussed online, to demonstrate that online discussions are an integral part of the class interactions.
- Instructors and students must embrace inclusive and equitable opportunities for contributing, fostering a sense of community where informal, positive and critical interactions are not only allowed but actively encouraged.
- Instructors can create opportunities for discussing tangential topics and utilize various discussion formats, to enable opportunities to enhance student confidence.

IV. Context and Methodology

The practice described in this section is based on data collected from a senior level engineering course and follows a qualitative methodology developed for the course assessment.

A. Participants

Data was obtained from a large public institution in the Southeast region of the United States, through an engineering capstone course sequence during the fall 2023 and spring 2024 semesters respectively. This cohort had 92 students from ten engineering and computer science programs. The exact demographics for this cohort of students was not determined for this study, nonetheless, another study including most students from this course during the period of 2021 through 2024, disclosed that 68% identified as male and 27% as female, while for race, 52% identified as white, 20% as Asian, 20% as Latin, 2% as black and 6% as other [17].

The 92 students were grouped into seventeen teams, each assigned to a unique industry sponsored project. Naturally, the course follows the Constructivist pedagogical framework of Problem-based learning for the engineering objectives [18]. This course-sequence also has the objectives of providing students with the experience to develop teamwork, leadership, management, communication, and people skills, for which all the learning modes of the ICAP framework are intertwined. Students experience most of the Passive learning mode during the first half of the fall course, while the I, C and A occur throughout the year as they design, develop and test their project solutions. Student communication skills are continuously developed throughout all learning activities.

The capstone program that runs the course has six staff members, including the assigned instructor, the Lab Manager and the Course Assistant (part-time graduate student).

B. Inducing Course Contributions

The course includes a *Class Contribution through Participation* assignment (CCA) that weighs 5% of the total course grade, with two modes for participation, in-class and online. Fig. 1 shows an abridged description of the assignment. The course staff persistently persuaded students to share opinions, questions, and learnings with the whole class, kept track of their contributions, and ensured equitable, inclusive, and constructive support to the students. For example, staff would initiate a reply with "that's a good question" and provided perspective to demonstrate how the topic applied to other teams as well, thus motivating further discussions. Students were encouraged to collaborate outside of their teams through weekly activities such as presentations during class with time for peer feedback discussions, rubrics for documented feedback, and online discussions outside class meeting time.

For online discussions, students could use the course Microsoft Teams Class team channel (MSTC) and the Canvas Discussion Board, though they only used the Teams channel. The MSTC has a General Channel (MSTC-GC) where course-wide announcements and discussions take place, plus it hosts various apps which students needed to use for course tasks. Each student team had a private channel within the MSTC, which they used as their project repository, for meetings, and most teams used it for discussions and managing additional apps they added.

> The course instructor will provide a grade based on the impact and number of participations you had during the semester, as described the first day of class.
>
> Participation criteria:
>
> - Contributing to the lectures with information or questions
> - Contributing to the guest lectures with appreciated questions and feedback
> - Contributing to the peer presentations during lecture with appreciated questions and feedback
> - Contributing information or questions through our 24/7 online course-wide channels. Bonus points if eliciting positive reactions from the course staff.
>
> Grading, based on the rubric provided to students:
>
> - Each week you may accumulate up to 5 points per participation criterion. Up to 5 points for original contributions and up to 3 points for follow-ups, based on the significance of the contribution to the class.
> - A perfect grade will accumulate X points by the end of the semester. (X = 25 in fall, X = 30 in spring)
> - (shared example) On a class meeting day where we have lecture, team presentations and a guest speaker, a student could potentially accumulate 15 points for this grade. If that same week, the student also makes a significant contribution online for 5 more points, it could be a 20-points week.

Fig. 1. Abridged instructions for the Class Contributions assignment (CCA).

The CCA grades were updated monthly to allow students to monitor their official progress and update their plan for this assignment. Students would continuously monitor their credit obtained for the CCA and reach out to the staff when they deemed credit was not given. As described by them, for some a low grade would persuade future contributions, while for others attaining the grade they wanted was enough to hold back on contributions, either for inner peace or to allow space for others.

The description of the CCA during the first meeting was somewhat vague defining "significance of the contribution", to allow the staff to gauge the initial class reaction. Upon the first monthly grade update, a discussion in class clarified most questions about the assignment. "Significance" was described as "anything that leads to shared knowledge or appreciated questions". Students were encouraged to "just talk and allow yourself to be heard". The topic was revisited after the second and third grade updates, and reminders of the assignment were given at the beginning of all class meetings.

Text-based replies such as "I agree" or "Thanks", and reactions such as "likes" were not considered contributions for grading purposes. The instructor used similar reactions as well, which based on anecdotal evidence, may have inspired additional replies. Inversely, in-class verbal communication usually contained enough substance to gain points and thus more likely to obtain contribution points compared to online.

C. Data Collected

The Results and Discussion section in this paper includes the the number of contributions credited to the students and content from these contributions. It also includes student perspectives extracted from a course evaluations assignment students completed at the midpoint and end of each semester. As all data included hereafter is extracted from regular course activities not created for research purposes, the Institutional Review Board classified it as not applicable for review.

V. Results and Discussion

Table 1 shows the results of contributions for each semester.

TABLE I. Tallied Contributions for the Course

Term	Number of Students out of 92 who:					
	Contributed through			*Did not Contribute*		
	Verbal in class	*MSTC-GC Posts*	*MSTC-GC Replies*	*Verbal in class*	*MSTC-GC*	*Neither in-person or online*
Fall	86	59	79	6	10	0
Spring	72	42	70	20	7	3

Students could provide verbal contributions during the ten class meeting days in fall and nine days during spring, each with a duration ranging from one to three hours, with the average close to two hours. During fall, 86 students (93%) contributed verbally and during spring 72 students (78%) contributed. Fig. 2 and Fig. 3 show histograms for the number of credited verbal contributions per student for each semester respectively. During the fall semesters, contributing students had between one and three participations, with two the most common value. During spring, the maximum value was nine, with zero the most common at 20 students, followed by two again, with 19 students.

For the fall semester, 82 students (89%) gained contribution credit through the MSTC-GC, by creating approximately 175 posts and 564 replies to these posts. For the spring semester, 74 students (80%) gained contribution credit through the MSTC-GC. Near the end of the spring semester there was an optional activity for the CCA where students provided feedback for project posters, which were posted by a member of each team. The assignment had 50 participants who generated 184 replies. In total for spring, students created approximately 119 posts and 565 replies to these posts. The word “approximately” is used to account for possible errors either manually counting these or due to deleted posts and replies.

Fig. 4 and Fig. 5 show histograms for the number of MSTC-GC credited contributions per student, for each semester respectively. For a fair comparison between semesters, the results in Fig. 5 do not include the posts and replies for the poster assignment, since this was a prompted activity rather than a voluntary contribution and had minimum impact towards further contributions. Fig. 4 shows that for fall, 60% of the students made six or more credited contributions, with almost 30% making between six and ten contributions. For spring, Fig. 5 shows that 36% of the students made six or more credited contributions, 20% made between six and ten, and 25% made between three and five.

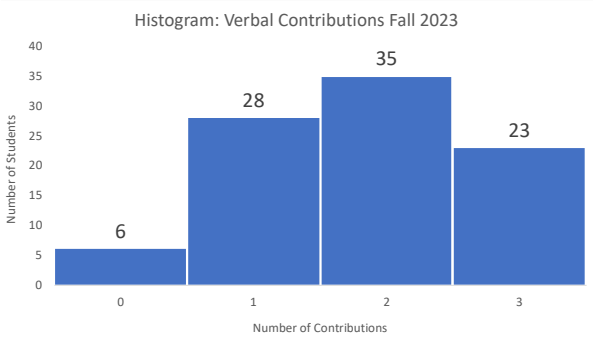

Fig. 2. Histogram of the number verbal contributions by each student during the Fall 2023 semester.

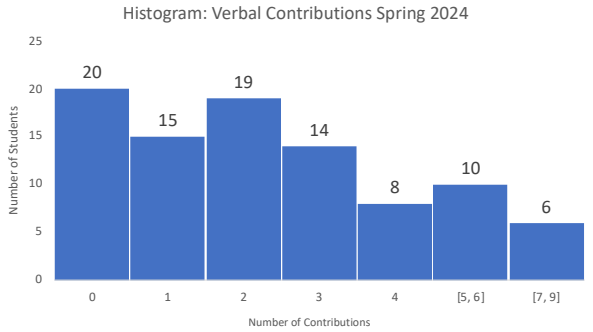

Fig. 3. Histogram of the number verbal contributions by each student during the Spring 2024 semester.

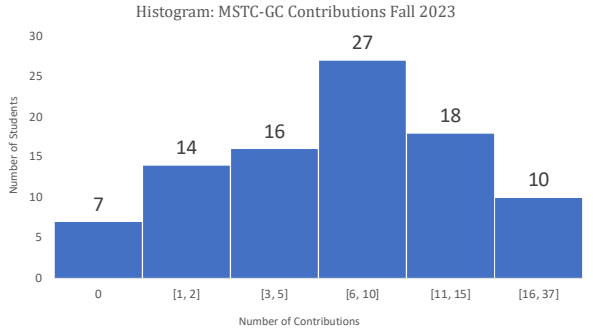

Fig. 4. Histogram of the number contributions by each student through the MSTC-GC during the Fall 2023 semester.

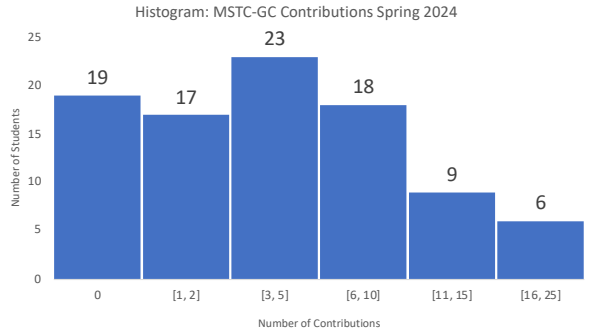

Fig. 5. Histogram of the number contributions by each student through the MSTC-GC during the Spring 2024 semester.

Combining both verbal and MSTC-GC contributions, for the fall semester, all 92 students (100%) obtained contribution credit and 82 (89%) students had three or more contributions. For the spring semester, 89 students (97%) obtained contribution credit and 77 (84%) students had three or more contributions.

For the fall semester, 55 students (60%) obtained the full 25 points for the CCA. Of these 55, 51 participated online. Of the 37 students who did not obtain the full 25 points, 6 did not participate online. For the spring semester, 34 students obtained the full 30 points for the CCA, all of which participated online. In contrast, of the 58 students who did not obtain the full 30 points, 7 did not participate online. The exact reasons for which students did not maximize their grade or utilize the online option for their contributions grade are not clear. Based on overall student feedback, the two most prevalent reasons were (1) they did not need these points to pass the course with their expected grade, and (2) they did not have interest in further contributing. The first reason was especially true in the spring semester, as the course grade breakdown in the syllabi are similar.

Considering the positive results above, subsections A and B describe additional implementation details and student feedback of the tactics towards inspiring students to contribute.

A. Inspiring Verbal Contributions

Class meeting started with mainstream topics relevant to the class and discussed openly. Staff supported all student opinions, encouraged fair counterarguments and maintained attentive eye contact and body language. Often times the instructor did not immediate respond to every request, instead yielding to discussions between students. The course plan included ample for student contributions. Most planned instructor questions were open-ended, about current student experiences, and if applicable, considered for revised course expectations. Close-ended questions were used to foment students speaking up, to confirm lecture information was received by students and as a repetition to those who missed the information. These quick questions were often answered by multiple students simultaneously, without raising hands, and not counted towards the CCA. Nonetheless, for some students, merely participating in these would provide motivation or confidence to contribute on future opportunities.

Cold calling students with questions was not implemented, but cold calling teams was used. Teams would have a volunteer or decide at the moment who would speak. Team presentations were not considered for the CCA, but feedback from the class was counted and these presentations were indeed successful in inspiring audience contributions. Often times the informality of the presenting team, and sometimes the experience of having gone through that activity, would inspire the audience to contribute to the presentation with constructive help, positive feedback, or questions for their own benefit. Sometimes the instructor asked easy questions to help them convey their message or supplemented anecdotes from past teams to inspire further discussion. Discussing the student course evaluations was another highly successful event for stimulating discussion.

Initially, several students disclosed that they did not appreciate providing verbal contributions, and to a lesser extent, providing online contributions either. The CCA was 5% of the course grade, enough to sway half a grade point for the course. While some students found contributing a natural activity, others found motivation whether they were goal or performance driven. In some cases, their teammates would share their CCA progress and inspire them to make progress as well. By the final course evaluations, under 10% of students disclosed issues with the CCA for either not appreciating providing verbal contributions or disdain for the discussions from their peers, regardless of verbally or online, as they viewed these as “wasting everyone’s time for CCA points”.

B. Inspiring Contributions through the MSTC-GC

As expected, there were many more contributions online compared to verbally during class time. To help motivate use of the MSTC-GC, the course staff was active in the channel, creating approximately 68 posts and 185 replies during fall, and 49 posts and 149 replies during spring, roughly 40% of the number of students posts and 30% the number of student replies respectively. The staff mostly used the same language and informal style as most online discussion channels, to help the students feel comfortable and free to converse. For example, the channel is full of online jargon, GIFs and emojis.

To start the channel use, an assignment in early fall had the seventeen teams create a post to share their team logo, and the class had to provide feedback to those logos. This feedback was considered for the CCA. This activity was highly engaging, and while not every reply was a contribution, the activity fulfilled the feedback purpose and helped most students feel comfortable with participating in the channel. Afterwards, student activity in the channel kept increasing moderately, with posts limited to questions related to the course. For questions where the answers were previously discussed in class or were already available in Teams or Canvas, the staff’s approach was to not answer immediately, to allow time for other students to contribute. The instructor provided a positive reaction to the replies or clarified the answer. This approach provided space for the students to freely participate and contribute. It was evident that many exchanges led to meaningful sharing of ideas between teams. Having the students involved in “their own Q&A sessions” also provided feedback to the course instructor regarding areas of concern and opportunities to improve. No devious attempts for grade points were identified.

During fall, students struggled with completing the CCA. Upon the October monthly update many still had a low grade, so the Course Assistant (CA) shared that students concerned about their grade could tag him when using the MSTC-GC. This was meant as an encouragement, as there had not been concerns about unaccounted contributions. Afterwards, student activity ramped up significantly with multiple daily questions and a high response rate, resulting in 93% of the class contributing during November and December. The rush for points started with the CA tagged in almost every post and reply, making explicit their expectation of points (the unnecessary tagging subsided after described by the instructor in the next meeting). Nonetheless, the questions and responses were legitimately good and of high quality, based on the instructor’s experience in previous years. As this course is multidisciplinary and team projects vary widely, it is enrichening to have the students share their experience. This rush for points did not occur during the spring.

C. Enduring Impact

Having the students be alert for opportunities to contribute helped the staff with obtaining course feedback, such as when the instructor asked students about the CCA and seven students gave long insightful replies, and when the CA posted feedback on the lab notebooks assignment and five students made questions that also helped other students with their notebooks.

Student contributions influenced the course instructor towards improving the course experience for current and future cohorts. For example, some student questions lead to adding information in the course materials or to identifying topics that required further guidance in class. Similarly, when questions arose about course assignments, students had contrasting answers due to their unique projects, which generated examples of how students interpret and determine their project plan.

Some contributions facilitated monitoring team progress. For example, a student asked "What feedback or insights have you gathered from testing your prototypes so far, and how are you planning to iterate or refine them based on this feedback?". Four students from five other teams replied with comments on their sponsor liaison meetings, how they are staying on track with their project plan, how and why they are updating testing plans, current testing results, and two conversed on their contrasting plans as teams with and without hardware. Another example was when a student would ask about how teams made use of their project work sessions during class time, as this type of questions generated several replies, which essentially served as feedback for the instructor on how teams used those times and updates on their progress. Another example of recurring questions that generated several replies were asking for reactions to a guest speaker. In one case upon sharing this information with that guest, they replied being inspired by the student comments to develop further research on the topic.

Other popular threads included how to approach a task or assignment, feedback requests on project challenges and achievements, how to prepare for course events, post-event reviews, and job interviews. The replies provided a view into areas of concern for students and how they were approaching the challenges. For example, reviews of course events were generated shortly after the events thus providing an immediate and honest response to their experience, arguably more insightful than the feedback obtained with traditional course assessment methods, likely due to the students appreciating the freedom of expression and bouncing reactions off one another.

As student authored contributions, these threads provided a uniquely valuable perspective for future students. Therefore, these threads instigated a *Student Course Insights* knowledgebase, to share with the future course cohorts on a timely basis as they prepare for the respective course assignments and events. Future studies will investigate how this knowledgebase impacts the students' experience and how to grow it with new contributions from each cohort. Fig. 6 through Fig. 14 show extracts from threads created by students and added to the knowledgebase. The threads were chosen to resonate with a broad audience. The extracts were edited for brevity and to remove identifying information unique to each project.

- Can any of the teams who had their PDR presentation over Zoom share their experiences? We were thinking of maybe changing the way we do it a bit for the SLDR, but don't know what the best option would be. Us five met up in a meeting room and set it all up, but our stakeholders were all at their homes. What did you guys do and how did it work out?
  - Three students from three teams discussed the topic. The instructor supplemented the conversation.
- What is everyone thinking of including on their SLDR PowerPoint for the presentation?
  - Six students replied with details of the sections of their presentations with emphasis on how decisions were made based on previous presentations.
- (*the day after the last fall meeting*) Is your team still having your sponsor meeting next week to discuss SLDR and next semester plan?
  - Two students shared how they were done and two students shared why they had a meeting pending.

Fig. 6. Sample of student fall threads on how to approach a class task.

"How is everyone preparing for SLDR?" (19 students generated 27 replies)

- "…same preparations we did for PDR and practicing how to go on about the presentation taking into account the peer evaluations we received before."
- "Personally, I didn't get as much practice with presentation making on the PDR so I'll try to work more on that stuff this time! I think also getting some different types of media (sound/video) so spice things up a bit."
- "I think now that we are used to the environment of presenting and way more comfortable with the projects, my team will be able to execute a better presentation and still get valuable feedback for the future."
- "…my team and I are pretty knowledgeable of the project at this point that most of, or all, the talking points we have memorized like that back of our hands. But that is how we prepared, practicing the flow of the presentation and going over the slide content together."
- "…going over some potential commonly asked questions regarding the project and noting some points we would like to mention. …we will ensure that we are providing the audience a unambiguous answer to their questions within the designated time for Q&A."
- "…We learned that it is important to keep the audience engaged and have fun with it…"
- " … adapting the slides to fit more of the content that is relevant to… what the company is trying to achieve as a whole, what we have ownership over and how we are contributing towards those deliverables…"

Fig. 7. Fall thread for help on preparing for an evaluation event.

"What's some useful feedback your team got from the SLDR peer review?" (28 students replied)

- …most teams were unclear on what their actual solution is (to be implemented) and what they will deliver next semester. We were also recommended to…make the presentation more generalized to explain the problem, solution, and deliverables."
- "…we needed to have a better elevator pitch to introduce the product as well as a better closing that signified the gap we were closing with our product"
- "…We were told that the non-presenting team members could look more engaged. Anyone have practical tips on how to do that?"
  - "*(tagged that student)* perhaps looking at the speaker or audience, making sure everyone answers questions, standing tall, arms uncrossed."
- "… we decided to…have a business case slide as this will cover the features we intend to have, as well as illustrate to the audience how our project should look once it's finished."
- "Definitely our interactions within our model. More important to me other than feedback was the seeing the update of other teams and how they advanced over the last presentation. It helps to see what some teams are focusing on to see where my team and I can improve."
- "…Some of our technical slides were slightly confusing to follow the progression of our prototype, so we'll be using a standard slide template for those (slides)..."

Fig. 8. Fall thread of students reviewing a course event.

"What were some peoples favorite events so far this semester? Personally it was our visit to [site], it was great … gave us a boost in our development." (34 students replied)

- "Our team had a great time at PID and visiting our sponsor… we had helpful discussion with our liaison on early engagement prototyping and were able to see some of his prototypes for new product designs."
- "…I enjoyed meeting the liaisons in person and seeing how much hardware is involved behind the scenes even though our team is only working with software…"
- "…it was so cool to see their labs and luxurious amenities for employees. It was also fun to present to engineers as well as product managers and have the opportunity to network with them."
- "…I also really enjoyed bonding with the team outside of our normal meetings!"
- " …We all really bonded and had a lot of fun!... It felt really awesome to see some subject matter experts give us feedback and compliment us on our work.

Fig. 9. Fall thread on the students' favorite events of the semester.

"How was everyone's… SLDR?" (26 students replied)

- "I think its a different experience when you have to dress up and everything being a little more formal. I was a little nervous but… Overall, It went great.…"
- "I really enjoyed SLDR! It was a great opportunity for networking, and I also really enjoyed the speaker. My team liked…to view presentations by (other) teams..."

Fig. 10. Fall thread of students reviewing a course event.

"Does anyone have any tips for QRB 2 that they found out from QRB 1?" (10 students replied) **QRB is a review event where the team presents to a panel of faculty.*

- "Our team limited the amount of detail that we included regarding our exact testing procedures in QRB 1, but they came up during our Q&A session and were among the most useful feedback we received. ...going into QRB 2 with a heavier focus emphasis on our testing…"
- "Try to keep in mind who you're presenting to and observe their expressions while you present your part. …If you know how informed your audience is in advance, you'll be able to adapt the depth of information in the slides, but it's also good if you can pivot to a simple or more detailed explanation on the fly."
- "I am focusing on explaining the overall plan for my portion of the project. I think that I focused on small details about my current step but didn't talk about how the outlook to the end product looks so I lost points for not covering long-term risks..."

Fig. 11. Spring thread for help on preparing for an evaluation event.

"How did everyone do on QRB 2?" (16 students replied)

- "…the feedback we received shifted towards refining our testing strategy and optimizing data utilization to better align with our project management objectives as specified in our TPMs. The addition of a new faculty member to our presentation panel provided valuable insights, contributing to an overall enhancement in our delivery compared to QRB 1…"
- "Last time, it was clear that our team was falling behind schedule, and we used the feedback from QRB 1 to implement some new project management frameworks and prioritize our bottlenecks. By QRB 2, we have made significant progress catching up!"
- "…Rearranging our slide order and refining points (more detail in some places, less in others) seemed to help the panel follow along better than in QRB 1. We got some useful feedback about our current testing methodologies and suggestions for what we should prioritize testing in the near future too. At least for me, some of my own plans were clarified and I'm definitely thankful for it."

Fig. 12. Spring thread of students reviewing a course event.

"What is everyone's strategy to not get behind schedule with deliverables…during the break?" (17 students replied)

- "Most likely will divide my week in half, that way I have days where I strictly working on stuff and days where I get to fully vacation"
- "Agreed, ensuring all materials are ordered before the break is crucial for a smooth workflow. Taking some time off to recharge is essential for maintaining productivity and avoiding burnout. We are aiming to balance progress and relaxation during the break"
- "Relax so that I am 100% when I get back. Our team planned around spring break so we also don't need to work then"
- "Taking project instrumentation home and working on preliminary testing throughout the break. This way, when we come back, we will have a jump start for prototype day."

Fig. 13. Spring thread on how to approach the upcoming academic break

"Good work today everybody! How does everyone plan on delegating their time with project work / preparing presentation materials for next week?" (11 students replied)

- "Most of our time leading up to PID is going to be spent programming the last few vital parts of our application, and we'll probably only spend around a day or so together on preparing presentation materials over the weekend. PowerPoint and pre-recorded demonstration w/ live walkthrough are our planned materials."
- "I think our team is mostly done on working on the actual prototype part, so we plan on focusing on the actual presentation and making a script so we can divide roles. We also plan to rehearse our demo a bit to make sure we have it down."
- "…we focused the most on finishing manufacturing and assembling all internal components… To ensure we could meet our goals, responsibilities were divided between manufacturing parts, assembling subsystems, … It was a lot to balance, but communicating daily was the key, and we're proud of the final product!"

Fig. 14. Spring thread on managing their time towards the project demo event.

While this course requires students to share course evaluations on multiple occasions and these have been highly valuable, the figures above showcase candid information not obtained through the evaluations or verbally during class. A natural question is, what exactly inspired the students to share their thoughts so detailed and openly? Plausible reasons include the specificity of the questions, that questions were generated by the students, the timing of the questions, reading other students' answers, the inclusiveness of the channel, or not having the pressure of a required evaluation. Future studies will address this question, including a posterior analysis to evaluate (1) number of elements and actions based on this feedback that were effectively implemented in the course, and (2) the responses of future cohorts of students as they review these comments.

The results here presented are limited by only covering the experience in one year of one course, nonetheless, this practice evolved over previous course years and the results are consistent with the references listed on improving student participation. Future studies will further examine these tactics to encourage active student participation and the enduring impact of the contribution knowledgebase for this and multiple courses. Follow-up surveys, interviews or focus groups can be used to determine the extent to which their contributions were a natural activity for them or what were the specific factors that inspired them to contribute, and can be used to evaluate their perspective of the CCA after they complete the course.

VI. Conclusion and Future Work

The activities towards providing contributions left an enduring impact for the current students through the development of their skills in communication, teamwork, diversity of perspectives, social interactions, intellectual agility, professional feedback, and collaborative thinking. While some of the student generated questions are typical instructor questions for feedback and engagement, in many cases obtaining high-quality responses can be challenging. Conversely, the quality of the course feedback obtained through these student-initiated posts was as good or better than the feedback obtained through instructor led assessment tools. Therefore, their contributions provided an enduring impact for future students through the enhancement of a course knowledgebase that provides student perspectives, concerns and recommendations for the course topics, tasks, and events, which they can use to help them prepare, as if they had an older student giving them advice on what to do or not to do.

The results here presented show that by requiring students to share a significant amount of course contributions while providing them with equitable and accessible tools, and continuous instructor support and motivation, led them to sharing numerous ideas, insightful feedback to student peers, revealing feedback about the course to the staff and a legacy to future cohorts.

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