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Incorporating a Mid-semester Project to Evaluate Communication, and Leadership Skills for Undergraduate Engineering Students in the Statics/Strength of Materials Course: A Comparative Assessment Before and During COVID-19

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Incorporating a Mid-semester Project to Evaluate Communication, and Leadership Skills for Undergraduate Engineering Students in the Statics/Strength of Materials Course: A Comparative Assessment Before and During COVID-19

In this research study, the authors attempt to answer the following questions: How does incorporating a mid-semester project in a virtual format affect engineering students' communication and leadership skills? And how does this differ from face-to-face engagement? Popsicle-bridge project was assigned to a cohort of undergraduate engineering students enrolled in a Statics and Strength of Materials course to assess technical, communication, and leadership skills when working in a group setting. In most undergraduate engineering courses, the technical content is primarily emphasized for the academic development of the student. However, a practicing engineer must be able to possess and apply communication and leadership skills, which are often excluded from the existing curriculum. The authors employed a qualitative approach that sought to obtain insight regarding students' experiences engaging in the Popsicle-bridge project. As a part of the study, the first assessment of this project was completed with a cohort of 85 students in the Fall of 2019 before the outbreak of COVID-19, when all the students were attending in-person instruction. In this case, students were allowed to work in groups of four. The second assessment was conducted with a cohort of 95 students enrolled in the Fall 2020 semester, in which 49% of the student population was fully remote and 51% attended in-person instruction. For safety purposes, students in this cohort conducted the project individually but were provided opportunities to communicate with their peers. Results, before the pandemic, indicate that leadership roles and communicating effectively with group members were critical aspects in completing the project on time and having a functional, well-designed project. The students highlighted several factors such as delegating tasks to each member, meeting frequently to ensure each assignment is being executed properly, and managing different ideas as fundamental components in communication. Results for the second cohort of students indicate that completing individual projects represents a challenge despite being allowed to communicate with their peers, particularly, since working with team members can alleviate the burden of having to construct every single component on the project. However, being able to communicate with their peers allowed for ideas to be exchanged and for specific questions to be addressed.

I. BACKGROUND AND MOTIVATION

Communication and leadership skills are undeniably essential tools needed to succeed as a practicing engineer, and are implemented to share a vision of a project, motivating people toward a goal, and managing expectations. In a study conducted by Keil *et al.*, it was reported that communication, team management, project management, people skills, and organizational skills are indispensable when managing IT projects [24]. These skills compromise verbal communication, written communication, leadership, scope management, time management, negotiation, conflict management, attention to detail, and multi-tasking. Similarly, Lee *et al*. concluded that organizations focus on interpersonal and management skills rather than technical knowledge [21], [22], [23].

Leadership, for instance, was identified as the most necessary skill a project manager can possess in order to guide and motivate team members, and to ensure the focus reflects the priorities of the organization [21]. Similarly, verbal communication was the second highest skilled identified, and was found to be imperative to control various aspects of a project and be able to resolve any type of issues that arise during the process. According to the survey, verbal communication skills are developed by attending training classes or workshops. Another skill that was identified as necessary was listening, which is useful to fully comprehend project status and risks, as well as managing stakeholder expectations. Several participants emphasized the importance of listening to their team members to avoid overlooking potential problems that can result in major setbacks [21].

However, most entry-level engineers are not adequately prepared to employ any sort of communication and leadership skills as engineering curricula centralizes on strengthening and nurturing areas in physics and mathematics. As such, numerous institutions have implemented additional programs/centers that foster communication and leadership skills to undergraduate students, while various scholars have encouraged and implemented these skills in their research groups. Marquez and Garcia, for instance, studied the effects of incorporating communication and leadership skills, as a scaffolding process, with students participating in engineering undergraduate research [18]. In the study, five technical aspects, or scaffolds, were incorporated to reinforce engineering curriculum, develop research aptitude, and enhance cognitive development such as literature review, design, implementation, testing, and research [18]. The communication skills were developed through continual oral interaction between faculty advisor and team members, while reports were required to further enhance the use of technical writing.

For this reason, the number of STEM undergraduate students engaging in research opportunities is rather significant given its short-term and long-term benefits [13], [15], [16]. In a survey conducted by Russell in 2006, 53% of all STEM majors indicated some sort of research commitment throughout their undergraduate matriculation [12], [14]. Mogk and Tomovic similarly reported that partaking in undergraduate research is considered an effective educational tool which enhances the overall undergraduate experience [6], [7]. Such tool has further proven to increase the pursuit of STEM degrees and graduate education for every ethnic group [8], [9], [10]. It was reported by Bauer and Bennett that participating in research venues improves skills such as carrying out research assignments, speaking effectively, and acquiring and interpreting data [11].

Not only are the communication and leadership skills essential for the practicing engineer, but also the technical knowledge, which is the central focus in engineering curricula. Thus, numerous pedagogical methods such as Problem-based learning (PBL), Project-based learning, and visual cuing have been identified and implemented with the intention of enhancing student comprehension and scholarship abilities [17]. It was reported by de Koning *et al.* that students increased their academic performance and scores when visual cuing was incorporated [1] [2], [3], [4], [5]. Marquez and Garcia reported that the physical understanding of fundamental concepts in Engineering Mechanics were strengthened by the integration of visual tools during lecture sessions, and aided their understanding of real-world applications [17].

With the outbreak of the COVID-19 pandemic, the routinized and normalization of the educational process was thrown into a tailspin that forced both educators and students to adapt to a profoundly different learning environment. This new, complex environment presented educators both challenges and opportunities to reimagine, reassess, and reorganize course structure, content delivery, and assessments in a complete virtual setting. The efforts and proactive responses undertaken by educational institutions to rapidly adjust from face-to-face instruction to remote learning have illustrated institutional commitment to ensuring student learning continues.

In the context of engineering education, the transition has deeply affected the traditional approaches to student engagement and facilitation of course assignments. Engineering educators find themselves in a position where they are tasked with providing and affording their students with opportunities to enhance engineering related skills and competencies in a remote/virtual setting. As such, the inclusion of innovative and/or creative methods to provide opportunities to help strengthen students' engineering competencies are of critical importance.

II. PROPOSED WORK

In this research study, a Popsicle-bridge project was assigned to a cohort of undergraduate engineering students, primarily sophomores, enrolled in a Statics and Strength of Materials course to assess technical, communication, and leadership skills when working in a group setting. In order to promote creativity, students were granted liberty to design their own bridge. For those students who found it difficult to generate a design, the instructor highlighted several homework sets from the course as a guiding tool. However, the instructor did not indicate that the project would serve as an assessing tool regarding communication and leadership skills. This was done to observe student behavior and patterns during the process of completing the project, and consequently, gage their current background in such skills. It was particularly important to observe student behavior and communication capabilities prior to COVID-19 when all the academic resources were available to the student, and during the pandemic.

Instructional methods in engineering education have evolved over time with the intention of conforming to academic and professional standards. Such pedagogical strategies have been developed and implemented to enhance comprehension, student engagement, and scholarship abilities [33]. The most prevalent and utilized of these methods include Problem-based learning (PBL), Project-based learning, and visual cuing. PBL's primary objective involves developing self-directed capabilities and critical thinking skills through problem-solving, interpersonal skills, and team skills [34]. Project-based learning, on the other hand, enriches student comprehension by giving a closer perception towards professional development by incorporating project-based instruction [43], [44].

Subsequent research themes have further transpired in STEM fields relating to classroom environments, academic inclusion, team dynamics, and communication. One of the most impactful themes geared toward strengthening student learning, engagement, and success is classroom environment, which alludes to the climate, tone, or ambience that influences the setting [30], [31], [32]. The literature reports that educational productivity in the classroom factors with the surrounding social environment [28], [40], [41], [42].

The effectiveness of these instructional practices, however, have depended on two principal conditions: 1) undergraduate students residing or traveling from off-campus housing, which allows for the utilization of campus resources such as study spaces, books, outdoor recreation programs, computer labs, internet service, advising programs, etc., and 2) established campus practices adopted by students, which involve the formation of study groups, attending office hours, communicating after lecture hours, etc. These two conditions have factored towards the implementation of specific pedagogical methods and development of campus resources/programs to enhance comprehension, student engagement, and scholarship abilities.

Authors such as Pascarella & Terenzini, Tinto, and Thomas have argued that student success will transpire in higher education if all learners are integrated into the social and academic fabric of the respective institution [35], [38], [39]. Research suggest that having additional resources on campus such as peer tutoring, academic advising, personal and career counselling, and disability services may be compensatory in various ways [36]. For example, it can assist disadvantaged students overcome potential lack of academic information, cultural capital, or academic preparedness [25], [38]. In a study conducted by Bauman *et al.* in 2004, the likelihood of students using campus services was analyzed [26]. Results indicate that three quarters of the participants were likely or very likely to utilize career counseling services, while half of the students mentioned the likelihood of using financial aid, time management workshops, and stress management resources [26].

Research further attests that campus outdoor recreation programs and facilities provide numerous benefits such as student recruitment, retention, and the opportunity to support academic programs. Andre *et al.* concluded that benefits such as lower levels of stress and anxiety, increased academic success, smoother transition to college, and better mental and physical health result from students utilizing campus outdoor recreation programs [24]. Further, it is well established on the literature that students' ability to work with others in academic settings is significantly improved as a result of outdoor education experiences [24]. For instance, Cooley *et al.* observed an improvement in the students' perceived group-work skills as well as the attitude and confidence toward group work [24], [29]. Sibthorp *et al.* concluded that students found gratification in learning by using outdoor education resources, while Bell and Holmes reported higher learning outcomes on students participating in an outdoor adventure-based seminar course [27], [37].

In this study, it was imperative to observe student behavior and communication capabilities prior to COVID-19, when all the academic resources were available to the student, as well as during the pandemic. Due to the rapid transition during the Spring 2020 semester, traditional communication methods amongst students were interrupted. Thus, it was critical to assess the team communication components for each particular case.

For comparison purposes, the authors utilized data gathered from a cohort of 85 students in the Fall of 2019 before the outbreak of COVID-19, when students were attending in-person instruction. In this particular case, students were allowed to work in groups of four during the project. The instructor gave each group 100 popsicle sticks, a glue-gun, and glue sticks. The second assessment was conducted with a cohort of 95 students enrolled in the Fall 2020, in which 49% of the student population was fully remote and 51% attended in-person instruction. For safety purposes, students in this particular cohort conducted the project individually, but were granted the opportunity to communicate with their peers.

III. METHODS AND ANALYSIS

For this research study, the authors employed a social constructivist theory with the intention of guiding the research and meaning making process. Social constructivist theory posits that knowledge is actively constructed by individuals through engagement in different social settings and interactions [24]. This philosophy on knowledge views the learners as active participants in the learning process and positions educators as facilitators to create the conditions that support and nurture inquiry, relationships, and collaboration [19]. Further, this theoretical position provides a framework through which student experiences are examined and learning environments are structured and enacted by the educator.

The authors employed a qualitative case study research design to understand the communication and leadership skills perspectives of students [20]. Their classification ranged from mostly sophomores to juniors. The primary method of data collection was a self-developed survey instrument that was administered after the Fall 2019 and 2020 semesters, respectively.

Limitations of Study

The authors identified the following limitations of the study: small sample size; replicability of the study is limited to engineering students; lack of a comparison group to perform a T-Test for group differences; data collection was limited to surveys; study is limited to students enrolled in one engineering course.

The first administered survey, intended for Cohort 1, consisted of ten open-ended questions.

Question 1: Mention the importance of delegating responsibilities and meeting frequently with your group members?

Question 2: What did you learn about leadership roles and communication in a group setting?

Question 3: How did you manage different ideas and opinions in the group?

Question 4: What were the challenges of working in a group setting?

Question 5: What was the planning process of developing and completing your project ideas?

Question 6: After your experiences with the project, would you prefer group work, or independent work, and why?

Question 7: Do you feel your ability to work with others improved during this process? Explain

Question 8: How was the group synergy?

Question 9: Did group work catalyze your thinking?

Question 10: What role, if any, did you assume in the group?

The second administered survey, intended for Cohort 2, consisted of

Question 1: Given that he instructor allowed communication with other students when working on the project, did you communicate with your peers and discuss anything related to the project? If so, what were the main topics of discussion?

Question 2: Did you find it useful to discuss the project with your colleagues? If so, tell us why.

Question 3: If you did not discuss the project with any of your colleagues, tell us why?

Question 4: What were the challenges of working independently?

Question 5: What was the planning process of developing and completing your project ideas?

Question 6: After your experience with the bridge project, would you prefer group, or independent work? Tell us why

Question 7: If you were fully remote this semester, what were the challenges (if any) you faced, and how would you have benefited from being on campus?

IV. RESULTS

IV.1 Cohort 1 Results: Fall 2019

The questions administered on the survey were designed gather insights into students' group and collaborative learning experiences. Collectively, the survey questions covered a wide range of aspects related to group dynamics, and provided students the opportunity to reflect and share their unique experiences within this collaborative context. As part of the analytical process, the authors identified emerging themes based from the responses and are highlighted in the following section. Logistical constraints (i.e. word count) require an explicit selection of student responses and are limited to 2-3 statements for each question.

In relation to question 1, the participants acknowledged the importance of delegating responsibilities and meeting frequently with other group members. The following responses highlight students' thoughts and provide insights into newly acquired knowledge of group dynamics. Here, students agree that meeting regularly plays an important role in ensuring completion of projects.

Meeting Frequently is Most Important

"*Meeting regularly makes projects come to completion much more quickly."*

"Meeting frequently was most important. Most tasks were shared, although one person wrote up all of our calculations (since she had an ipad), and the rest of us took on more of the shared tasks."

"I thought it was very important to meet frequently. Our group met three times before we started building so that we would already have a very specific design and plan in mind when we started building."

Students also indicated the significance of delegating tasks and responsibilities and how by doing so, contributes to ensure team success:

"This was important in bringing different ideas to the group because by splitting up the responsibilities each member got to focus on different aspects of the project. Meeting

frequently helped because these ideas were discussed amongst all of the members so we could come to agreements and make progress."

"The project was definitely too much for an individual to tackle, so we needed to make sure we split everything up evenly, and since not everyone would necessarily follow through on their part we had to meet multiple times to make sure that everyone was staying on track and also working together/double checking each other's work."

Communication is Key

Concerning question 2, students acknowledged the value and importance of developing interpersonal skills with managing and working within a group context.

"You need a different leadership approach to every person. For instance, some people are much more proactive to report progress whereas others need to be checked upon quite frequently to ensure they are not stuck or off track."

"I learned that it's super important to show respect for all ideas suggested, even if you disagree with them."

'The key was to be respectful and always discuss every idea'

The literature on group dynamics is replete with evidence of the complex nature of interpersonal and group settings. Student responses triangulated existing research studies by illustrating some of the challenges and adaptations they made to safeguard successful group outcomes.

"We had some strong personalities in our team and unfortunately our only solution was reducing the number of times our entire team met. The more hard-minded individuals were given individual tasks so they would not disrupt the team's progress."

"We made sure to discuss every idea or dispute so that we chose the best path forward, and used arguments based in the mathematical principles to decide which idea was best."

"We talked through it. We were friends and knew how we liked to work, so we were able to come to resolutions quickly and respectfully."

Scheduling Time to Meet

As indicated by student responses, a major challenge students had to overcome was carving and coordinating time to meet. Below are a few comments that illustrate this challenge.

"I think the only difficulty was trying to work out a time when we could all meet. Since the three of us were busy, we typically talked over dinner or lunch."

"The biggest challenge by far was just finding times to meet up, we needed to all be together in the OEDK for like 3 hours and everyone's schedule didn't overlap."

"Finding time to work--I remember we had to resort to late night meetings because everyone had full schedules. I think groups of 4 are slightly better than 2/3 because it's easier to function when you're missing one person, but still small enough that most meetings will have the full group."

Brainstorming Sessions to Create a Plan

The general process students undertook to develop and complete project ideas was to engage in initial brainstorming sessions followed immediately engaging in the building process.

"We met to the discuss ideas and brainstorm, then to build the bridge a few times, and then to test the bridge and complete calculations."

"The planning process for the bridge included the initial calculations and brainstorming. We utilized information from class to try to complete our calculations, and once we completed these initial calculations, we began construction."

"When we initially met our group would draw out our ideas to provide visuals since we could not build yet. We also used techniques learned in class to mathematically analyze our ideas to come to a conclusion on which X worked best. Once we found a set plan, we broke the building up between the three of us so that each person could contribute to the building process and then we all assembled our parts."

Group Motivation

Question 6 attempted to gather insights into students' perceptions of group work based on their experiences working on their specific project. While a few indicated they would prefer independent work, the majority indicated their preference for working within a group setting.

"I would prefer group work for a similar activity in the future, because I believe that it was useful to discuss and bounce ideas between the team members to come up with a final concept."

"Group work, I enjoyed doing the project in the group. We came up with more ideas for the bridge and could split the work."

"Group work--it's more motivating to work with others."

Becoming a Better Group Member

Question 7 asked students if the research process strengthened and/or improved their interpersonal skills. The major of the students agreed that this experience did improve their ability to work with other students.

"I believe that my ability to work with others improved during this process, and we had good practice coordinating between the schedules of our teammates."

"In a way I believe so because it was such a fun project that it allowed everyone to practice effective communication without the pressure a more daunting assignment would have. Thus, I feel like it would behoove how we handle future projects with more demands, such as senior design."

"*I'm not sure I noticed a considerable change, but I think all practice in group work helps me to become a better team member."*

Tension, Cooperation and Communication

Question 8 allowed students to reflect on the synergistic potential of group work. The results below shed light into this aspect of group dynamics.

"Tense. Some hard-minded individuals."

"Group synergy was good overall. I had not communicated with some of the members previously, and so while it took some time, we eventually were able to establish good teamwork and communication."

"There was very good cooperation throughout this project. It was a very comfortable environment to work it."

Group Work and Conversation Catalyzes Thinking

Regarding Question 9, most students agreed that the experience of working within a group setting help to catalyze their thinking.

"Group work and conversation definitely helped us think of more ideas on how to progress with the device."

"I believe so because we all bounced our ideas off one another, so we were able to come to an effective plan quicker with the various opinions."

A few students did offer differing opinions regarding this experience.

"Not sure/not really. I think I had a really good grasp of concepts before the project so it felt a little repetitive after the homework."

"Hmm, I'm not sure if it made that big of a difference. It was nice to have all my work checked by the team though."

Assuming Roles

The final question on the survey sought to explore the different roles students assumed during their research group experience. In all, a total of 53.8% of students noted assuming leadership role, while another 38.5% indicated their role as a member of the group.

IV.2 Results Cohort 2 – Fall 2020

The survey questions administered to Cohort 2 departed from the questions administered to Cohort 1 and were designed gather insights into students' group and collaborative learning experiences in a virtual context. Collectively, the survey questions covered a wide range of aspects related to group dynamics, and provided students the opportunity to reflect and share their unique experiences within a virtual/distance environment. Similar to the results presented above, the authors identified emerging themes and selected 2 statements that highlight the prominent theme for each question.

Communicating Virtually

In relation to question 1, the majority of the participants acknowledged that they communicated with your peers when working on the assigned project.

> *"Yes! I got on Zoom with a friend and we built our bridges together. We mainly chatted while doing so, but we would discuss how to connect things and how to glue the sticks together in the best way."*

> *"Yes, I did communicate with some of my classmates on the project. The main topics were calculating the forces in the members for a design idea that I wasn't sure how to calculate, overall design, and weight distribution."*

It is worthy to note that several students did not directly communicate with other group members, but were informed of the general conversation occurring in the group.

> *"Personally, I did not directly communicate with others regarding the project. However, I did see some of the discussion that was done in the chat. Students were mainly discussing the specifics of the project (the required length, for example)."*

Generating Ideas

Question 2 posed the asked students if it was useful to discuss project with their peers. The majority of students, roughly about 75%, found it useful to discuss and communicate project related topics with their peers. Moreover, it they highlighted other facets of group work, such as increased levels of engagement and motivation.

> *"Yes, it made it more fun, first of all. Second of all, it was motivating and also I could get continuous feedback and bounce ideas off of someone."*

> "*Yes, I think it was very important to discuss with others because they could provide insight in areas that I may not have thought to do certain things."*

An expectation of facilitating group work was that several students would engage in differing levels of engagement. As such, Question 3 of the survey afforded students the opportunity share various perspectives.

> *"I didn't need my colleagues' help in order to complete the project, and I don't talk to any of them on a regular basis."*

> *"I did not really know anyone in the class all that well, and I didn't feel as though I needed the additional help."*

> *"I felt comfortable with accomplishing the task of completing a bridge that satisfied the guidelines independently. I also felt that doing the project with my own creative design would warrant the most rewarding learning outcome."*

A Single Stream of Ideas

Within any group experience, challenges will arise in which students must make intentional and strategic decisions to navigate effectively through those encounters. The following reveal a few of these challenges students faced during their group experience.

> *"I had to make all the engineering design decisions by myself than what is normally a cohort of people with different ideas, so opportunity-wise I felt working independently is more taxing than working with others at least in the building and designing phase."*

> *"I usually like to get second and third opinions on something I want to test out, so it was difficult not asking anyone. So I guess the main challenge was trusting my instinct and not relying on other opinions.'*

> *'Having only one stream of ideas. I thought my design was good and that I didn't need outsider input, but another opinion would have been beneficial."*

Researching Designs

Question 5 asked 'What was the planning process of developing and completing your project ideas?' Although students took different approaches to planning and completing the project, a common theme found in the responses was that the students engaged in preliminary research to inform their designs. The following responses indicate these similarities.

> *"First, I looked online for pictures of bridges. After I got inspiration, I chose one that looked doable and then planned how many sticks I would need. I looked up YouTube videos of previous bridges to see how they broke and learned how to effectively connect the popsicle sticks. Then, I got to building."*

> *"I completed some research on truss design and used the tips our professor discussed in class. Then, I discussed the research I had done with classmates. Then, I selected an appropriate design on paper and built the bridge. Finally, I completed a full analysis of the structure."*

Group Work vs. Individual Work

An important question is to assess students' preference for engaging in individual or collaborative learning experiences. Both group and individual work offer students unique, distinctive advantages and disadvantages. In regards to this question, roughly two-thirds (66%) of the students prefer group work as opposed to independent work. The following responses display an example of each preference.

> *"I would definitely prefer group work. Although it is good to see what you can do on your own, engineering is all about team work. Plus, multiple brains is better than one. With a group we could definitely be quicker and smarter."*

> *"Group work, mostly because the calculations are very repetitive (especially with a symmetric bridge like mine), so breaking up that work would allow everyone to complete it a little faster, and also check work (with a symmetrical bridge)."*

The following responses highlight the preference for independent work:

> *"I think independent work can be more engaging in a way, since it forces everyone to "get their hands dirty," rather than relying on a couple extraordinarily "passionate" or hardworking people."*

> *"I would prefer individual work, because this is a precious chance for us to realize our individual ideas. In a group work, we will eventually narrow down our solutions to one, which means that many interesting designs can't be put into reality, and that's quite a shame."*

Challenges of Remote Learning

Question 7 inquired about the challenges students faced while learning in a fully remote context. Student responses articulated the a few of those challenges, ranging from having access to a quality work space to the social isolation one can experience from being removed from campus environment.

> *"I'd say one of the biggest challenges would be the lack of a specific space to do my project. Albeit, nothing was wrong with completing the project on a dining table, but I would often need to find random objects (such as a wood plank) to act as tools for creating the bridge. I would have been nice to have a dedicated space like the ODEK to construct the bridge, but maybe the resourcefulness of working in a non-dedicated space is a useful lesson."*

> *"Some of the challenges were the thoughts that if I was doing the project correctly, and the fear that I'd have to start over I had not properly done all the steps right. Being remote, I think is a lot more isolating, especially in terms of communication, and I feel as though I would've been able to meet some people in person to just discuss the project itself."*

V. CONCLUSION

The traditional forms of teaching and learning changed dramatically with the outbreak of the COVID 19 pandemic, which forced educational institutions to alter their approaches and delivery of instruction. Faculty were required to make necessary changes to their instruction and develop novel solutions to overcome the challenges associated with virtual/remote learning while not sacrificing academic standards and rigor. Since many students opted or were required to learn in a remote setting, they no longer had physical access to university workspaces and peer interaction, which is critical to the development of engineering skills sets. As such, this new reality prompted the authors to examine student experiences related to a class group project that sought to enhance their leadership, communication, and technical skills and how this new environment affected student experiences and outcomes.

In this research study, a Popsicle-bridge project was assigned to a cohort of undergraduate engineering students enrolled in a Statics and Strength of Materials course to assess technical, communication, and leadership skills when working in a group setting. The first assessment of this project was completed with a cohort of 85 students in the Fall of 2019 before the outbreak of COVID-19, when all the students were attending in-person instruction. In this case, students were allowed to work in groups of four. The second assessment was conducted with a cohort of 95 students enrolled in the Fall 2020 semester, in which 49% of the student population was fully remote and 51% attended in-person instruction.

Results from the study noted noteworthy changes in student experiences related to group project engagement and experiences. Similarities were found between the two cohorts in terms of orientations towards group work and its associated benefits and outcomes. Cohort 2 data also students tended to engage in group conversation and communication at lower rates than their peers in Cohort 1, who functioned in a face-to-face environment. Moreover, remote students did not have the luxury of having dedicate workspaces to complete certain assignments and therefore might negatively affect their overall academic experiences and outcomes. Such data reveal the need for faculty members to consider the limitations and constraints of integrating such projects and generate proactive solutions to remedy such issues. Furthermore, the intentional inclusion of projects in a virtual setting to help simulate in person experiences can greatly benefit students' acquisition of engineering related skills and competencies along with faculty guidance, can encourage them to engage in intentional dialogue with their peers to bolster interpersonal and critical thinking skills.

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