

## **Building a Sense of Community in a Multidisciplinary, Split-level Online Project-based Innovation Design Course**

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## Abstract

In March of 2020, faculty across the nation had to adapt their teaching methodologies due to the COVID 19 pandemic as universities across the country suspended face-to-face classes. This involved short-term solutions to complete the spring semester such as switching in-person lectures to synchronous lectures utilizing a university purchased platform. During the summer of 2020, many schools and courses saw record enrollment. Instructors were tasked with transitioning the once face-to-face class into a complete online environment of educational equivalence for the entirety of the course (unlike the partial transition during the spring semester). Most faculty are not trained in the pedagogical content knowledge related to designing, organizing, and maintaining an online course environment, yet were tasked with developing their summer courses in a short period of time. In addition to these sudden educational delivery changes, research findings indicate that supportive interventions to reduce loneliness should prioritize younger individuals during the COVID 19 pandemic [1]. This paper reviews the successful online transition of an in-person engineering innovation course that utilizes project based educational methods to an online environment during the summer of 2020 and the subsequent fall semester. In total, 174 undergraduate and graduate multidisciplinary engineering students completed this course in the new online format during the summer and 131 students took the course in the fall semester of 2020. Various methods were used to create a diverse and engaging learning experience for the students, while simultaneously creating a sense of community during a period of loneliness for many of the students. Anecdotal student feedback noted that the sense of community the course encouraged was one of the best aspects of the course. Two main ways the instructor helped to build this element of community was through the user experience and through course assignments.

## 1. Introduction

On December 8, 2019 the first case of pneumonia was reported and around a month later it was identified as the novel coronavirus (SARS-CoV-2) [2]. It then spread worldwide becoming a global pandemic. On Monday March 9 of 2020 many universities in the United States, including the authors' university, notified instructors to prepare to migrate their courses into an online environment. By Monday March 16, the university was fully online. During that spring semester, instructors had to make do with how to transition their course halfway through the semester. This included live synchronous lectures via an online platform (such as Zoom) with students and trying to convert the current course content and assignments fully online. While the goal of spring 2020 for many instructors was to get through as best as they could with these short-term solutions, the real challenge was converting these in-person classes for the summer and fall semesters as the future was unclear with respect to the pandemic.

E-learning or online learning is used to refer to web-based training, distributed learning, web-based learning, virtual learning, or internet-based learning [3]. Online learning is a method to facilitate distance learning by embracing various technologies and platforms. The first instance of online learning was in the 1960s and it has dramatically evolved over the years [4, 5, 6, 7]. However, despite the growth of online learning, there are still some major issues with its implementation. The largest concern is the lack of trained faculty in the pedagogical framework

for developing an online based class. Faculty involvement is imperative in online learning and prior to the global pandemic, many instructors were hesitant to convert their courses online for a variety of reasons including lack of support, assistance, training from the higher education institution, time required to develop the course, time learning new technologies, workload, course quality, and student contact [8, 9, 10]. Many instructors have designed and taught face-to-face courses; however, online courses require skills that many instructors lack and/or need additional training in order to develop these online courses [11, 12, 13]. This is especially true in their usage of learning management systems (LMS), which have become a common means of delivering course content. LMS platforms should serve not only to share course lectures and materials, but to help students to focus on their learning and allowing them to build relationships with their peers [14]. Many technologies exist to foster communication between peers, from chat functions to social media; however, instructors often are unaware of how to integrate these technologies into their online classes [15]. Professors should use the LMS to build an interactive UX that provides clear structure and organization [16]. This is especially true in the era of the pandemic when the students are being thrown into the unknown with many having not experienced online learning in the past.

During normal circumstances for college students, there is already a prevalence of heightened mental distress and negative academic circumstances. With the rapid shift in educational delivery methodologies due to the pandemic along with social distancing measures in place, it was expected that it would exacerbate stressors for collegiate students. In addition, research findings indicate that supportive interventions to reduce loneliness should prioritize younger individuals during the pandemic [1]. Students crave a sense of community in their classes, and though it may be more difficult to build in an online environment than in a physical classroom, it is even more essential. Students taking online courses can be geographically spread, but with today's technology, this should not be a limiting factor [17]. The technology exists for several different means of communication and connection in an online classroom setting. Still, online students report feeling more isolated and alienated when compared to in-person students [18]. The feeling of loneliness and isolation associated with online learning have detrimental effects on the learning and mental well-being of the students involved. Students in online classes are more likely to drop the course [18], less likely to take another class in the same subject area, and less likely to graduate [19]. A sense of belonging in an online learning community is important for the learner's degree of emotional participation [20]. Higher amounts of interaction in a course, both quantitatively and qualitatively, increase students' satisfaction in the course [15]. Therefore, higher levels of interaction are beneficial for both the students and the professors.

One of the greatest factors that impacts a student's experience in the course is the instructor. The instructor is responsible for designing the course, organizing assignments, instructing students, and facilitating both peer-to-peer and student-to-instructor interactions. Students are quite aware of whether their professors care about them; however, instructors often do not make this aspect of teaching a priority. The first study regarding this topic was in 1997 when Abrami and d'Apollina [21] conducted an analysis to determine if there were common traits that exist amongst the best-rated instructors. The authors discovered that there are two important factors that effective instructors possess: "the instructional role" and the "personal role." The "instructional role" refers to the instructor's knowledge, clarity, and preparation. While the "personal role" refers to the instructor's availability, respectfulness, concern for students, and

willingness to answer questions and foster interaction. Another study arrived at similar conclusions [22]. This study referred to the first aspect as “intellectual excitement,” or the professor’s organization, clarity, enthusiasm, and ability to stimulate student interest. The second aspect was the “interpersonal rapport,” which relates to their tendency to encourage students, welcome their questions, acknowledge their input and feelings regarding the class, and care about students on an individual basis. Meyers [23] discusses that students’ “favorite professors are knowledgeable, articulate, and have clear and high expectations for students’ performance.” He also goes on to discuss that in addition to being knowledgeable, that these instructors “genuinely care about their students.” In his article, Palmer [24] claimed that: “good teachers possess a capacity for connectedness. They are able to weave a complex web of connections among themselves, their subjects, and their students so that students can learn to weave a world for themselves.” Caring professors can translate this effect on students that is not proportional to the actuality of the relationship because “perceived relationships” can be influential to the extent that a caring and responsive student-professor relationship can even extend to online learning environments [25]. One method an instructor can use to show they care is through immediacy, which refers to overt forms of communication (verbal, non-verbal, and written) that enhance the relationship between students and instructors [26]. Examples of immediacy include body posture, remembering names, being available, smiling, listening, and showing an interest in the lives of students. Building a good rapport with students impacts the students’ attitudes toward the class, their academic performance, greater student enjoyment, and improved attention [39].

The purpose of this paper is to discuss the development of a community in the online transition of a highly interactive, in-person engineering innovation course that utilizes project based educational methods during the summer of 2020 and the subsequent fall semester. In total, 174 undergraduate and graduate multidisciplinary engineering students completed this course in the new online format during the summer and 131 students took the course in the fall semester of 2020. In this paper, we will begin by discussing the face-to-face version of the course with the workaround online option for a handful of students each semester. We then discuss informal stakeholder interviews that in addition to the aforementioned literature helped to develop the requirements of the online course. The goal of the transition was to develop an online version of the course that provided an educational equivalence to the in-person version of the course, while continuing to encourage the community element present in the face-to-face version.

## **2. Course Background**

The pre-pandemic version of the class was delivered weekly through three periods (a three-hour block, one time per week) typically consisting of lecture overviews of the weekly topics by the instructor, class discussions, presentations from guest speakers that discuss facets of their innovation journeys, in-class activities, workshop sessions, and student presentations that illustrate their grasp of the course material. The course was presented in an experiential learning “real-world” format. Students pursue problem solving ideas and develop an innovation process book (“Innovation Playbook”) that advances a proposed problem-solving solution with innovation concepts learned during the course. Upon completion of the course, students have acquired the hands-on, multi-faceted “tools” and marketable skills they can use to pursue engineering careers ranging from entrepreneur in a startup venture, to intrapreneur working in a corporate enterprise, to senior executive leading a multinational organization.

The course centers around the creation of an “Innovation Playbook,” which is a semester long group project. It begins with students individually identifying problems and drafting need statements [27] for a problem they would want to work on over the course of the semester. Once students individually identified need statements, students would then pitch their statements as a one-minute elevator pitch to the class and then would be given time to self-create teams of five to six individuals per team. They were given the constraint of having at least three different majors represented on their teams. The overall structure is taught with the IDEO framework in mind: inspiration, ideation, and lastly implementation [28]. Each week the course lectures would align with information important for the group project. The course embedded activities throughout the three-hour time block in order to facilitate creativity in the students and to allow students experience in understanding the content. These structured interactive lectures would have students split into groups to complete a task or work on their group project before rejoining and sharing their results with the class. In addition, TopHat was used to allow for students to pay attention during lectures but to also create engaging learning experiences. TopHat is a platform that “makes learning active with live discussions, polls and quizzes students can respond to on any device” [29]. To reduce groupthink in course discussion, students would be asked a question such as “does competition help or hurt innovation?” The students would each vote and then the class would have a discussion on why students took their stance. This aided in facilitating meaningful discussion in gray area topics that would get the students to see different sides without initially being influenced by their peers. In between lectures during the three-hour class period, students would get “brain breaks,” which are riddles, 3D puzzles, brain teasers, and other cognitive flexibility tests to enhance innovative and inventive thinking abilities [30].

The course did have an online component as part of the university’s online graduate degree program. Only a handful of students took this method of delivery. The online version was also not optimized for online students. It included recordings of the live lectures; students being placed on teams with other online students for the semester project and completing activities on their own. They were unable to use TopHat, engage in the full extent of the structured interactive lectures, participate in the class discussions, or group workshops with the course guests. The instructor met with the teams to complete their brainstorming workshop virtually. Unfortunately, as with many online courses this was an easy solution for a few students.

### **3. Informal Interviews**

The literature discussed in the introduction of this paper discussed some of the important items that should be considered when developing an online course. In order to understand the current state of online course development and to gather various stakeholder perspectives in understanding what works and does not work in project based online learning environments informal interviews were conducted. Stakeholders interviewed included students from the spring of 2020 class, instructors who has already been teaching online courses, and students in fully online degree programs.

Students from the spring 2020 class were asked to reflect on their journey in the course and the pandemic online transition on their college experience. A total of 140 students were enrolled in the class across two course sections. Many students noted in their feedback that this was their best group experience of college. Partly due to being given class time to complete assignments, but also because the groups consisted of students of different ages, majors, and backgrounds.

Many students noted that switching online in general “sucked” because they enjoyed working in class with their teams as it was very beneficial to their innovation process for their group project. An overwhelming number of students (over half) noted that the required weekly group meetings via a video platform was a great way to keep the group on track with the group project. Without the regular group meetings, students believed that their groups’ projects would have been of lower quality as it would have been rushed to be completed near the deadlines. They recommended that this continues into the fully online version of the class. Many students also noted the role of a caring and adaptable instructor in their comments. They appreciated being able to reach out to the professor and even to be allowed to submit assignments early for feedback. Another comment that many students noted was that the course helped improve their communication skills and confidence. Many of the students identified as introverted or shy and noted that they became comfortable sharing their ideas with their group without fear of rejection. Students did note that the zoom student presentations did remove some of the personality from their classmates, but that it was easier to ask questions through the chat feature than it would have been in person. Another highlight mentioned on the overall class experience was that students missed the in-class creative activities and discussions as it was not the typical lecture style class. Many of the international students and students who returned to homes in rural areas experienced internet issues. This led to problems attending synchronous online lectures in which the lecture was given over a video platform. Students also noted that the willingness of the professor played a key role in the success of the online transition. Most noted that this class was seamless, but that other courses they were enrolled in were not. Other comments often noted by students include a lack of motivation in the online environment, sleep pattern irregularities, mental health issues, lack of routine, loss of internships, loss of social lives, lack of timely communication from their professors, and lack of interaction.

Interviews with instructors who had already transitioned to online education before the pandemic shared some insights on best practices and what works for them. Many stressed the importance of an organized LMS. They specifically noted how “modules” or weekly activity breakdowns was helpful for students to follow along in the class to limit confusion. There were mixed opinions on lecture length. Some recommended one long lecture per week with all the content, whereas others recommended smaller lectures no longer than 30 minutes in length and to have a couple each week. The instructors who recommended one long one had found that more students watched the one lecture, when compared to those with many as students would often skip a video or two. Most of the online instructors recommended asynchronous lectures so that it is not necessary to recreate lectures every semester. While this is a large, front-loaded time commitment, it has saved them a lot of time in subsequent semesters, and they were able to focus more on student interaction and addressing student questions. The use of discussion boards was recommended by many instructors with the requirement for students to comment on others’ assignments to facilitate peer to peer interaction.

When discussing with students who had taken fully online classes prior to the pandemic, there were quite a few consistent opinions. The first was that while students will often skip a lecture or two if there are numerous in one week, they often feel like they retained the information better when there are multiple smaller lectures than in classes with one long lecture. Students also prefer asynchronous lectures as it allows them more flexibility to do the coursework on their own time. However, they dislike when professors upload their lecture as only a slideshow with

voiceover as it dehumanizes the experience and creates a disconnect between the professor and the students. The students would prefer to be able to see the professor during the lecture videos. In courses that utilize breakout rooms/group projects, students feel camaraderie when the group participates and keeps their cameras on as it creates an element of community and personalization. When the group is silent or fails to share their video, students often feel disconnected from their peers and even more isolated. Many students expressed liking activities that allowed them to interact with their peers, such as group discussions over a video platform regarding a case study. While students do not mind completing discussion board assignments, many stated that the commenting on others brings little to no value to them and seems like a waste of time. They would prefer to talk and see their peers.

#### **4. Design of the Fully Online Course**

##### ***4.1 Goals and Requirements***

The instructor had two main goals in the development of the online course:

1. develop an online class that facilitated an online community; and
2. provide an educational equivalence to the on-campus version of the course.

In addition, based on the literature review in the introduction of this paper and the informal interviews the professor developed a list of requirements that must be included in the course to achieve the goals:

1. an easy-to-use LMS experience.
2. peer-to-peer interaction.
3. clear expression that the instructor cares about the students' success; and
4. ability to learn from and see their peers.

In order to achieve these goals, the user experience and assignments will be discussed to demonstrate the creation of an online community and the successful transition of the online course.

##### ***4.2 User Experience***

The LMS is often the first impression an online student will have with an instructor, so it is important to ensure that the UX is welcoming and easy to follow. UX refers to the overall experience related to the perception, reaction, and behavior that the user (in this case student) feels and thinks through use of a system [31]. The informal interviews noted that organization and transparency were important factors in an online community. This was further supported in the literature that said online courses should leverage their LMS to have a clear structure and organization for the students [16]. This translated to a user interface (UI) that was organized, structured, transparent, easy-to-use, and welcoming. UI refers to a system (in this case LMS) and user (student) interacting with each other [32]. In short, the UI refers to the overall aesthetic design and organization. The UI has a large impact on the UX. Prior to the pandemic, the course was operated with just uploading slide decks for student access, assignment submission, and announcement. The UI for the online course had to shift to facilitate the structure and organization of the class often through weekly modules. The goal was for the student to access each module from the course home page. A clip of the homepage for the course demonstrating some of the weekly "modules" can be found in Figure 1. Students would click on the week and immediately get taken to the activities for that week. Figure 2 demonstrates what a module for a week looks like. It features the objectives for the week, the lectures, readings, and other learning materials. It also includes the list of assignments due at the end of that week and the "Innovation

Toolbox” items introduced that week. The “Innovation Toolbox” is a way for students to dive deeper into a topic by featuring instructor vetted videos or articles to enhance the comprehension of a topic.

The figure displays three vertically stacked module cards. Each card features a photograph on the left and a text box on the right. The top card, 'Week 2', has a teal background and a photo of a vintage camera. The middle card, 'Week 3', has a dark red background and a photo of a library. The bottom card, 'Week 4', has a bright red background and a photo of a woman on a phone.

Week	Topics
Week 2	IDEO, design thinking, discovery skills, defining the problem, brainstorming, need statements, needs filtering, biases
Week 3	Stakeholder analysis, market research, competitive landscape, social innovation
Week 4	Interviews, surveys, cognitive biases, design criteria, target market

Figure 1: Some of the modules on the homepage of the course LMS



## Week 11 <sup>AD</sup>



### Objective

- Learn what value means in the eye of the stakeholders and the difference between value and features.
- Develop project management skills for mapping out the future of projects.
- Acquire a basic understanding of different commercialization pathways.

### To-Do

Complete the items:

1. Review the following lectures and materials:

[Value Proposition \(20:35\)](#) <sup>en</sup>

- Slides: [Value Proposition.pptx](#) <sup>en</sup>

Readings:

- [Use 5 Whys to Get to Your Value Proposition](#) <sup>en</sup>
- [The 31 Best Value Propositions that You Wish You Had](#) <sup>en</sup>

[Implementation Strategy \(22:11\)](#) <sup>en</sup>

- Slides: [Launch Strategy.pptx](#) <sup>en</sup>

2. Review the [Innovation Playbook](#) and [Playbook Pitch](#) Assignments
  - Message me with any questions or set-up a meeting
3. Work on finalizing your playbooks. Remember to submit early for feedback.
4. Complete the remaining activities due this week.

### Due this Week:

- [Week 11 Creative Activity](#)
- [Week 11 Discussion](#)
- [Week 11 Reflection](#)

### Toolbox Items



Figure 2: Example of a weekly module used for the online class.

The qualitative feedback from the students illustrates that the UI was very successful in achieving the requirement of an easy-to-use LMS experience. Students greatly appreciated the transparency that all assignments along with due dates were posted at the beginning of the semester. Anecdotal evidence from students at the end of the semesters (over 75%) displayed an overwhelming positive experience with the UI of the course with some of the direct quotes noted below.

- *“I absolutely loved the format of your canvas page with each individual page having cute background images as well as the toolboxes.”*
- *“Thank you for posting everything in the beginning of the semester. This really made my life easier compared to my other classes.”*
- *“I also really liked the layout of this course and how the assignments were presented.”*
- *“Thank you for being very adaptable and creating such an organized and meaningful course, despite the change of format.”*
- *“This class is great. This is my 4th year at [this college] and I can say, without a doubt, this has been my favorite so far. The lectures were very informative, the readings were engaging, and the activities have been exciting and thought-provoking. Just based on this week, I can tell I will have an excellent time during this class.”*

This further demonstrates the importance of transparency, consistency, and organization, when implementing an online course. One of the comments that was received quite often was the appreciation for a consistent day of the week in which assignments were due. In the case of this class, it is Sunday evening at 11:59 PM. The UI is the first impression the students receive from the course. It lays the framework for expectations for the class, instructor, motivation, and so much more. In the first quote referenced above, the student discusses how the colors and images for the modules were greatly appreciated. It is often these little things that help to build that interpersonal rapport or immediacy with the students [22, 26].

The professor is also a pivotal aspect to the UX. As noted in the introduction, the best professors display “intellectual excitement” and “interpersonal rapport” [22]. This means that the professors not only exhibit knowledge about their subject, but are open, caring, and accessible to their students. One method that has been utilized by the instructor has been to allow students to submit assignments early for feedback. The rationale behind this started with the fact that many students have busy schedules and cannot always make office hours so this would be a way for students to get feedback on their assignments. Many students noted how this was unique to this course. An anecdote from one student stated: “what stood out to me the most that I have never had in a previous class is being able to turn in assignments early for feedback, finished or unfinished. I think many other courses could benefit if that were implemented.” Another student noted, “the prompt feedback was invaluable to learning the content because it gave myself and my group the opportunity to revise our work to really understand what we were doing. A lot of classes grade you and keep moving forward, never allowing you to learn from your mistakes. I think this is a huge disservice to education as often the best way to learn is from one’s failure.” This student anecdote perfectly exhibits the goals of teaching, which is to help students learn even if it is from their own mistakes. This practice shows aids to show that the instructor truly cares about the students and develops the instructor-student element of the community of the course.

At the end of the semester, students completed course evaluations with optional free-response questions. Students were asked to “Please identify the instructor's strengths that contributed to your learning in the course.” The results of the question are in Table 1.

*Table 1: Free response comments on the instructor's strengths that contributed to your learning in the course.*

Criteria	Summer 2020 (n=55)	Fall 2020 (n=29)
Positive Personality	29	19
Organized LMS Course Page	7	6
Early Feedback	15	5

Students who did respond to this question often referenced the enthusiasm and other positive personality traits of the instructor, organized course and LMS page, and the early feedback policy as incremental to their success in the course. Students described the professor as enthusiastic, passionate, caring, animated, witty, and more. These attributes illustrate principles of immediacy used by the instructor to build rapport with the students [26]. Instructor enthusiasm and genuinely caring for students is important for student outcomes in the course [33]. These same sentiments can also be found in the end of course reflections. Students noted that the professor’s passion is contagious and unforgettable; that she has so much fervor for the subject; that they appreciated how approachable and available she was; and that she genuinely cares for her students. These aspects of immediacy noted by the students leads to greater interest in the subject, resulting in higher participation and engagement [26]. The instructor serves as the backbone to any course and in the instance of an online course, it is on the professor to set the platform for a community. The instructor sets the standard for the class as it is a journey that everyone is going on together.

### 4.3 Assignments

In transitioning the class, one of the biggest challenges was to think about the assignments that would go into the educational experience and replace the structured interactive learning that occurred in the classroom. In total, there were five categories of assignments: Innovate U, Reflections, Innovation Playbook and Discussions, and Creative Activities. Each helped to bring an element of community to the course and aided in the successful transition online.

#### 4.3.1 Innovate U

The first week of the course focused on students getting to know themselves. It is important to develop self-aware individuals to understand how to be a teammate and a leader [34]. Self-awareness allows students to reflect inward to allow them to identify, process, and store information about oneself [35, 36]. The value of self-awareness is obvious as it means having a deep understanding of one’s emotions, strengths, limitations, values, motives, and perceptions [37]. The first assignment for the class is to write a biography to allow for students and the instructor to get to know one another. The text of the biography focused on experiences both professional and personal that the students thought would be relevant to their peers. The students posted these biographies to the course discussion board in order to familiarize themselves with their peers. In addition, they included a favorite quote, their innovation inspiration, their Myers Briggs Personality Type (MBTI) [38], and a picture. The MBTI was important as students were challenged to reflect on whether they agree or disagree with their results, and why. It is this self-reflection that is beneficial when working in a group. It forced students to take a moment and

think about their strengths and weaknesses. An overwhelming majority of both the summer and fall classes agreed with their results and were astounded as the accuracy. In addition to the biography, students would reflect on their life and find at minimum of five objects that reflect what made up who they are and describe those facts in a three-to-five-minute video to the class. Many students noted that this quickly began to feel like a more in-person class as they could see who their peers were. While not required, students were able to view their peers' videos. On average the students of the summer course watched 12.12 videos, while the fall course watched 9.42 videos. This illustrates that students took the initiative to get to know their classmates and likely the course groupmates. Students discussed that these videos really helped to reinforce the notion that innovation occurs with diversity, and while nearly every student enrolled in the course is studying engineering that they all have different life experiences.

#### 4.3.2.2 Reflections

Each week every student was tasked with sitting down for approximately 10 to 15 minutes to type up a reflection. The content in the reflection was solely up to the student. It was their place to reflect on their experiences. The reflections served many purposes. The first was to reflect on the material learned in the course that week. This helped reinforce the material taught, but also helped identify potential areas of improvement for the class. With the pandemic causing isolation and mental health issues with students, it was a place for students to write about their lives, their isolation, their stress, their battles with covid, or anything that they wanted to write as it was their safe space [1]. During the in-person class, the instructor strives to create connections with the students. Additionally, the instructor got to know the students. The instructor set a goal to comment on approximately one-third of each weeks' reflections, which many students valued as it illustrated the instructor cared furthering fostering the community developed by the course. The instructor also utilized the reflections to identify those students struggling with mental health and create a safe atmosphere to help them get connected with the correct resources on campus. Some of the anecdotes about the students writing reflections are included in the bullets below.

- *“Even when writing this reflection now I have been able to recap on everything that I have learned and realize the impact it has actually had on me. I value this role and I will continue to do it not only in this class but in every class from now on.”*
- *“One thing about this class that I think you should never stop requiring each semester is the reflections. At first, I thought they were a waste of time but, as I’ve been doing them, I realized that it really helps to get your thoughts out. As a college student, I have a lot going on in my mind all the time, and the reflections really helped me get a better understanding of what I was feeling.”*
- *“I really enjoy these reflections I like stopping to just think and process the week. I somewhat naturally process my week.”*
- *“I hope I can continue writing weekly reflections for myself. This is a good exercise that has been part of my life for the last 14 weeks, writing a summary of what I did all week. I will though have to scale it up. Not writing just about what I did related to course, but what has been my weekly highlights.”*
- *“I think the class went well even for not having in person lectures. I think the class structure was very well put together, especially the weekly reflections. These reflections, although a small part of the class, really helped me mentally review the items I learned to better remember and apply them for the future.”*

### 4.3.3 Innovation Playbook and Group Discussions

As with the pre-pandemic version of the class, the course centered on a group project in which students develop an Innovation Playbook. Project based learning is a proven methodology to foster peer-to-peer interactions in an online course [39]. It was important to keep this element as the focal point of the class to allow students to have some peer-to-peer interaction in the online transition. The overall resulting playbook did not significantly change, but some of the assignments did change in order to fit the online environment. The first big change is that the instructor designed the teams. A survey was sent out for students to fill out regarding their major, degree program, location, weekly availability, and potentially one friend. In order to ensure diversity of majors, each team had a minimum of three different majors. Requests were only honored if both people listed the other on the survey. Teams were designed in order to mix graduate with undergraduate students (this was not fully capable in the fall, but was during the summer), majors, and to ensure that there was an overlap in availabilities. Based on the feedback from the spring semester, when the course was forced online halfway through the semester, the students highly recommended continuing to require each group to meet weekly. This would require the groups to stay on task and the project would be completed in “bite-sized chunks” as some students stated. In addition, it was also important to include course discussions as that was a large part of the structured interactive learning for the in-person version. Each week there would be a discussion topic that the group should talk about and provide notes for in addition to their weekly team minutes. One such discussion topic was, “What cognitive biases do you find yourself most guilty of? Why? How?”

These group assignments were distributed throughout the semester culminating in their final playbook. This gave the students a goal that they were working towards and the team a mission. The weekly meetings ensured the teams worked on it regularly to never fall behind and interact with their team. Some anecdotes from students regarding the role of the group project and interacting with their teammates are included below.

- *“This course was really valuable and equipped me with many tools for problem-solving that I hope to maintain and use in the future. I couldn't have asked for a better group to be paired with and I am incredibly thankful for ending up with them. Meeting with the girls every few days was very refreshing, given how limited my social interaction was.”*
- *“This course's group assignment also gave me some much-needed social connection via our GroupMe and weekly Zoom calls. Even though the vast majority of our interactions regarded the assignments, it was still nice to talk regularly with my teammates. I did like that we had to submit a weekly discussion. I think it held the team accountable and also forced us to meet weekly to ensure we were on track and all tasks were being completed on-time.”*
- *“It's a bittersweet feeling to end this semester. Part of me is excited to move on, but the other part will miss all the late-night discussions and bonds I have made with my group.”*
- *“I'm actually really sad this semester is coming to an end. I've had so much fun working with this group and completing the assignments throughout the semester. This class taught me skills in a way I think other teachers and courses just can't touch.”*
- *“I'm grateful for the experience and that I was able to make some new friends even in an online course. I hope I continue to speak with my team in the future.”*

#### 4.3.4 Creative Activities

In the on-campus version of the class, the lectures included in-class activities that would aid in encouraging an innovative and inventive mindset. Most weeks consisted of a number of these activities and students would share their results with the class. The students in the pre-pandemic version of the course thoroughly enjoyed the in-class activities as noted in the informal feedback from the spring 2020 course so it was important to continue a similar version in the online format. As it would be demanding to require numerous activities for each student and demand an additional group activity beyond the semester long project, it was decided to settle on one creative activity per week that aligned with the weekly module. These activities were completed either using the discussion board in the LMS for the course or Flipgrid, a video platform that allows users to upload videos of themselves. Flipgrid was chosen because of the ability to link directly into the LMS used by the university. Both the discussion board and Flipgrid submissions were public for their peers to see. Appendix A describes the activities and some anecdotal responses from students' reflections on each weeks' activity. Note that these are examples of some of the responses in the reflections. Students often reflected at how despite being given the same assignment, that everyone completed it differently.

The creative activities helped to create a sense of community in the course because students can view other students' submissions. Reflecting on the informal interviews, this was an important takeaway. It was important for students to see their peers' responses in order to help create that sense of community. Additionally, Flipgrid specifically allowed students to get to know their classmates better through seeing not only their ideas and creativity, but also their faces and their personalities. The sense of community that is built because of the Flipgrid platform can be demonstrated in the fact that students watched their classmates' videos, even though this is not a requirement of the activity. The average number of views per video can be seen in Table 2.

*Table 2: Creative activities that used Flipgrid and the average number of videos each student watched.*

<b>Activity/Week</b>	<b>Total Views Summer 2020 (174 students enrolled)</b>	<b>Average Views per Video for Summer 2020</b>	<b>Total Views Fall 2020 (131 students enrolled)</b>	<b>Average Views per Video for Fall 2020</b>
Week 1- Introduce Yourself	2109	12.12 0 students failed to submit	1234	9.42 5 students failed to submit
Week 4 - Skit	2203	12.66 7 students failed to submit	1403	10.71 13 students failed to submit
Week 7- Egg Drop	1452	8.34 11 students failed to submit	1141	8.71 17 students failed to submit
Week 9- Elevator Pitch	1093	6.28 14 students failed to submit	669	5.11 10 students failed to submit
Week 11- End of Semester Toast	1030	5.92 8 students failed to submit	603	4.60 13 students failed to submit

The average views per video was calculated by dividing the total number of views for all submitted videos by the number of students enrolled. The number of submissions was subtracted from the total number of views on the assumption that the grader watched each video once in order to grade the activity. Not all students submitted the assignment each week, but the average is based on the total students enrolled in the class because students may have watched peer videos and decided not to share their own.

Through the reflection comments on each activity and the number of unsolicited views for the Flipgrid specific activities, the creative activities were imperative in aiding to build a community in the class. The students would often look to their peers for inspiration or to see how others solved the problem at hand. It humanized their peers and showed the diversity of their peers, but also their similarities. It allowed students to feel a sense of camaraderie as everyone was doing the same tasks. It also illustrated the similarities and differences across the students. Some anecdotes from the role of the creative activities are noted in the bullets below.

- *“Creative activities always kept the class entertaining as they were always fun to film and watch other people’s creative ideas too. It helped with thinking outside of the box because everyone thinks of things that you may not have thought of. It sucked not being able to go into class to interact with the people face to face, but I feel like Flipgrid did a good job of keeping the class ‘face to face’.”*
- *“The creative ideas were my favorite part of the class and I believe provided the best learning experience, because they were memorable and fun, but still served a purpose.”*

## **5. Conclusion**

In transitioning a highly interactive, multilevel engineering class online it is important to consider various factors in the design of the course. With the global pandemic more classes have switched online, but many have not been done successfully. The same methods used in person cannot be used online. This paper looked at techniques used in the online transition of a design-based engineering class to facilitate community and to achieve an educational equivalence as the face-to-face version of the course. Prior to the transition, the instructor conducted informal interviews with students, faculty, and others who had experience with online learning. In addition, a literature review was done in order to understand what key aspects were to keep in mind when designing a course online. Both revealed the LMS plays a large role as the foundation of the class and guiding students through their UX. The instructor is the backbone as the designer of the course, but also the leader in creating an online community. When students believe their instructors care, they are more motivated and engaged in the coursework.

With respect to the experience transitioning the class in the paper online, the instructor wanted to create a similar educational experience to the pre-pandemic class. In addition, in an era of isolation it was important to include the interactivity that students enjoyed so much in the in-person version of the class. Assignments needed to be restructured. The group project successfully aided in creating an element of community in the course as reported by anecdotal feedback. This was especially true with the required weekly group meeting via a video conferencing platform. The course evaluations revealed that the personality, organization, and ability to submit assignments early were key strengths of the professor. This further illustrates the research that organization and care for you students will in fact lead to a better in course experience for the students. The creative activities allowed for students to explore their mind and

have fun, while being able to see the responses of their peers. Flipgrid proved to be an invaluable tool in designing assignments as students could watch each other and see their classmates' approach to the task. It put faces to their peers and built an element of camaraderie. This was evident through the number of videos each student watched as it was not a course requirement to watch your classmates' work. The role of self-awareness was important to illustrate the differences of the class, but also to help students understand more about themselves so they could better contribute to their group. Lastly, weekly reflections provided the students with an opportunity to share their thoughts on the course material or their own lives. It was a way for the professor to interact with each student to really build that element of "immediacy".

With respect to future work, it will be important to figure out methods to encourage further peer to peer interaction outside of one's own group. One student did note this, while she did like working with her group that, "*the biggest thing I didn't like about the class is that it was so isolated. The course had high enrollment, but I only knew 4 people.*" In addition, methods need to be explored to improve the methodology used for peer evaluations for the group project. Ideally, it should note the strengths and areas of improvement for each student.

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## Appendix A: Creative Activity Descriptions

Activity	Description	Student Anecdotes from Reflections
Week 1- Introduce Yourself (Flipgrid)	Innovation improves at the intersection of many different backgrounds, experiences, cultures, interests, etc. This idea is known as the Medici Effect. Students must first recognize their own intersections before they can effectively combine their intersections with their peers. Students use five or more items around their house to introduce themselves to their peers. They use the items to illustrate the many intersections that make up their identity.	<ul style="list-style-type: none"> <li>• “Eye-opening to understand how past experiences impact who we are today.”</li> <li>• “This activity helped in getting to put faces to the names of some of my classmates, as online classes make it hard to get to know people very well.”</li> <li>• “I enjoyed watching the other videos. Everyone had interesting objects in their boxes. It really goes to show how much variety that people have despite being same major/degree of study.”</li> </ul>
Week 2- PAIN Exercise (Discussion Board)	Students must take a 5-10 minute video of someone performing everyday tasks. Through watching the video, students must identify inefficiencies in the tasks and complete a PAIN chart (Persona, Activities, Insights, Needs) to identify potential innovations for these inefficiencies. Students must post their chart to the discussion board.	<ul style="list-style-type: none"> <li>• “This week’s creative activity also really changed my thought process regarding painstorming. I decided to go with a video of a barber and at first, I found nothing wrong with how he performed his job. But after watching it over at different speeds I found some things the barber did inefficient or methods that could be improved upon. Even though I have no experience cutting hair, I was still able to pick up on some things that could be improved upon in the performance of that job. In other words, I feel more insightful and am able to analyze situations from different points of view.”</li> </ul>
Week 3- Photograph Journal (Discussion Board)	Students must take pictures illustrating how their life has been impacted by COVID-19 for three days. They must then post a minimum of 5 pictures to the discussion board along with a sentence or two describing the impact. Then, they must comment on a peer’s post comparing experiences.	<ul style="list-style-type: none"> <li>• “I appreciated reading my classmates’ photo journals because I was able to get to know them a little more. It is encouraging to know that my classmates are people just like me who have similar struggles. The solidarity helps the feeling of isolation that comes with staying home often. It was also very interesting to see the perspectives of others and how they differ from mine.”</li> <li>• “As classes are now in full swing, I have really been thinking and reflecting on how my year this year is much different from my past three years in undergrad at UF. I found it fun and interesting to reflect on how my life has changed due to COVID-19 and to share those experiences and changes with my peers.”</li> </ul>
Week 4- Props and Functional Fixedness Skit (Flipgrid)	Students are tasked with selecting an everyday item and spending three minutes listing the possible ways this item could be used outside of the traditional role of this item. The students must then present a skit portraying the many uses of this object. The goal of this assignment is to overcome functional fixedness.	<ul style="list-style-type: none"> <li>• “There is beauty to creativity in the world of innovation. It only takes one creative thought to begin a process of innovation. I enjoyed this week’s creative activity, because it did show how an innocent creative thought could guide innovation. It was amazing to see what everyone from the class selected as their item and the different things you could use the item for.”</li> <li>• “I looked through some of the other students’ activities for inspiration, and some of the ones that I saw that were quite unique to me was all of the possibilities that newspaper could be used for. This made me think of all of the times that I have used newspaper in the past. Another one that I watched that was good was the spoon on. He did a great job really going outside of the box and taking a creative approach as well as some of the everyday uses.”</li> </ul>
Week 5- Bucket List (Discussion Board)	Students must write a 100-item bucket list for their life. These items can be anything that they hope to see, do, experience, etc. at some	<ul style="list-style-type: none"> <li>• “It took me quite some time to figure out what I really want to do after my tenth to-do or so, but after all, I am happy with the list I made, and I am looking forward to accomplishing them. I also read others’ bucket lists and</li> </ul>

	<p>point in their life. Students must post their list to the discussion board.</p>	<p>found out that I share a lot of to-dos with other classmates and realized that I am not the only one who wants to cliff dive or build a treehouse (always wanted one).”</p> <ul style="list-style-type: none"> <li>• “The bucket list took a considerable amount of time once I got past around number 40 on the list. Honestly, I had to look at others for ideas from other people. However, I enjoyed constructing this list because I don't typically spend that much time thinking about the things I would like to do in my life.”</li> </ul>
<p>Week 6- Inside the Box (Discussion Board)</p>	<p>Students must take the Systematic Inventive Thinking method covered in lectures this week and apply the ideas to a product of their choice. Students must post their ideas and analysis to the discussion board.</p>	<ul style="list-style-type: none"> <li>• “This week’s creative activity was my second favorite after the creative activity in which we had to select five items which had special meaning to us. For this week’s creative activity, I chose my system to be an Automobile. I chose this specific system because it aligned with my career interests and thought it would be easier to come up with ideas about this topic since I am particularly interested in it. The systematic inventive thinking tools: Subtraction, Multiplication, Division, Task Unification, Attribute Dependency used in this week’s activity actively promoted creative thinking. I found myself brainstorming about each one extensively before putting my idea down on paper. Inventive thinking is something I enjoy because, as an engineer, I am passionate about thinking of new solutions, or better solutions to problems.”</li> </ul>
<p>Week 7- Rapid Prototype (Flipgrid)</p>	<p>Rapid prototyping is important to innovation for the purpose of developing many ideas in a short period of time, extracting information from each prototype, and accepting failure as part of the process. Students are given the choice between four exercises to practice rapid prototyping. The students are limited to items in their house and everyday life for the solution. Students must upload their video to Flipgrid.</p> <ul style="list-style-type: none"> <li>-Classic Egg Drop: device to safely drop an egg seven feet</li> <li>-Kitchen Kapers: design a new kitchen utensil using five different materials</li> <li>-Hold Your Water: device to safely drop a cup of water seven feet retaining as much water possible</li> <li>-Pong Basketball: device to shoot ping pong ball seven feet into a cup</li> </ul>	<ul style="list-style-type: none"> <li>• “Initially I was kind of stressing out about the assignment because 7 feet felt like a lot, but then I heard from students about how much fun it was and that it was not that difficult. After this I started and was soon enjoying it (it was also much more achievable than I first thought), which made me think about how powerful the psychological state of learned helplessness is.”</li> <li>• “I think it was interesting to see that most of my peers chose to do the egg drop choice for the creative activity. I have always loved done egg drops and having fun creating wonky contraptions but felt like I'd have more fun trying to use my imagination with a new utensil.”</li> <li>• “I built the “Egg Drop” prototype and that was fun. The videos that other students posted were fun and some were very unique.”</li> </ul>
<p>Week 8- Innovation Obituary (Discussion Board)</p>	<p>Students must write an innovation obituary for a failed product or solution. Example topics include Sears, Blockbuster, and the Blackberry. Students must post their list to the discussion board.</p>	<ul style="list-style-type: none"> <li>• “Props to the professor for having the creative assignment. Not only do I enjoy doing them, but I actually, I mean actually, want to read other people’s submissions. That has never happened in the history of my formal education.”</li> <li>• “I have enjoyed the creative activity this week a lot, I have laughed a lot seeing the documents of my colleagues and doing mine in an original way.”</li> <li>• “It was fun to scroll through the discussion board and see how creative everyone got with their obituaries. Many were pretty comical and entertaining.”</li> </ul>

<p>Week 9- Elevator Pitch (Flipgrid)</p>	<p>This exercise is inspired by the IDEO brainstorming activity Mash-Up, where participants must join together two seemingly unrelated things. Students take two words from a random word generator and combine them to develop a solution or idea. They record a video pitching the idea to their peers.</p>	<ul style="list-style-type: none"> <li>• “This was probably my favorite creative activity. Mine were decision and pie. It was so fun and takes some stress off and allowed me to just be silly for an assignment, which I loved.”</li> <li>• “The creative activity this week was interesting. Watching how other people gave a pitch helped me figure out how I can give mine.”</li> </ul>
<p>Week 10- Safety Engineer (Discussion Board)</p>	<p>Students select an item and must complete a basic Preliminary Hazard List to identify the hazards in that item and the harms that could result. Safety and creativity go hand-in-hand, as creative people will use designs and not always as intended. It is important to think about how something could be used in order to develop a mitigation strategy.</p>	<ul style="list-style-type: none"> <li>• “It was fun putting myself in a child's shoes or a pet's perspective to think of different potential hazards a laser printer has. I also enjoyed reading other people's hazards for their objects because you don't realize how many potential hazards there are in common everyday objects. This activity has helped me learn to think more creatively, unlike most of my other classes.”</li> <li>• “I thought the creative activity was useful this week, as I have experienced having to think like a safety engineer in industry and some of the things listed as safety issues with a product are a bit farfetched, in that you have to really think sadistically and outside of the box to be thorough.”</li> </ul>
<p>Week 11- End of Class Toast (Flipgrid)</p>	<p>Students record a one- to three-minute video of themselves proposing a toast to the end of the semester. This activity was inspired by Toastmasters.</p>	<ul style="list-style-type: none"> <li>• “After doing my creative activity and writing a toast to this new normal, I realized that you can always find the good in any situation.”</li> <li>• “In my creative activity this week, I decided to toast innovation itself. Innovation does not come easy to most, is learned by some, and is an enigma to others. It is the crossroads of productivity, creativity, value, invention, needs, and requirements. Innovation has pushed society forward and will do so for as long as it exists. I had a really good time writing and performing my toast about innovation, mentioning all of the above and then some regarding what I had learned and why I felt innovation was important. I also saw a few other toasts about other aspects of the class and really enjoyed seeing them performed by my peers and relating to them.”</li> </ul>