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Paper: Transition of Instructional Methods from an In-Person to Online Course and the Lessons Learned

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1. Introduction

After 121 years, San Francisco State University (SFSU) flipped the switch and went fully online on March 16, 2020. SFSU University is a Hispanic Serving Institution (HSI) and Primarily Undergraduate Institute (PUI) located in the diverse San Francisco Bay Area Area. Known as a commuter school, 86% of students commute to the campus via public/private transportation daily leading to a daily campus population of approximately 33,500[1]. Motivated by mandates from the local Department of Health, SFSU decided to move courses online and provided faculty one week to switch all courses into an online version. This transition was met with various levels of preparedness of faculty and students along with a series of uncertainties related to home and family situations of all participants.

This situation raised the question of, what instructional methods translate to online courses and what adaptations are needed? For Engineering Statics, a core pre-requisite course for Civil and Mechanical Engineering undergraduate students, the change in the course presentation needed to be done with a high level of tact to ensure the quality of the course was maintained. Engineering Statics is the first major engineering course taken and is expected to prepare and instill foundational and necessary skills for continued academic progress. For these very reasons, the online course needed to provide the same level of effectiveness compared to the in-person offering.

The paper herein uses the author's Spring 2020 Engineering Statics course as a case study presenting the transition of in-person instructional methods to the online course and the rapid introduction of new methods to address the course and students' needs. Students completed feedback forms before and after the move to online courses providing quantitative and qualitative responses. This data was then used to evaluate the effectiveness of the transition of the instructional methods and identified areas for continued development. Students completed the feedback forms as part of their participation grade in the course, however, the points associated only comprised of 5% of the available participation points. These results help identify which instructional methods effectively transitioned from the in-person to online course. The methods discussed herein include synchronous/asynchronous lectures, use of music, group work, and approaches to note taking (e.g. applications, color-coding), and exams (e.g. problem randomization and timed windows).

2. Context

Before discussing the course's instructional methods in detail, it is important to cover the context of the course including the timeline leading up to the transition, the original format of the course, the online format of the course, and the preparedness of the instructor and students.

2.1 Timeline

The Spring 2020 semester began on January 27, 2020. This was approximately 30 days before the state of California had its first communal spread of the COVID-19 virus[2]. The switch to remote learning was done out of necessity due to mounting concerns and regulations being imposed from

the local Department of Health. In the weeks leading into March, departments prepared faculty for course changes in the case of a widespread COVID-19 outbreak. This preparation allowed faculty to conduct test classes online using Zoom, an online teleconference platform, with the freedom to move online if students and faculty were prepared. All members of SFSU have free unlimited access to Zoom and can be accessed using University credentials. By March 9, all campus events were cancelled. By the evening of March 9, all classes were cancelled for the rest of the week in preparation to move fully online on Monday, March 16. This move to online was well timed as a state-wide shelter in place order was announced midday Monday, March 16.

2.2 Original Course Format

The usual format of the Engineering Statics course is an in-person class scheduled for three, 50-minute lectures a week with no additional laboratory or discussion section associated with it. The grade for the course was broken down as: 10% Participation, 15% Homework, 15% Quizzes, 30% Midterms, and 30% Final Exam. The participation grade initially included attendance as a factor; however, after the official transition, University mandate did not allow attendance to be a graded item. In addition, this grade included the completion of activities associated with the course materials. Homework consisted of weekly assignments with a hard copy turned in at the beginning of lecture. A graduate student was hired to serve as a grader for this course to receive and review the homework assignments with a one-week turnaround time. Quizzes were administered through the required course publication created by this paper's author available through the Great River Learning (GRL) site[3]. These were timed quizzes with time limits dependent on the quiz topic and were available over a 4-day window. Two midterms are administered for this course. Midterm 1 was administered the week before the online transition was announced and was conducted in-person during a single, 50-minute lecture. The exam included a take-home problem and allowed students one page, one side of notes which was consistent with previous offerings of the in-person course. To reduce opportunities for academic dishonesty, student seating was randomized with two versions of the exam produced. The two versions only differed with respect to the order of the problems but the content and all numerical values associated with the problems were the same. This exam was not multiple choice but required students to show a full set of calculations associated with their final solution. The instructor would then hand-grade the exams providing mark-ups on the exams directly.

2.3 Online Course Format

This section briefly describes changes to the course format compared to Section 2.2. To try and maintain a sense of normalcy, the course continued to offer three, 50-minute synchronous lectures a week at the normal assigned time via Zoom. The course grade breakdown was maintained. Participation no longer included attendance but maintained all other exercises associated with the required course publication. Homework continued to be assigned weekly with the exception of submissions being accepted through the course's iLearn site. The course grader continued to work on the assignments with the same turnaround time. However, assignment markups were provided as notes in the submission site versus on the paper directly. Quizzes continued to be offered through the GRL site but the time limit was increased to a standard 1.5 hour which was approximately 3-4 times the recommended time for the quiz. This time extension was done to

accommodate for problems with the internet and workspace conditions. The second midterm and final exam were administered online and will be discussed in further detail in Section 3.5.

It should be noted that engineering courses normally are taken for a letter-grade. However, due to the COVID-19 situation, the University mandated an option for students to take the course for credit/no-credit (C/NC) or letter grade. This did not make an impact on the course approach; however, this may have impacted some of students' level of efforts related to the course activities. Out of 51 students, 14 chose C/NC. The associated data and statistics related to the final course grade selection will not be discussed in further detail in this paper.

2.4 Preparedness of the Instructor and Students

This paper's author and instructor for the case study course stayed abreast of the developing news related to the COVID-19 situation worldwide. Having first heard of the situation's increasing seriousness in January, the author continued to follow the news, especially the local news. The first communal spread occurred 50 miles away from the University at the end of February. As a result, the author took efforts to prepare herself, her family, and her students for the potential imminent impact to their daily lives. This was based on the changes seen especially in China which was the first hard-hit country.

Through open dialogue in the department, faculty asked questions and began preparing their students for changes in the course. As a result, the author offered her first test online class on March 6. This was accompanied by an evaluation sent out to students about the experience and any resources they may need. By March 9, the author gave her last in-person lecture, hours before the University mandate was announced. As an instructor, the author felt prepared to move forward into an online teaching platform given that her personal and department preparedness increased her time to plan and prepare for this transition in courses and general daily life. Although this increased planning time could not foresee all issues, it definitely decreased the level of stress associated with the one-week transition period. Additionally, the instructional approach applied to the in-person course offering allowed an effective transition to the online platform as will be discussed in further detail. Note: Resources were made available to faculty during the transition through the Center of Equity and Excellence in Teaching and Learning (CEETL); however, due to time constraints and additional responsibilities, this author was not able to participate in the available sessions until Summer 2020. It should also be noted that the author has taught this course six times and has developed her curricula progressively over four years.

The Spring 2020 offering of Engineering Statics had 51 students enrolled. An initial voluntary feedback form was provided to students after Midterm 1 along with additional questions related to the course transition preparation including feedback on the test Zoom class. Fifty-one percent of students responded to this inquiry with the majority stating they were prepared for the transition. Only two students commented on having connectivity problems. Other students noted that it was an "easy adjustment" and "better than expected." However, students did begin to note the social connection differences as the "professor asked questions nobody answered" and "I like that you can type in your questions if you don't want your voice or camera on." Although the students were receptive after this test class, they did express concerns such as "feel[ing] less focused", "not being able to organize enough group work practice", and "harder to understand the material."

Interestingly, there was an even split between the students in terms of these concerns. For every student who felt less focused, there was another response that stated they felt more focused. In relation to the general response to the current instructional methods, one-third of the students noted the note-taking experience was the most valuable aspect of the course with 75% of respondents stating it helped their comprehension of the material. In addition to note-taking, the students found the general instructional approach to discussing the material valuable. Over 75% of the responses noted the current amount of group work being an effective and sufficient amount. At this point, group work was occurring once a week on average and comprised of students working collaboratively on problems. At this point, the majority of students were content with not only the current pace and offering of the course but also the move to an online platform.

3. Transition of In-Person Teaching Methods to Online Course

The following methods are discussed based on feedback available prior to the transition and at the conclusion of the course reflecting 76% of the student enrollment. The student feedback questionnaires were part of their participation grade and created to allow students to provide quantitative and qualitative responses based on their concerns, curriculum design, stimulation of interest, and personal characteristics. The questionnaires were developed based on approaches recommended by Rowley[4], Richardson[5], and Huxham[6]. Both questionnaires were offered online providing students several days to a week to respond. The questionnaires were conducted by the instructor and were not used as part of any University review of the instructor's performance. The instructional methods applied to this course will be discussed in the following sections. Each section will preface the literature associated with the instructional method followed by the usage in the case study course, the student feedback, and comparison to available control group.

3.1 Synchronous/Asynchronous Lectures and Video Recordings

Synchronous lectures are those given in "real-time" with students meeting at a regular course time to take part in the lectures. Asynchronous lectures are ones that are recorded and posted to a course site for students to follow at their pace. The case study course was synchronous, however, all lectures were recorded and made available for students to participate asynchronously. It should be noted that at the time of transition, the instructor was not aware of the option to have asynchronous lectures. Although the instructor would have most likely not approached the subject matter entirely asynchronously, other instructors have noted positive effects by teaching hybrid courses[7-11]. No student respondents noted in the feedback their desire to pursue asynchronous courses/lectures; however, this could be related to their level of exposure at the time of the questionnaire.

Synchronous lectures did give a sense of normalcy to the class that helped keep the instructor and students on track. The use of video recordings for classes was an easy transition to the online setup. Once familiar with the Zoom platform, the instructor was able to quickly and easily record the videos. The videos included a projection of the instructor and the lecture notes which will be discussed in more detail in Section 3.4. The one caveat was the large file size. The instructor opted to record to computer which allowed the video to be saved directly but a 50-minute lecture in general was approximately 1-2 GB of data. Another caveat of using direct recordings was that close captioning was not available. The Zoom platform will automatically generate closed captions when recorded to the cloud. Although the accuracy of the captions is not 100%, it does allow for

a wider group of users to access the video recordings. At the time of this course, the instructor did not opt for cloud recordings due to the delay in processing times experienced. Video recording files were uploaded to the course page where students could either watch directly in their browser or download to their personal computers. This allowed students working off any type of technology (e.g. laptop, desktop, tablet, smartphone) to have access to the videos.

The student feedback reflected that 10% of respondents utilized the video recordings for full-participation in the course. Only one student noted asynchronous participation due to time difference while the remainder of respondents noted work preventing synchronous participation. With the availability of the video recordings, 82% of respondents used the videos either for asynchronous participation or review of the class material. The availability of recorded lectures did not change 48.7% of respondents' attendance. However, 20.5% of respondents stated they found themselves less likely to attend lecture which is 10% more than those who needed to utilize the recordings due to work/time difference issues. Nevertheless, students felt more encouraged to attend the lectures as their commute time was significantly reduced. On average, the students were traveling 7.7 hours a week commuting to school. This is nearly an entire workday that was spent coming and going to class which is quite significant. Several students commented that prior to online courses, they would miss certain classes due to traffic or the sheer desire to escape the commute for the day. As a result, these various reasons impacting attendance to synchronous lectures balanced out to present an average attendance comparable to in-person lectures.

The instructional approach of synchronous lectures still remains to be a preference for student participants. The availability of video recorded lectures appears to be highly desirable based on the number of student users as they are effective in reinforcing material. In fact, some students noted that they watched the videos several times to help review examples and prepare for exams. Educational videos such as these have shown in numerous studies very positive effects as they reach various student learners[12]; instill 21st Century skills[13]; expand classroom boundaries[14] and not only heighten, but increase repeatability of emotions that excite, teach, and engage students [15, 16]. Additionally, the use of video recordings did not produce a decrease in the number of student participants. On average, there are typically 10% of students absent from in-person lectures which did not change significantly during the online course offering. As such, the instructor will be pursuing technology available on her campus to explore video recording lectures once students return to the campus. The ability for students to participate in the course synchronously and asynchronously has strong positive feedback from this student base. A control group for the use of synchronous/asynchronous instruction was not available at the time as all courses were recommended to be conducted synchronously.

3.2 Use of Music

Overcoming silence to initiate discussions in the classroom is a major challenge that has been studied by numerous researchers[17-19]. In an in-person setting, the classroom can be quiet at times. However, there is still noise from the chairs, doors, floor, etc. This breaks up the silence in the room to give the sense of human presence. However, in the Zoom setting, this silence is further emphasized by the deafening lack of any noise from muted students.

As part of the in-person class, to add onto the ambient noises, music based on a student playlist was played at the beginning of class to lighten the mood and create a welcoming atmosphere. The

songs were mainly mainstream pop music. Music has numerous positive benefits to student development[20, 21] as well as serving as a stress reliever[22] in the classroom. This transitioned easily online and in some ways was more effective than in-person. As students entered the Zoom meeting room, they were welcomed by songs from the student playlist similar to their normal in-person lectures. This provided a sense of normalcy while also creating a less strenuous environment.

In the feedback forms, 92.3% of respondents found the use of music helpful in breaking the silence of the Zoom classroom. One student even commented that the music was relaxing which further emphasizes one of its additional benefits. Using uplifting and upbeat music improved the overall response the instructor received during the lectures. In the online platform, the conversations initiated were a mix of oral communication and written chat messages. On the Zoom platform students not only can communicate orally but can also send chat messages to each other and the instructor throughout the session. Students across the board had concerns about internet connectivity and background noise from their housemates and family. Nearly one-third of respondents stated they did not have a workspace in their home to focus on classes. As a result, many students did not unmute themselves to avoid disruptions to the lecture. However, even in these cases, the fact that the chat messages were initiated at the start of the lecture was excellent. Students would ask for the title of the song or give positive feedback on the song of the day. Although many students found themselves communicating via chat, it helped to initiate conversation. It got students feeling comfortable to engage which was the most important goal of the instructional method.

Chat was the number one way that students communicated in the main lecture sessions. Respondents noted that oral communication was “awkward” as the etiquette to question asking seemed to not have transitioned well to the online course. Although the instructor would intentionally pause for questions, the majority of questions would come via chat rather than unmuted students. Additionally, the use of the “raise hand” function still remains to be rarely used by students in the courses this instructor has taught. In in-person lectures, the music-initiated conversations orally between students as well as with the instructor.

The use of music in lectures was easy to do in overcoming the ambient silence to initiate conversation amongst peers and the instructor. However, the form of communication between the in-person and online offerings differed. While in-person initiated oral communication, the online courses saw increases in chat or written communications. Although it would have been ideal to initiate more oral communication, limitations beyond the control of the instructor and the student participants restricted this option. Nevertheless, it created an opportunity for students to still remain engaged and feel free to comment/ask questions throughout the sessions. In other engineering courses that did not utilize music at the start, the silence and lack of communication in any form was the number one concern from faculty as discussed in teaching roundtables led by the author. Faculty attempted to overcome this lack of engagement using question polls or verbal question prompts. Although the music was powerful enough to help initiate conversation, it was not able to overcome the immense challenges that group work in an online platform presents as discussed in the next section.

3.3 Group Work

Group work is a core component of the instructor's pedagogy. It instills communication, teamwork, and technical skill that cannot be created through independent study alone[23, 24]. As a result, on average, the students participated in weekly exercises with their peers. In these settings, students openly discussed and worked on problems as the instructor moved from group to group providing additional assistance. Groups were comprised of students that sat adjacent to each other. At the end of lecture, the class would unite and review key elements of the problems worked on.

In the transition to the online platform, the instructor still wished to maintain this collaborative element via Zoom breakout rooms. Within the main meeting session, students can be randomly divided into various sub-sessions where they can discuss privately, use chat features, share screens, etc. These breakout groups would have 3-4 students each. The instructor as host is capable of moving from breakout room to breakout room to provide help and review the progress of the group. Given this is very similar in theory to the in-class group work sessions, the instructor implemented this in the first weeks of online classes. However, the implementation did not last.

Although the arrangement was similar to the in-person conditions, the sense of social engagement was completely different. In student feedback forms, students expressed frustrations as classmates were unmotivated to unmute themselves or interact in effective ways. Many students attempted to engage their classmates with no success. This result was very counter-intuitive. In most in-person classes, the level of interaction between students was greatest during small group discussions rather than the large class wide discussions. However, in the online course, this general response was the opposite. Students found themselves more interactive at the larger classroom level. Although the instructor found numerous groups having fruitful discussions, there were enough rooms that did not reflect this engagement resulting in a change in approach.

As a result, the use of group work in breakout rooms was replaced with class wide discussions on problems. Instead, the instructor opted to use polls available on Zoom to engage the entire class. The instructor would post a problem and have students provide feedback on their progress through these polls at incremental locations. The instructor would work through the portion of the problem covered and continue to provide time increments for the students to work. This proved far more effective than breakout rooms; however, it lacked the social engagement that was a key feature of the activity. As Zoom breakout rooms was the recommended approach for group work, the availability of a control group was not available. As a result, the course was redesigned in Fall 2020 to challenge students to be motivated to work together by implementing games as will be discussed in a future publication.

The general reception to group work was surprising. In terms of unofficial and official study groups, 67% and 44% of respondents participated in a study group before and after the switch to online courses respectively. However, the 20% that noted that they no longer participated stated part of the reason was the difficulty of connecting with other students. Those who did continue used texting and teleconferencing software to interact. From the in-person lectures, 74% of students found the group work sessions to be helpful in reinforcing the material. Based on the feedback, it appears those who continued to be active in group work out of the classroom were more open to in-class breakout room sessions than those who did not. With the majority of students no longer participating in any form of group activity outside of the classroom, this proved to be a major hurdle in student engagement.

Interestingly, 51% of respondents noted that they would be interested in a study group if it was organized by the course instructor. Several were interested in ones organized by student professional organizations while the minority wanted to create their own. This is quite different than in-person sessions where students would rather create their own groups. Comments reflected on the fact that instructor organized groups would assist students who were more introverted as well as bridge the lack of network that is present in these early engineering classes. Given the association between the participation in a study group and the ability to work in groups via breakout sessions, this approach will be further investigated for future course offerings.

3.4 Note-Taking Approach

At the time teaching moved into the remote learning status, there were two techniques being implemented for the course: electronic notes and color-coding.

3.4.1 Applications

As there are numerous types of student learners[25-27], the instructor evolved her note-taking to engage as many students as possible. Through using the GoodNote application available on the Apple iPad, the instructor is able to write directly on the iPad and project the notes onto a projector screen in the classroom or share screen via Zoom. In addition to the projection versatility, the notes can then be saved as a PDF file at the end of the class to be posted onto the course webpage. This process transferred very well onto the Zoom platform as the students now had the lecture notes very clearly shown on their personal screens. They also could enlarge or zoom in on the notes as well. The benefit of this note taking approach allows auditory learners to focus on the discussion at hand rather than multi-tasking with writing. This is a benefit as it allows these students to better focus and absorb the material.

In feedback, respondents noted note-taking and accessibility to the notes as being one of the highlights of the course. Over 90% of respondents stated the note accessibility was extremely useful in their review and studying of the material. As the transition of the notes from the in-person to online course offering changed very little, respondents gave positive notes to this fact and liked that the note-taking experience did not change drastically with the shift. The students were familiar with the presentation of the notes.

3.4.2 Color-Coding

The most positive element of the note-taking experience had to do with the use of color. Board notes or lecture notes are an extremely important class component and the American Society of Civil Engineer's Excellence in Civil Engineering Education (ASCE ExCEEd) emphasizes the use of color-coding[28]. The use of color helps students to begin to visually identify key concepts and more importantly embeds a life-long learning practice within the course. Colors in the Statics course were used to differentiate and highlight headers, definitions, examples, and formulas. Using this note technique helps students transcend its use across to other courses. Additionally, in the case there is a color-blind student, the color-coding is done in parallel to non-color related annotations including underlining (blue), boxed text (green), and force vectors or arrows (red).

Students found this very beneficial with 95% of respondents stating the color-coded notes helped them comprehend the material. Students found the color engaged them more as they paid more attention to the discussion and the notes presented. It also increased their organization by highlighting key topics in the class. They also stated that although it increased the level of colors in their notes, it was not a distracting feature but made their notes more inviting. Several students noted that they have taken this skill learned from this course and now apply it to other courses they are taking. The approach to note-taking in the course translated very well to the online platform. The only change to the experience was the fact that students had a closer view of the projected notes on their personal screens. The benefits achieved with these instructional methods in the in-person offering continued to be present in the online course. Given that students noted difficulty of focusing on online lectures, the use of color added to the experience as it kept them engaged throughout the lecture. In general, students across the board have thoroughly enjoyed these methods and the instructor will continue to apply them as the courses transition back to in-person.

In control groups associated with this and other engineering courses, there was strong feedback from the student community about the note-taking experience. As not all engineering instructors were familiar with tablet technology, the transition to effective online notes was difficult for some. Many students expressed frustrations with the poor visibility, poor quality, and accessibility of notes. The University did provide instructors with basic tablets, if requested, however some faculty encountered technical issues with limited access to IT support.

3.5 Exams

Next to group work, exams were the next most difficult item to transition to the remote learning platform. This is due to a number of challenges that needed to be overcome due to student resources and academic integrity. Online exams were administered through the iLearn system which is a platform that allows course pages to be developed with various features such as a gradebook, activity development (e.g. quizzes, forums), and communication. The exam itself comprised of 2-3 problems that students had to write out full solutions with final answers boxed. Students needed to submit the hand calculations in order to be graded with no final answer accepted without the supporting documentation. These submissions were all made online through the course page. However, there were differences between the in-person and online exam experiences.

3.5.1. Timing

An in-person midterm exam for this course would take 50 minutes and allow students the use of a single page of notes. However, with the remote learning switch, the midterm not only became open notes but more importantly the timing needed to be adjusted. Instead of 50 minutes, the exam increased to a 2-hour exam experience. The number and level of difficulty of the problems remained comparable to what would have been provided in-person. This time increase was required to accommodate for internet/connection issues, student workspace, and time to scan hand calculations. The students were also provided a window of time to take the 2-hour exam. This was necessary to account for the fact that the 2-hour time period expanded outside the regular 50-minute class allotment. To accommodate students who had courses before and after the assigned lecture time, the exam window allowed students flexibility without the stress of having to miss a

class to take an exam. Students were surveyed prior to the exam date to determine this window of time to ensure all students had two-hours within the exam day to participate.

Students faced numerous challenges in the transition to remote learning with internet and workspace being the most critical[29]. As the workspace might not be conducive to an ideal exam environment due to noise, lighting, etc., the exam timing was elongated to acknowledge these circumstances. One-third of student respondents noted workspace insecurities which is significant given that exam workspace is normally automatically provided in an in-person setting.

Student respondents found the flexibility in the exam timing beneficial. Numerous students noted that they had internet connection issues not only in this specific course but in other courses as well while taking exams. The extended time to negotiate the technical issues was welcomed. This approach was used for the second midterm as the first midterm was conducted in-person. For the final exam, the exam time was preset at 2 hours which required the instructor to modify the exam slightly to ensure there was enough buffer time to cover any technical issues while still covering the material necessary for the final cumulative evaluation.

3.5.2 Problem Randomization

In-person exams allow proctors to visually observe the students for any unusual behavior. However, online exams make this visual check far more difficult. Although some educators require students to have cameras on during exams, this was not required for this course. This is due to the equity issues that exist in our student community where some students do not have the internet bandwidth or equipment to do this effectively. As a result, the main method of challenging any potential issues with academic integrity is to randomize the problems.

In an in-person class, all students would be provided the same problems with the same numbers but potentially in a different order along with randomized seating. However, for the online exam, students received the same problem but with variations to the loading locations and values. This would still test students on the same objectives at the same level of difficulty but would deter students from trying to direct copy. As students were required to submit hand calculations, the instructor was reviewed them for any unusual responses or signs of academic dishonesty.

One nuance of the randomized problems was that a solution set could not be easily distributed to students. Additionally, it was not desirable to release this either as the problem bank is meant to be used in future course offerings. In in-person exams, as there is a finite number of problems, the exam solution could be easily posted and discussed in the class. These problems are re-used with variations but not to a level of similarity that having the exam solution set available would be detrimental. However, in the case of these randomized banks, to make the most out of the time and effort associated, these problems must be re-usable. As the percentage of students who complete each problem is relatively small, the instructor's approach was to have students meet with her one-on-one. She preferred this approach as she generally likes to interact with the student to understand what problems he/she are encountering with the subject matter. Although this is not fully feasible with the size of the course, this approach worked for the time being.
Overall, the problem randomization and timing worked quite well but took immense effort on the instructor's part. For the Final exam, there were seven versions of each problem with the exam

having a total of four problems. Thus, a typical four-problem exam turned into a 28-problem exercise. This is a definite increase in time for exam preparation. The course site automatically would randomly pull a problem from a given bank which allowed for automated exam creation/distribution. The benefit of this problem bank is that each semester more problems can be added to it. As a result, as time goes on, instructors can have a large problem bank that can be effectively used for computer proctored exams. Creating in-person exams from this randomized bank will require a bit more manual support but definitely presents a good resource for instructors.

Within the course, there was a control situation that the randomized problem usage was compared against. Midterm 2 was not randomized and the instructor noted a higher average score for the class at 89% compared to 80% in previous course offerings. Although no obvious signs of academic dishonesty were present this did raise concerns especially as other engineering courses experienced issues with problem support sites such as Chegg. For the Final, the average score was 76% which was comparable to previous course offerings. This suggested a possible correlation in performance and potential for academic dishonesty. Although the startup time and effort for randomized exams is substantial, the benefits and long-term use can make it a worthy venture.

4. Continuing Challenges with Online Teaching

The instructional methods discussed in the previous section eased the transition to online teaching. However, there were various challenges that continue to be present as will be discussed next.

4.1 Lack of Visual Cues

The use of music helped to break the auditory silence that plagues online classrooms. It initiated written communication mainly in the form of chat. Although, many students also unmuted their microphones to participate via oral communication. But the visual connection that is generally experienced between the student and instructor was lacking. The instructor did continue to keep her video on; however, understandably many students did not use their video due to resource issues concerning equipment and internet connection.

In-person lectures allow for social cues such as head nodding or brow furrowing in confusion. These reactions aid the instructor in identifying when the topic discussed is making the impression desired or completely missing its mark. However, in the online platform this was missing, presenting a lack of vision. This creates a problem as instructors try to pace discussions and present examples based on these queues. It was not until this vision was removed that the instructor realized the significance of its role in her teaching. The typical questions of, “Does this make sense?” no longer were followed by a series of nodding heads but rather silence as students were most likely nodding their heads not realizing no one could see it. Some students did find themselves unmuting to give affirmations but still left the instructor curious about the majority of the class. This visual challenge will continue to be studied to identify ways to overcome it.

4.2 Pace Pressure

Continuing with the lack of affirmation from students, this leaves the pressure to maintain a necessary pace to the course. Many colleagues in non-engineering courses commented in

teaching forums that they were not covering as much material as usual in their courses. However, those who responded with this comment, typically taught courses that did not necessarily create or provide knowledge or skills required for further success in the major. However, with the case study course, this is a core pre-requisite for two majors (Civil and Mechanical). This makes this course a crucial first step in the students' academic path at the University.

With this in mind, the course schedule changed only slightly due to the week off students/instructors received to prepare for the online transition. Discussions of various applications where Statics is applied in future courses was minimized due to the adjustment. However, the core material was maintained with the breadth of the course still covered. As this course serves as a core prerequisite, the removal of topics would impact follow-on courses and the foundation for practice in engineering. The intent of reduced course material is to humanize the course by acknowledging that students do not comprehend the material online in the same way they do in-person. However, this is countered by the requirements for students to have exposure to certain topics and skills. There is no right or wrong answer to this issue as both sides are equally supported. SFSU's CEETL has encouraged reasonable course adjustments such as changes in activities, methods of student interactions and class topic scheduling. Course redesign grants were provided to aide faculty in re-evaluating core course learning outcomes [30]. By doing this, essential skills and knowledge are preserved in this new approach to the course curriculum.

4.3 Time Commitment

For many instructors, courses are not recreated every semester but slowly developed over time with various adjustments through the semesters to add new technology or new information. With the transition to online teaching, course redesign started immediately. The instructor for the case study course has taught this subject for over four years. There have been various adjustments over time but the online switch has been the most substantial.

The switch in the group work led to efforts to recreate the problems into a series of milestone points as well as create polls associated with these points in the problem. This pushed the instructor to envision being in a group and determining which questions or issues would typically arise while working through these problems. Questions related to logical inference from the problem along with more technical calculations were derived. This required the weekly group work lectures to be redone to fit this model. However, it also meant that the number of problems that typically covered were reduced. The remainder of problems that typically would be provided were posted as optional practice for students. However, due to the pacing of the polling and the time to allow students to work, created a longer than usual process for each problem.

For the exams, as mentioned, the time and effort to create the randomize problem banks was immense. Given the significant increase in the number of problems needed, the instructor devised ways to utilize spreadsheets to track and calculate the various problem scenarios. The best approach to the randomization was to create drawings that were generic and could be catered to the specific set of loading locations and values in the problem statement. This decreased the amount of drawing necessary while maintaining the level of content. Although forces and load values can be easily changed, the greatest concern was to the ensure the level of difficulty was comparable between all scenarios. Although the challenges each problem presented were not

identical, the problems were designed to push students' critical thinking and problem-solving skills utilizing the knowledge acquired from the respective lessons. This overall process is quite time consuming and will require instructors to dedicate time throughout the semester rather than the days ahead of the exam to create a quality bank of problems.

Time has been an immense challenge in various ways. Although the amount of time spent for classes, meetings, and office hours was the same pre-online classes, the work outside of this protected time added up quicker than usual due to the additional tasks required to redesign courses and provide flexibility to students. These efforts although are difficult now will be very rewarding in the future as it presents new ways to potentially engage students back in-person.

5. Conclusion and Lessons Learned

Ultimately, the course ended on a very positive note. The majority of respondents found this course transitioned the best due to the very instructional methods discussed. Additionally, the overall grade results did not present any unusual skews or changes to student performance. In Fall 2020, the instructor taught a course that utilized this Statics course as a pre-requisite and there were no notable discrepancies in the students' skill set or need for remedial work.

The transition to online learning was rapid and done so under a very precarious time due to the level of uncertainty in students and instructors' lives. The success of this course's transition is due to the level of preparation made ahead of the transition, and most importantly, the versatility of the instructional methods applied. In all engineering projects, we are taught that the planning phase is one of the most important phases of an entire project. From this case study, the time to practice using online platforms, notifying students of upcoming changes, and personal preparedness for the unknown really helped relieve a substantial amount of stress associated with rapid changes. Without this extra couple of weeks, the results of this case study might have been different.

The techniques used in the in-person offerings in general transferred well without much additional effort. These included synchronous meetings, note-taking, and music. Group work and exams definitely took additional effort on the instructor's part to improve their transition. These activities had nuances that needed to account for the constraints of the students while aiming for the same goals. The overall level of flexibility of the course was increased by accounting for accessibility and timing. Understanding these constraints and knowing the student community is crucial. There were definite challenges and demands made on the instructor given the lack of visual cues, the pressure to stay on pace, and the time commitment needed to revamp the course.

In all these cases, there was a common goal: to continue providing quality education to our students. This mission is a difficult one to achieve in-person and with a new hurdle introduced by the removal of physical presence which enhances the learning experience. However, it has taught us that there are instructional methods that can transcend the teaching platform and be effective anywhere. There are also methods that must be modified such as group work to retain its effect.
There are two major conclusions that can be drawn from this case study. The first is that similar courses such as Engineering Statics can excel both as an in-person and online offering. There are various challenges present in both scenarios. However, these challenges are not so significant that they cannot be overcome by modifications to the instructional methods. There should be

acknowledgement that the first implementations of these course offerings will require additional effort on the part of the instructor but this is not time wasted. It is an investment in long-term development that is rooted in this foundational work. Secondly, instructional methods will have varying outcomes. In the case of music, it initiated communication in different ways between the online and in-person courses but it still made progress. In both scenarios, the results were positive but manifested differently. Turning on the online switch was an unexpected and major change to the course dynamics. The shift for the case study course did come with unexpected demands but it has created new insight into ways teaching can be effective in any platform.

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