Transitioning to Online Learning amid COVID-19: Perspectives in a Civil Engineering Program

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Abstract
The transition from face-to-face classes to fully online learning (OL) during the spring semester of 2020 occurred almost globally because of the imposed COVID-19 lockdown. The present study investigated the perception and experiences of undergraduate students and faculty members of the Civil Engineering program at the United Arab Emirates University concerning switching to OL during COVID-19. Quantitative questionnaires were distributed to faculty members and students following the end of the spring semester of 2020. Students and faculty members identified student engagement and online exams as major areas that require improvement. Online exams were challenging for students and difficult to prepare, control, and administer for faculty. Providing technical support is critical for the successful streaming of online courses. Initially, half of the surveyed students began the transition with a positive attitude toward OL, and this percentage increased during the transition. The capacity to continue learning during the COVID-19 crisis and the availability of recorded materials were perceived by the students as the main advantages of OL while challenging online examinations and the lack of social interaction were the main disadvantages.

Keywords: Student perception, faculty perception, COVID-19 pandemic, online learning, civil engineering, emergency remote teaching

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The world has yet to recover from the COVID-19 outbreak since the first statement was issued on December 31, 2019, announcing the emergence of cases of "viral pneumonia" in Wuhan, China (WHO, 2020). The virus has spread globally, with more than 274 million cases and the deaths of over 5.3 million people being reported worldwide as of 18 December 2021 (WHO, 2021). The outbreak has set unprecedented limits on social interaction (Murphy, 2020). These restrictions have impacted different sectors and services that rely primarily on social interaction for producing effective outcomes. The health and economic impacts of the pandemic have been the main focus of many recent studies (Nicola et al., 2020; Sohrabi et al., 2020). One sector that has been directly impacted is higher education, particularly as there has been considerable uncertainty concerning the safety guidelines required to limit the spread of the virus (Murphy, 2020; Nicola et al., 2020; Zhang et al., 2020). Higher education institutions (HEIs) were forced to take immediate action, ranging from mild measures, such as campus cleaning and disinfection, to extreme measures, such as campus closure (Bao, 2020; Crawford et al., 2020; Murphy, 2020; Zhang et al., 2020).

The COVID-19 pandemic impacted the learning environment in HEIs drastically. For example, the higher education sector in the USA made the most significant investment jump ever in education technology in 2020 and 2021, mainly by HEIs that had not invested significantly in technologies related to online teaching before the pandemic (Garrett et al., 2021). Some scholars posit that the effects will transform teaching and learning practices worldwide (Crawford et al., 2020; Dhawan, 2020). Transitioning to emergency remote teaching and learning in engineering is difficult because the design and hands-on course delivery requirements are compromised. Accordingly, this study aimed to identify the perceptions of the students and faculty of the Civil Engineering program at the United Arab Emirates (UAE) University regarding the impact of transitioning to online platforms during the pandemic. Quantitative questionnaires were distributed to faculty members and students following the end of the spring semester of 2020 (hereinafter Spring 2020) to identify the challenges faced during the transition and the opportunities for maintaining online pedagogy afterwards. Findings of this study are intended to inform engineering program administrators and university strategists about the factors that influence the effectiveness of the transition from face-to-face (F2F) to fully online learning (OL) pedagogy during a crisis.

Literature Review

Planned Versus Unplanned Online Learning

OL pedagogies have received considerable attention over the past two decades. Most studies have differentiated between planned transitions to OL and emergency remote teaching that took the form of OL but lacked preparation (Gacs et al., 2020; Hodges et al., 2020). The differentiation was intended to ensure a fair judgment of the performance of OL compared to F2F learning (Helms, 2014). In emergencies, the transition to remote teaching is often too rushed to secure the support required for a successful learning experience (Gacs et al., 2020; Hodges et al., 2020; Thompson & Copeland, 2020). Moreover, the focus was on transitioning to an online environment; the pedagogy of virtual education received little attention (Crawford et al., 2020). This haste to implement remote education could create a poor learning experience that would deter faculty members and students from viewing OL as a reliable learning approach (Gacs et al., 2020; Hodges et al., 2020; Thompson & Copeland, 2020). This is particularly true for persons with visual, hearing, or mobility limitations, as the transition to remote teaching could pose new obstacles (Thompson & Copeland, 2020). Nevertheless, emergency remote teaching (i.e., the

unplanned version of OL) has been touted as a viable alternative for HEIs during emergencies and as a disaster response (Czerniewicz et al., 2019; Mackey et al., 2012). Blended learning, which combines OL and F2F learning, was proposed as a measure to increase HEIs' academic resilience (Mackey et al., 2012). This "planned" incorporation of OL into HEIs' program delivery has several advantages: the gradual expansion of existing resources and support infrastructure required for the successful adoption of OL; sufficient time and training for faculty members to design OL modules; identifying pitfalls in OL so that technological and pedagogical innovations to improve OL can be implemented; and structural and systemic changes in the organization of the HEI that strengthen its ability to adapt to new challenges (Mackey et al., 2012).

Despite the differences between "planned" OL and emergency response remote teaching, both scenarios share many characteristics that are relevant to the success factors and challenges faced. There is a consensus in the literature that the elements of success in OL comprise securing resources and infrastructure, including access to alternative learning formats; preparing students for the skills needed for independent learning, such as time management and effective communication; training faculty and staff in OL technologies and strategies; and establishing and maintaining a resilient learning community through communication and feedback channels for all stakeholders to foster an inclusive, responsive, and flexible learning environment (Gacs et al., 2020; Mackey et al., 2012; Thompson & Copeland, 2020). Student engagement and the interaction between students and faculty remain key factors in any learning environment yet are particularly difficult to achieve in OL (Paechter & Maier, 2010).

Transitioning to OL During COVID-19

Several studies have emerged over the past two years on the transition to OL during the COVID-19 pandemic. Some assessed imposed policies and proposed strategies to enhance OL. For example, Zhang et al. (2020) assessed the Chinese policy for transitioning to OL during the pandemic, finding vagueness and a lack of consensus regarding the teaching approach, materials, teaching environment, workload, and the consequences on education equity. Potential challenges included weaknesses in the required infrastructure, teachers' lack of experience, and complex home environments. This was echoed by Huang et al. (2020), who called for an expansion of the information technology infrastructure and the provision of relevant technological resources to teachers and students. Rapanta et al. (2020) provided experts opinions on the pedagogical knowledge needed by new online instructors, emphasizing the importance of instructional design and organization, faculty presence, and student assessment. The authors concluded that designing an effective learning environment is not the sole responsibility of faculty but requires management support for faculty development.

In another group of studies, researchers shared their experience or thoughts about existing OL programs (Long, 2020), delivering courses online (García-Alberti et al., 2021), redesigning course content for OL (Reck, 2020; Riley et al., 2021; Streveler & Smith, 2020), improving online delivery of specific courses (Giles & Willerth, 2021; Zapanta et al., 2021), using new approaches for effective online teaching (Alqahtani & Rajkhan, 2020), enhancing student self-study (Balakrishnan & Long, 2020), enhancing student engagement (Mosquera Feijóo et al., 2021; Prince et al., 2020), applying new methods for student assessment (Barra et al., 2020; Teo & Pueh, 2020), and enhancing student motivation (Leung & Chu, 2020; Miller, 2020).

The third group of studies focused on conducting surveys to assess the effectiveness of the OL process during the pandemic. Some of these surveys were conducted for HEIs without consideration of variations in the academic programs. For example, Hayashi et al. (2020) surveyed administrators, faculty, and students at 56 HEIs in Sri Lanka and found that the HEIs had made a remarkable transition to OL, mainly because of free internet access. However, the adoption of OL still varied by discipline, university, and household income. Johnson et al. (2020) surveyed faculty and administrators in 672 HEIs in the USA and found shortfalls in support for students, access to online material, and guidance for working from home. Mishra et al. (2020) conducted a survey of 78 faculty members and 260 students from 26 departments at Mizoram University, India. The main challenges faced by students were an interrupted electricity supply, an unstable internet connection, and a lack of essential resources, whereas the primary concerns raised by the faculty were student engagement and motivation. Lassoued et al. (2020) reported that faculty and students at HEIs in Algeria, Egypt, Palestine, and Iraq faced weak internet connections and a lack of needed devices in transitioning to OL. Students also indicated a lack of motivation to study online and a lack of class interaction; however, faculty members indicated a lack of willingness to implement OL and a lack of professional training. Al-Salman and Haider (2021) surveyed 4,037 undergraduate students in Jordan. They found that economic and psychological stress decreased students' willingness, while instructional and assessment quality improved their attitudes towards OL in the future. Means and Neisler (2021) surveyed 1,008 American undergraduate students and found that they were generally somewhat satisfied with their OL, although their course satisfaction sharply dropped after moving online. Jelińska and Paradowski (2021) surveyed nearly 1,500 school and university instructors from 118 countries. They found that instructors were most engaged and coped best with the transition when they had prior experience with remote instruction.

Other studies conducted surveys focusing on particular programs. Of interest to this study are those that are related to engineering. Liu et al. (2020) surveyed 801 undergraduate engineering students at the University of Toronto, Canada, and found that students experienced decreased motivation for learning and reduced class participation. Naji et al. (2020) also reported a lack of student motivation. The authors further identified self-efficacy beliefs about OL, self-directed learning online, and support as the main factors influencing engineering students' readiness to transition to OL in Qatar. Maraqa et al. (2021) found out that the distance to campus did not play a role in students' perception towards OL during COVID-19 compared to the workload. As the number of courses increased beyond 4, students preferred more F2F settings. Ahmed & Opoku (2021) conducted interviews and surveys to examine the challenges faced by engineering students and faculty members at a HEI in the UAE. They concluded that technology-supported learning tools can enhance students' experiential learning and competencies, but there were several pedagogical, technological, and psychological challenges that faced students and instructors due to the lack of preparedness. Asgari et al. (2021) conducted a survey that involved 110 faculty members and 627 students from six engineering departments at California State University at Long Beach. They identified several challenges encountered by students and faculty members including logistical, technical, pedagogical, privacy/security, and lack of sufficient hands-on training.

The Need for Discipline-Focused Approach

Previous student and faculty survey studies provide insight into the general issues engendered by the emergency transition to OL during the pandemic. The findings also reflect the importance of the preexisting local conditions of the education environment. However, several studies indicated that the challenges faced by students in transitioning to OL during COVID-19 are discipline-dependent (Hassan et al., 2021; Liu et al., 2020; Martha et al., 2021). Thus, a proper diagnosis of the specific challenges encountered by each discipline requires a more focused approach. Further, although there has been considerable development in OL, remote learning for engineering education is still developing (Kocdar et al., 2020). It is challenged by the unique requirements for developing hands-on skills and other practical skills that are necessary for a qualified engineer (Bourne et al., 2005). As perceived by students in some engineering programs, conducting laboratory investigations and designing solutions are merely some of the critical components of engineering education that are difficult to achieve through OL (Vielma & Brey, 2021). However, innovative solutions have emerged in response to such challenges. These solutions often use advanced technology to address specific learning outcomes. One example is the development of virtual laboratories wherein students can conduct an experiment, make observations, and collect and analyze data (Balamuralithara & Woods, 2009; García-Zubía & Rodríguez-Gil, 2021).

This study investigated the sudden transition of classes to a fully online mode during the COVID-19 pandemic in the Civil Engineering program at the UAE University and the challenges thereof. The research questions are as follows:

(1) How did undergraduate civil engineering students perceive the transition to OL during COVID-19 lockdown?

(2) How did faculty members perceive the preparedness for the transition to remote teaching and the opportunities for maintaining OL after the COVID-19 pandemic?

Research Context and Method

Civil and Environmental Engineering (CEE) Department

The CEE Department offers undergraduate and graduate degrees in Civil Engineering in addition to graduate degrees in Water Resources. Currently, the CEE Department has around 250 undergraduate and 70 graduate students in the Civil Engineering and Water Resources programs. Twenty-one faculty members are affiliated with the CEE Department, with two fully released for administrative duties. Two instructors (teaching faculty) are associated with the department.

The undergraduate classes are offered during the day. All courses are scheduled between 8am and 6pm. Prior to the pandemic, the delivery modes included traditional F2F lectures and laboratory sessions utilizing smart boards that are available across campus. All courses were formatted for PC/laptop use and some units have been updated for tablets. The Blackboard learning management system (LMS) is the standard learning environment. All lectures, discussions, homework assignments, and other activities were made available to students through Blackboard, which can be remotely accessed at any time and from any location. Students interacted with faculty members and laboratory engineers through Blackboard, emails, and F2F office hours. For Spring 2020, 15 core courses, three technical electives, and capstone graduation projects were offered for undergraduate students.

Classes in the CEE Department range from 25 to 40 students per section, with multiple sections being offered. It should be noted that before Spring 2020, the undergraduate students at the CEE Department did not take fully online courses.

Readiness of Institution for OL

Over the past few years, the UAE University has formed several committees, communities of practice, and entities to promote smart learning. The Center for Excellence in Teaching and Learning (CETL) is an institution-wide center that aims to enhance and expand faculty teaching pedagogies to improve the student learning experience. This was partly achieved by developing and delivering courses through a blended teaching mode, whereby 25%–75% of the course would be administered online. This teaching pedagogy provides students with the benefits of OL and F2F learning in an integrated modality. The institution has ensured that faculty members have the instructional technologies needed to develop courses in a blended teaching format. In addition to the main LMS, Blackboard, there were several add-ons, including Panopto and Collaborate Ultra. Skype for Business, Microsoft Teams, and Cisco Webex were also made available. This was to facilitate the development of course content using either synchronous or asynchronous modalities. Starting the Spring semester of 2018, the institution began to offer blended teaching for selected courses. Since then and prior to Spring 2020, the institution has offered 53 courses taught in a blended mode, of which 42 were for undergraduate students and 11 were for graduate students. None of the blended taught undergraduate courses was offered by the College of Engineering. However, undergraduate students at the CEE Department could have taken some of these courses as 5 of them belong to the list of the university general requirement courses. During Spring 2020, five Civil Engineering courses (involving six faculty members) were put forward for transformation from F2F learning to a blended delivery mode. Four of these courses were at the graduate level and one was for undergraduate students. Thus, the institution possesses the basics of the required infrastructure and facilities to adopt and implement OL for some courses and faculty members. Nonetheless, none of the undergraduate or graduate level courses at the institution was delivered fully online before the pandemic.

COVID-19 in the Country and Institution

The UAE is keen to provide the technological and human resources required to maintain remote teaching and learning while building a reliable infrastructure to provide the primary services of energy, water, communications (including internet), transportation, healthcare, and education. Additionally, the UAE has established progressive strategies to transition its urban areas into smart cities. In the past two decades, the country has developed its information technology sector and successfully implemented an effective e-government network.

When hit by the COVID-19 pandemic, the UAE's response included flight suspension (excluding repatriation flights), a night curfew, a nationwide sterilization program, a nationwide virus testing program, the shutdown of malls and recreational facilities, and a transition to OL in schools and universities. All HEIs in the UAE switched to fully OL during March 2020. It was decided that all schools and universities would be closed for four weeks starting from March 8. Facilities were deep-cleaned during the closure. OL started on March 22, after the spring break was moved forward to prepare faculty and teachers for the transition. These measures resulted in a reduction in the number of daily cases and a partial reopening of commercial centers in July 2020. Nevertheless, strict measures remained in place for educational facilities, with many HEIs,

including the UAE University, continuing to teach fully remotely in Fall 2020 and Spring 2021. In Fall 2021, the restrictions were slightly relieved, allowing 55% occupancy on campus and splitting the students into two groups based on their colleges. The two student groups alternate in attending classes F2F every two weeks (i.e., one group attended classes on campus while the other group received education online). Classes with an enrollment of 33 or more received education online, whereas the final exams for all classes were administered on campus.

Once OL was announced, the CETL developed a series of videos to help faculty members deliver their courses using the available infrastructure. They communicated with students to familiarize them with the new teaching pedagogy. In addition, laboratories were instructed in a virtual format whereby instructors prepared a series of videos for the experiments while they were being conducted. Students were given datasheets with experimental readings to analyze and include in their reports. The Information Technology Unit at the UAE University was available online 24/7 to respond to any inquiry and handle any technical issues. Owing to the abrupt decision to transform to OL and the expected effect on students' performance, the institution decided to provide students with a pass or fail (P/F) option in Spring 2020 rather than retaining the final course grade. This option was provided per course, allowing students to receive P/F for specific courses. Such courses were not included in the students' cumulative or major grade point average (GPA).

Research Participants and Methodology

This study employed an empirical approach to assess the experiences and perceptions of undergraduate students and faculty members for OL versus F2F learning models. Quantitative questionnaires were designed to investigate the perceptions of undergraduate students and faculty regarding the transition from F2F to OL. The questions were tailored to include factors that may have influenced student perceptions, such as gender, academic level, and student seniority.

Student Survey

The undergraduate students in the CEE Department were asked to complete a 15-minute ad-hoc structured survey, which was developed by the authors. According to the Organisation for Economic Co-operation and Development (OECD), an ad hoc survey is defined as "a survey without any plan for repetition" (https://stats.oecd.org/glossary/detail.asp?ID=6276). The survey was designed for a single purpose during an emergency to collect answers to specific research questions. The survey questions were designed by the authors to collect information on students' perception in moving to OL and to gain an understanding of the challenges faced by the students with OL during the pandemic. Before being disseminated to the students, a preliminary form of the survey was distributed to a small group of students to assure the questions are understandable and free of technical jargons. Based on this, the survey form was modified and then circulated online via SurveyMonkey (see Appendix A). The survey was open to all the CEE undergraduates for a period of 10 days; however, students who were conducting their mandatory internship/industrial training in Spring 2020 were asked not to participate. The survey was sent to the students after the semester ended on June 25, 2020, with two follow-up reminders after three and six days, respectively.

The survey was divided into three parts: general information, perception about OL, and facilities and support for OL. The first part was intended to gather information about students' gender, GPA, earned credit hours (CHs) before Spring 2020, enrolled CHs during Spring 2020, and residence location. The second part gathered information about students' preference of teaching modality (F2F versus OL), their feelings about transitioning to OL in Spring 2020 and continuing with OL in the future, and whether OL facilitated learning, enhanced engagement, and enhanced communication skills. The third part collected information about students' access to resources needed for OL including a computer with a webcam, a spare computer, a printer, a reliable internet connection, and a quiet place. Students were also asked if they received support from family members, the university, and the instructors during the transition to OL. The survey questions were in the form of multiple-choice, rating scale, Likert-type scale, or open-ended ones. (An additional part of the survey focused on the assessment and outcome of online examination, but these questions and associated results were not included herein.) The results were collected digitally in a tabular format while ensuring anonymity. Based on the approval obtained by the institution's ethics committee, all the students were told that their participation was voluntary and that they were free to withdraw at any time. Participants were assured that their data would be kept confidential. Within the invitation, the participants were given details about the study and its objectives.

The total undergraduate student population enrolled in the program is 250 students. The target survey participants were 232 as 18 students were enrolled in industrial training and were asked not to respond to the survey. In total, 125 undergraduate students responded. The received responses for the survey represented 54% of the students in the undergraduate program.

Faculty Survey

The faculty survey was designed to gather information concerning the experiences and attitudes of faculty members with online teaching before and after Spring 2020. The survey was also intended to ascertain their overall assessment and possible suggestions for improvement. It comprised 20 questions (see Appendix B). Most questions were developed based on the stated preference approach, where respondents choose responses from a setlist. In some questions, faculty members were asked to choose one answer; in others, all applicable answers had to be selected from the provided list. The last two open-ended questions gave faculty members the option to provide written comments regarding their experiences with online teaching in Spring 2020 and their suggestions for improving the process. Their responses to the open-ended questions were aggregated anonymously, put in order by keywords (training, mode of delivery, and infrastructure), and important quotes were extracted.

The form was sent electronically to 12 faculty members in the CEE Department. The selection of the participating faculty was carried out in consultation with the department to ensure that they had taught courses during Spring 2020. Another selection criterion was to ensure that the faculty members were distributed in proportion to the offered courses in the specialization areas of the CEE Department. Thus, five faculty members were selected from the area of structures and materials, two from environmental engineering, and one from each of the remaining specialization areas—geotechnical engineering, highway and transportation, construction management, surveying and geomatics, and water resources. The surveyed faculty members represented more than half of the teaching staff of the department and taught at least 75% of the undergraduate courses that were offered in Spring 2020. All selected faculty had been affiliated with the department for at least three semesters and so were familiar with the

institution's pedagogies, rules, and regulations. The survey response rate was 100%; however, only half the respondents provided additional comments about their experiences and potential suggestions for improving the OL process. Measures were taken to ensure the anonymity of the survey respondents.

Data Analysis

The collected data were analyzed using descriptive statistics. SPSS Statistics was used to perform the regression analysis and calculate correlation coefficients. Microsoft Excel was used to conduct a frequency analysis of the responses provided by students and faculty. On the other hand, the responses collected for open ended questions to the students and the faculty were compiled and discussed.

Results

In the students' survey, male participation accounted for 19% of the students' responses, reflecting the gender ratio across the institution. Most students (62%), who participated in the study, had a GPA between 2.0 and 3.0 (on a 4.0-scale). Approximately, 65% had completed between 60 and 100 credit hours (CHs). The highest participation was observed for students, who had a GPA between 2.0 and 2.5 and had completed 80–100 CHs, representing 17.9% of the total respondents. This group is considerably larger than all the other groups, with the second-highest group at 8% for students who had a GPA between 2.5 and 3.0 and had completed 60–80 CHs. The group percentages could not be controlled owing to the anonymity of the survey. Nevertheless, the disproportionately large group could be explained by the active undergraduate student representatives who likely played a role in encouraging their peers to complete the survey.

For the faculty, the total teaching load in Spring 2020 varied from less than 6 CHs to more than 12 CHs. In addition, 59% of these faculty members taught graduate courses offered by the Civil Engineering or Water Resources programs in Spring 2020. The faculty members' experience in teaching had a range of 3–28 years. However, when asked about their online teaching experience before Spring 2020, 75% indicated they had limited experience or none at all, whereas the rest indicated they were fairly or adequately experienced.

Students' Perception of the COVID-19 Lockdown's Impact on the Transition to OL

A survey question was formulated to evaluate the readiness of students to participate in OL activities. This "Yes/No" survey question was related to students' access to nine basic requirements for OL. A hypothesis test was conducted to decide whether to continue the analysis based on gender or as an aggregate sample. The result of a t-test showed that the responses of male and female students were similar at a 95% confidence level. Accordingly, the following analysis was conducted by aggregating both genders.

The responses show that most of the students have the necessary tools for OL. Only 16 out of 125 students did not have access to a computer equipped with a webcam. However, more than half of the students surveyed (55%) did not have access to a spare computer in case of an emergency. Further, 60% of the students had access to a printer. Most students had a reliable internet connection (76% and 55% for Wi-Fi and cellular network, respectively). Access to a quiet study place was a challenge for almost half the students (42%). Most students received support from family, technical staff, and instructors at 76%, 61%, and 67%, respectively.

Figure 1
Perceptions of Online Learning

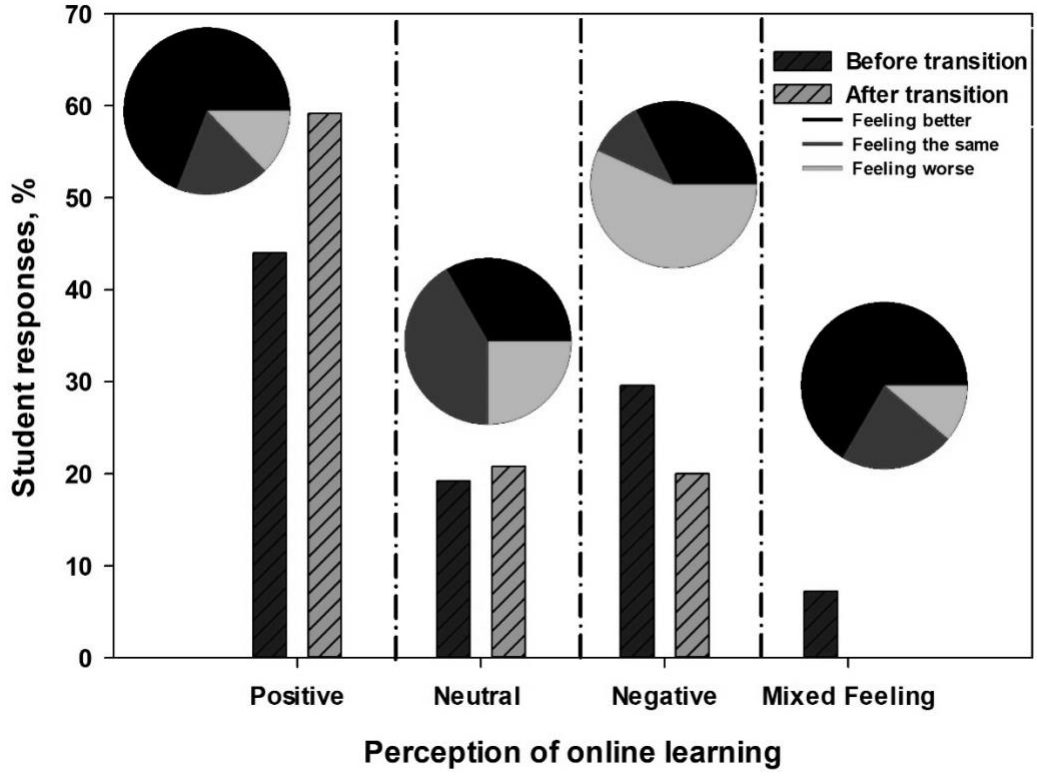


Figure 1 shows student perception towards OL before and after the transition, as summarized from the responses to Questions 7 and 17 (Appendix A), respectively. Responses were classified into the four categories given in Figure 1, e.g., afraid is negative, good is positive, etc. The pie charts indicate how the students' feelings changed throughout the semester. The results in the pie chart are grouped based on their initial perception before the transition, as collected from the responses to Question 8 (Appendix A).

Students were asked about their perception of OL when they first heard about the transition, during the transition, and after the semester. The categories assessed included various feelings ranging from positive (good and interested), neutral, or negative (not good and afraid). Students were allowed to select more than one choice. Subsequently, their responses were categorized into positive, neutral, negative, and mixed feelings. Figure 1 shows the percentage of total student responses concerning their initial feelings toward the change to OL. The majority of the students initially had positive feelings about OL (44%), whereas 30% had negative feelings. Only 13% of the students who initially had positive feelings indicated a change for the negative. Conversely, 68% of the students who had initial negative responses indicated that they felt worse or remained the same during the transition. Thus, the majority of students who started the transition with a certain attitude (whether positive or negative) generally did not change their perception. This fits the trend extracted from the responses after the semester. The fraction with positive attitudes increased; the proportion with negative attitudes dropped. A substantial number of students who had initially indicated a neutral attitude (19%) remained neutral (42%), while

33% became positive. Ultimately, approximately 60% of the students indicated a positive perception after the semester, while those who felt negative dropped to 20%. Two-thirds (67%) of the students who initially had mixed feelings changed to positive. Of the total responses, 64% indicated that OL enhanced students' comfort and engagement in discussions. Moreover, 43% of the total students believed that OL had improved their communication skills, 40.7% believed it did not, and 15.9% could not decide.

To better understand students' perception of OL, a set of questions were posed pertaining to the advantages and disadvantages of OL. Figure 2 shows a heat map of the responses, aggregated by student GPA and completed CHs. Regardless of their GPAs and CHs, the majority of the students indicated that OL allowed them to continue learning during the COVID-19 crisis. The second perceived advantage to OL was the availability of recorded materials that students could revisit at their convenience. More than half the respondents indicated that OL provided flexibility for attending classes outside of designated class time and that not being physically present on campus was an advantage. In general, students with higher GPAs had a more positive response rate for the advantages. The number of completed CHs did not exhibit any significant correlation. A small fraction of the respondents considered that OL made it "easier to concentrate at home," made it "easier to communicate with faculty," was "engaging," and had "easier examinations."

Figure 2

Heat Map Highlighting Students' Preferences Regarding Different Advantages and Disadvantages of Online Learning Classified by GPA and Completed CHs

GPA					Advantages	Completed CHs				
<2	2–2.5	2.5–3	3–3.5	> 3.5		<60	60–80	80–100	100–120	> 120
100%	79%	93%	97%	94%	Continuous learning during pandemic = 88.8%	90%	100%	78%	90%	92%
50%	63%	82%	77%	76%	Availability of recorded material = 72%	77%	77%	47%	90%	92%
[illegible]	52%	75%	80%	76%	Flexibility for attending classes = 66.4%	67%	65%	44%	86%	100%
[illegible]	46%	54%	73%	59%	I don't have to go to campus = 55.2%	60%	50%	39%	81%	58%
50%	31%	32%	43%	[illegible]	Easier to concentrate at home = 31.2%	30%	46%	14%	48%	25%
[illegible]	17%	25%	20%	24%	Easier communication with faculty = 20%	23%	19%	[illegible]	43%	25%
[illegible]	17%	25%	33%	[illegible]	OL to be very engaging = 20%	17%	15%	14%	38%	25%
[illegible]	21%	14%	17%	12%	Online exams are easier = 16.8%	13%	12%	19%	29%	8%

GPA					Disadvantages	Completed CHs				
<2	2–2.5	2.5–3	3–3.5	>3.5		<60	60–80	80–100	100–120	>120
[illegible]	21%	39%	43%	47%	Lack engaging in-class experience = 33.6%	33%	23%	39%	33%	42%
50%	27%	39%	40%	35%	Difficult to study in groups = 34.4%	40%	35%	31%	33%	33%
[illegible]	40%	21%	37%	47%	Lack reliable access to internet = 35.2%	40%	[illegible]	53%	43%	17%
50%	31%	25%	40%	59%	Lack of equipped quiet space = 36%	33%	23%	56%	29%	25%
100%	31%	39%	40%	41%	Staying at home is distracting = 37.6%	50%	35%	36%	33%	25%
50%	29%	46%	50%	35%	Hard to communicate with faculty = 39.2%	47%	19%	42%	38%	58%
50%	44%	29%	40%	47%	Difficult for group projects = 40%	50%	31%	47%	33%	25%
100%	40%	39%	67%	76%	Lack of social experience = 52%	60%	58%	47%	43%	50%
50%	60%	68%	80%	65%	Online exams are more challenging = 67.2%	60%	73%	58%	76%	83%

10 20 30 40 50 60 70 80 90 100

Students also indicated several disadvantages. The respondents ranked "online examinations to be more challenging" as the highest disadvantage, followed by a lack of social interaction. The responses regarding the remaining disadvantages were found to be in a considerably narrow range (34%–40%) without any particular pattern regarding GPA or CHs. Furthermore, all students agreed that staying on campus made them more committed to the learning process, whereas staying at home was distracting.

Students were also asked to rate on a scale from 1 to 10 the extent to which they favor several aspects related to OL during Spring 2020. Synchronous lectures received the highest rate (7.3±2.5), followed by pre-recorded lectures provided before class (7.2±2.5), while the two aspects that received the lowest rating were online laboratory demonstrations (5.8±2.7) and graded quizzes and exams (6.1±2.6).

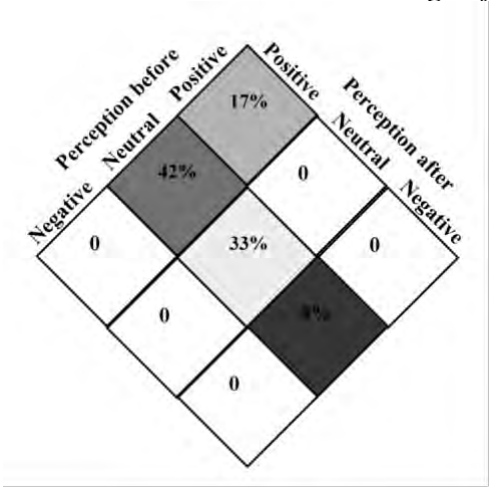
On average, 36% of students believed OL deprived them of access to equipped and quiet study spaces and engaging in-class experience. Approximately 34% of students, on average, believed that OL made it difficult to study in groups, conduct required group projects, and communicate with faculty members. Conversely, the least voted disadvantage of OL was the lack of regular and reliable access to the internet and computing facilities (laptop, iPad, and printer), highlighting the students' readiness for OL. The results were similar when CHs were taken into consideration.

Faculty Perception of OL vs. F2F Learning

Figure 3 presents the faculty members' attitudes toward OL before and after Spring 2020. Half (50%) the faculty members indicated no experience with OL, while the remainder chose "limited" and "acceptable" experience equally. No faculty member indicated extensive experience with OL. Furthermore, many of the faculty members indicated a neutral attitude before the transformation to OL. However, two faculty members with acceptable experience indicated a positive attitude. After their involvement with OL, 50% of the surveyed faculty members did not change their attitude, while 42% switched to positive. Only one faculty member downgraded their perception from neutral to negative.

Figure 2

Heatmap of Faculty Members' Attitude toward Online Teaching Before and After Spring 2020

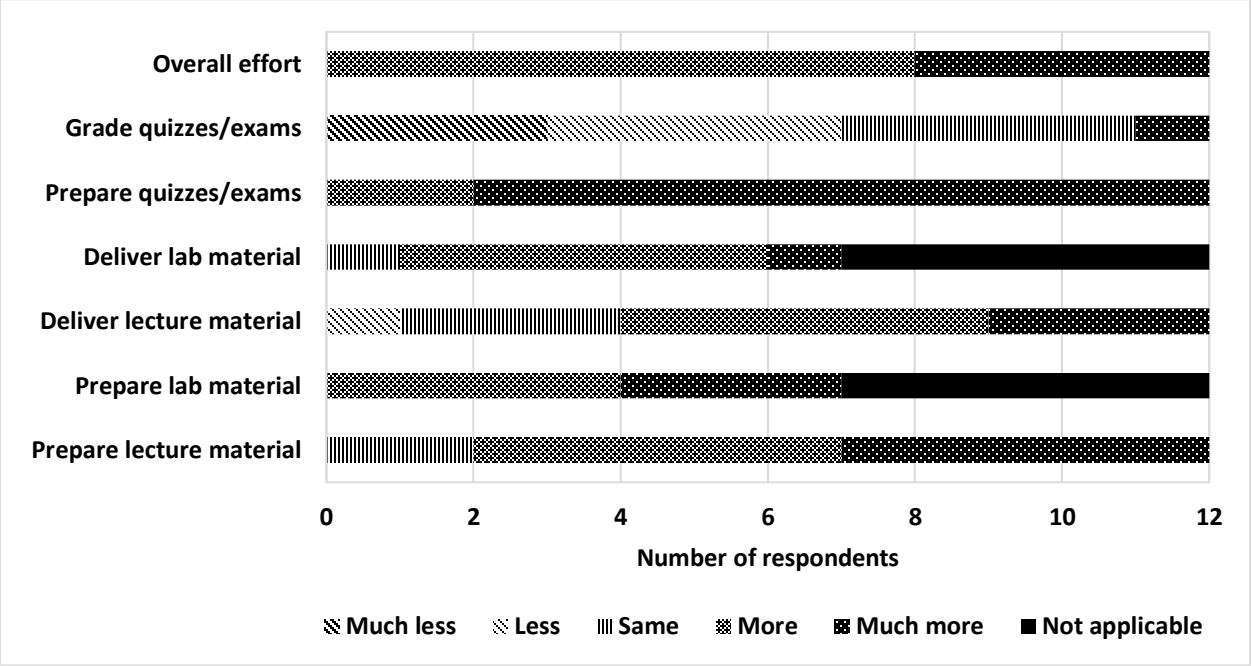


Regarding the transition to OL in Spring 2020, half the faculty considered the transition "acceptable," while the other half regarded it as either "difficult" or "extremely difficult." None, however, believed that the shift was "easy." Notably, the faculty members who described the transition as difficult or very difficult either had no experience with OL or had a heavy teaching load (three or more different courses).

All the faculty members agreed that the overall time and energy allocated to OL during the transition was more than that typically put into F2F learning, as shown in Figure 4. This is unsurprising, as the transition happened in the middle of the semester with a relatively short preparation period. The faculty also indicated that high and very high levels of efforts were required for transforming and delivering the course materials in addition to preparing and administering online quizzes and exams. Conversely, a similar or lesser degree of effort was required to grade online exams as opposed to grading in-class exams. This may be because of the automated online grading system provided by the LMS.

Figure 4

Faculty Members' Opinion of the Effort Allocated to Online Learning during the Transition Compared to F2F



In their teaching pedagogy, the faculty members used different modern tools and techniques to accommodate the sudden transition from F2F learning to OL. The majority (83.3%) used Blackboard to deliver the course material either synchronously or asynchronously (i.e., through recorded videos) because they were familiar with the system. About 67% also used the university conference or chat function to communicate with the students. More than 50% used the LMS to distribute information to students, while about 40% utilized videos from third-party sources to deliver some course material.

To adapt to the OL pedagogy during the COVID-19 pandemic, 11 of the 12 faculty members made changes in the course requirements and assessment tools. Typically, engineering faculty rely on essay or problem-solving questions with an in-class examination; however, the online examination forced them to change the question types to multiple-choice or true/false format, as discussed later. Forty two percent of the faculty lowered their expectations of the students' load, and just over one-half (58%) lowered their expectations of quality. A quarter (25%) dropped some assignments or exams; 17% dropped some of the assigned readings that they had originally given students.

The main challenge faced by all the faculty members was the preparation of online exams, likely owing to the challenge of preparing new sets of questions with a different style than those used for in-class exams, as well as having to edit and post these questions on the institution's LMS. Moreover, 75% of the faculty found it challenging to guarantee the integrity of the process and to prepare the lecture material. All faculty members with a laboratory component associated with their courses found it challenging to prepare material for OL. Becoming familiar with the digital tools of OL was another issue reported by approximately 58% of the faculty. Furthermore, half the faculty (50%) found it difficult to engage students in dialogue and utilize the delivery method. Grading was the least challenging aspect of the OL, as online exams were graded automatically using the LMS. Notably, however, the lack of time to prepare for the sudden transition from F2F learning to OL posed several challenges that, under normal transitioning conditions, could have been circumvented by proper training and preparation.

Nevertheless, the instructors did perceive some advantages of the suddenly adopted OL modality. For example, they all agreed that it allowed students to continue learning during the pandemic and that they could use the recorded material in future course offerings. Furthermore, one-third (33%) of the instructors thought that the shift to OL provided flexibility for scheduling class activities and reduced the effort exerted as a faculty member of multiple sections of the same course. However, only two faculty members (17%) found OL to be a relief from the campus commute, with one finding it engaging.

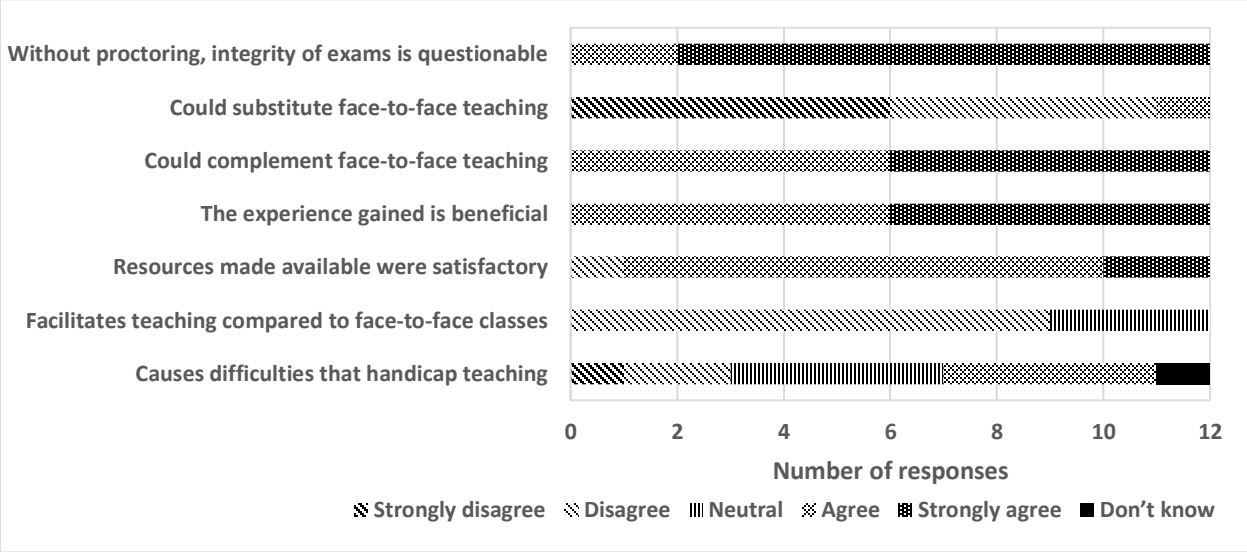
There was an overwhelming agreement among the surveyed faculty members that OL was beneficial and that the process could complement F2F learning going forward (Figure 5). However, given the lack of physical proctoring, the integrity of the online examination was a major concern, even though online proctoring software solutions, such as Respondus Lockdown Browser with webcam integration, were used. By contrast, most faculty members were satisfied with the resources that were made available by the institution to facilitate OL. Nonetheless, they believed that OL did not facilitate teaching and could not solely substitute for the F2F experience. No consensus was observed as to whether or not online classes caused difficulties that hindered their teaching process.

The faculty members were asked to describe the students' performance in Spring 2020 compared to other students who took the same course(s) with F2F instruction. Half the faculty (50%) thought that students' performance was lower; 42% thought that it was the same. The activities selected by all the surveyed faculty members to be most suitable for OL were office hours and group meetings. More than half the respondents (75%, 58%, 50%) agreed that delivering lecture material, supervising graduate students, and conducting tutorial sessions were suitable for OL modality, respectively. The majority, however, believed that OL did not facilitate conducting quizzes, written and oral examinations, and laboratory sessions.

When asked about the assistance needed to conduct OL in the future, 67% requested technical support. Although the institution's IT and CETL staff members responded to requests in a timely fashion, few faculty members were exposed to OL pedagogy prior to the pandemic. Therefore, a sudden surge in technical assistance requests at the early stages of the transition was observed. The second most ranked item (58% of all selected) was the provision of a webcast for students on how to succeed in OL and better access to online digital material. Forty one percent asked for information on best practices for supporting faculty for OL, training material on how to transition courses to an online setting, an online resource hub with links to information, and webinars hosted by OL experts.

Figure 5

Faculty Members' Assessment of Online Learning Based on Their Experience in Spring 2020



Written comments included various remarks on the suitability of the transition process. There was an agreement that the transition to OL experience was interesting but that it involved a steep learning curve. In the future, the prepared, recorded lectures combined with F2F teaching will benefit students and reduce the time needed in class to deliver the entire material. Although preparing the materials for OL was time-consuming, "it saved time when teaching multiple sections". Students found instructional videos explaining how to access the course material useful. OL may be more suitable for graduate courses; delivering undergraduate design courses is challenging. Virtual laboratory experiments were received positively by the majority of students. Some faculty members believed that the students became "careless" during OL. To increase student engagement, faculty members implemented a "reading quiz" at the end of every lecture, which students had to answer to access the following lecture. Consequently, students were more vigilant in completing the required tasks in a timely manner.

Comments received regarding the improvement of OL suggested that students and faculty members be informed about and trained on OL and its benefits. Specialized one-on-one consultation sessions or small group workshops for faculty members were proposed to highlight the different features accessible through the LMS, among other means. One faculty member stated "Inform and train students about online courses and how they can benefit the most. Also,

provide specialized one-to-one sessions for instructors". Depending on the nature of the course, blended teaching was recommended to supplement F2F learning at certain percentages. For example, a faculty member wrote "Blended teaching could be great to consider in future with lab sessions and exams are done using the traditional (F2F) methods". Comments on improving the OL infrastructure included the use of pen tablets (or touch screen laptops) instead of iPads, the use of platforms that focused on soft skills for engineers to complement technical programs (e.g., https://www.edx.org/learn/soft-skills), and investment in virtual labs, through which students can conduct experiments online (e.g., https://www.labster.com/). One of the surveyed faculty members noted "A policy should be available to address online legal issues… particularly when students request to have makeup exams due to experiencing technical problems during exams." The same faculty member added "A third-party exam proctoring system should be available."

Discussion

A few studies surveyed undergraduate students and faculty members in civil engineering programs to assess their perception regarding the transition to OL during COVID-19. Ayadat et al. (2021) conducted a student survey at Prince Mohammad Bin Fahd University, Saudi Arabia. They reported that the shift to OL generally met the individual learning needs of students, but it was not as convenient as F2F learning. Wenceslao & Felisa (2021) conducted a survey for students and faculty members at four HEIs in Philippines, with the majority (90%) of the students were from civil engineering programs. More than 90% of the respondents (students and faculty) believed that the quality of education declined because of the shift to OL and 64% thought it is not as effective as F2F learning. Wardhono et al. (2020) surveyed students in Indonesia who were enrolled in basic engineering and structure courses and found that the implementation of OL was not quite effective.

Initially, half of the surveyed students in this study began the transition to OL during the COVID-19 pandemic with a positive attitude towards OL, and this percentage increased during the transition. This is consistent with the findings of Ahmed & Opoku (2021) who reported that 52% of the surveyed engineering students were initially excited about the transition to OL during the pandemic. Meanwhile, most of the surveyed faculty members in this study either retained the same attitude about OL as before the transition or switched to a positive one. One of the aspects that could have caused this behavior is the readiness of the institute and the technical and administrative support received during the pandemic. Indeed, the readiness of the institution and its ability to mobilize resources play a critical role in its response to offer broader services and support to online transition (Bensaid & Brahimi, 2021; Hart et al., 2021), which could positively affect the quality of teaching (Nuere & de Miguel, 2020), and ultimately, results in higher satisfaction of the stakeholders.

The interaction between students and faculty members is considered a critical factor for a successful OL experience (McCaslin & Brown, 2015). Increasing student engagement requires a refinement of the delivery method. Following the transition, faculty members delivered their classes in absolute asynchronous, absolute synchronous, or a combination of both modes. In absolute asynchronous instructions, students watched pre-recorded videos and did not have to attend class at scheduled times. By contrast, the absolute synchronous mode mimicked F2F instruction by limiting learning to the designated class time. All combined models included pre-recorded videos that could be watched during or before class time. However, these models varied in the duration of engagement during designated class times. Synchronous lectures could be more engaging than asynchronous ones (Jelińska & Paradowski, 2021); however, the former

could be problematic depending on one's internet access and/or a lack of quiet space at home during lecture time. Having recorded synchronous or asynchronous lectures appears to be more favorable to students engaged in OL than having non-recorded synchronous sessions (Liu et al., 2020). Therefore, a combined mode involving a pre-recorded lecture followed by a recorded live discussion could be more effective for OL. This is in line with the findings of others (Alqahtani & Rajkhan, 2020; Ramo et al., 2021; Rapanta et al., 2020).

Students also seemed to miss the engagement and interaction with faculty members. Student engagement is considered one of the main challenges reported for civil engineering programs (Ayadat et al. 2021; Wenceslao & Felisa, 2021; Wardhono et al., 2020) and for other engineering programs (Asgari et al., 2021; Ahmed & Opoku, 2021). Several researchers have suggested different approaches to enhance student engagement in OL. Wilson and Allen (2011) suggested that increasing student engagement requires additional contact between faculty members and students through progress updates or discussion boards and forums. Asynchronous lectures were more convenient for accommodating different time zones. In the asynchronous mode assessment questions could be used to split the class to several parts and act as a prerequisite to access the following part. Bao (2020) has suggested several instructional strategies to improve the effectiveness of the delivery method of online classes, such as dividing the teaching content into smaller units to help students maintain focus.

McCaslin & Brown (2015) proposed some steps that faculty members could take to enhance students' interaction, including providing detailed instructions, being proactive in contacting students regularly, and developing self-assessment tools to help students decide early on if they need assistance. Mahmood (2020) recommended sharing resources before the class to help create interactive online classes. Pacansky-Brock et al. (2020) suggested that instructors facilitate interpersonal interaction and foster social presence in OL. Professional training may help instructors promote interaction and enhance engagement in online courses (Shepherd et al., 2016). This is emphasized by Rutherford et al. (2021), who noticed that generally, instructors who were highly supportive of implementing interaction-oriented practices during F2F teaching tended to be less supportive of these practices during the COVID-19 transition to OL. The extent of success in implementing OL could be discipline- and subject-related (Bourne et al., 2005). For example, courses with laboratory or heavy design components should be treated differently than theory-based ones. This is likely why engineering programs generally lag when it comes to adopting OL. The engineering faculty members surveyed overwhelmingly believed that OL could not replace—only complement—F2F teaching. Thus, a blended approach could be adopted to create a more meaningful learning environment wherein 25%–75% of the course would be administered online, as offered in some engineering programs (El-Zein et al., 2009; Ozer et al., 2003). Blended teaching and learning, if designed properly, could resolve some of the concerns raised by the surveyed students and faculty. Faculty members should determine the course activities to be delivered in the F2F or online modality. Students chose exams (with quizzes at the highest rank), followed by lectures, as the most suitable course parts for OL. The lowest ranks were for laboratories and group work. A blended course remedies the lack of social interaction, which was indicated as a major disadvantage of OL by the students.

There was an overwhelming agreement among the faculty members in this study concerning the increased time needed for converting courses to the OL delivery mode, mainly owing to the preparation of lecture materials and online exams. The transition from F2F teaching to OL is "considerably time-consuming and changes faculty's role and teaching responsibilities" even under normal conditions (Lichoro, 2015). The effort could have been amplified during the

COVID-19 pandemic, given the urgency of the transition with the limited time provided to faculty members to prepare and adapt. Adhikari et al. (2021) indicated that the transition to OL during COVID-19 had greatly affected construction educators, with more time spent in developing, communicating, and delivering the course content. A similar concern was made by engineering faculty members as reported by Ahmed & Opoku (2021). As for the students, no consensus existed among them on how OL affected the amount of time required for studying. The results showed a three-way tie between an increase, a decrease, and no difference between OL and F2F.

The faculty members perceived that students' performance in OL as either similar or lower than in traditionally taught F2F courses. Such qualitative assessment is important but needs to be verified through either direct or indirect quantitative means. Nonetheless, it appears to be in line with the findings of Supernak et al. (2021), who quantitatively assessed the learning outcomes of the same civil engineering students at San Diego State University before (with F2F instructions) and after (with OL) the lockdown. They found that the coverage of student learning outcomes with OL was quite high, but slightly lower than the pre-pandemic counterparts. They also found no significant difference for almost 80% of the compared student's scores performed for sixteen student outcomes. However, courses that rely on lab experiments or those involved assigned student teamwork during the pandemic were negatively affected by the lockdown. Apparently, achievement of students' learning outcomes cannot be generalized for all civil engineering courses, and possibly not for the same course at different civil engineering programs. Conflicting results regarding achievement of student learning outcomes between F2F and OL modalities were reported in studies conducted prior to the pandemic. For instance, some studies have indicated no significant differences between the two modalities (Aktas & Omurtag, 2013; Chirikov et al., 2020; McFarland & Hamilton, 2005; Mollenkopf et al., 2017; Silcox, 2004); others have found OL to be more (Dutton et al., 2001; Holbert, 2020; Ladyshewsky, 2004; Nguyen & Paschal, 2002) or less effective (Alpert et al., 2016; Bettinger et al., 2017). Similar conflicting trends were observed with blended courses wherein students' performance either improved (El-Zein et al., 2009; Reynolds & Paulus, 2009), remained the same (Alpert et al., 2016; Bowen et al., 2014), or decreased (Wellington et al., 2005) compared to F2F equivalents. These variations could result from other factors, such as the experience of the faculty members, the nature of the course, and student interest in the subject (Aktas & Omurtag, 2013). As this study evinces, access to a fast internet connection, a quiet study place, proper hardware, etc., can also be determining factors in the success of OL.

In the last two decades, there has been a rapid growth in fully online or blended courses (Allen & Seaman, 2013). The experience gained regarding OL during COVID-19 should lay the foundation for HEIs to expand their OL delivery methods in the future. Such measures are inevitable, given the uncertainties related to the spread of COVID-19. Positive OL experiences in undergraduate engineering programs, as found herein, are expected to reshape the delivery mode of undergraduate education. Learning pedagogies will never return to their pre-pandemic pattern, and a substantial transformation from traditional to a blended or fully OL approach seems almost inevitable. In fact, 77% of the chief online officers at HEIs in the USA predicted some or significant acceleration in future online undergraduate enrollment (Garrett et al., 2021). Therefore, it is essential to continuously assess the students' learning experience and their learning outcomes (Bourne et al., 2005; Francis & Shannon, 2013). The assessment of learning outcomes is already established as part of the enhancement process in many engineering programs (Schachterle, 1999). However, evaluating the effectiveness of blended learning or OL

entails more than merely relying on outcome assessment. Fortunately, most institutions transitioning to OL have a benchmark to assess the effectiveness of the transition by comparing the pedagogical features of online course delivery to those of the F2F counterpart. Many studies have compared student perception and performance in an OL course against those in a F2F equivalent (Girard et al., 2016; Kelly et al., 2007; Paechter & Maier, 2010; Paul & Jefferson, 2019). These studies focused on aspects of student engagement through course design, social presence, interaction with peers and faculty, and the attainment of learning outcomes. Nevertheless, continuous investigation and more studies are required to establish tailored OL requirements that would guarantee a successful learning environment given technical, cultural, and social factors.

Conclusion

This study investigated, through a quantitative survey, the perception of undergraduate students and faculty members in a Civil Engineering program concerning transitioning to OL during COVID-19. Results revealed that student engagement and online exams are major areas that need improvement. Moreover, provision of technical support is critical for the successful delivery of online courses. From a student perspective, the capacity to continue learning during COVID-19 and the availability of recorded materials are the main advantages of OL; challenging online examinations and the lack of social interaction are the main disadvantages. Although transitioning to emergency remote teaching and learning in civil engineering is difficult, results have shown that half of the students preferred OL. Results also show that the measures applied to engage students in learning activities designed to enhance hands-on skills were adequate given the emergency situation. OL course delivery in civil engineering will never match F2F because the nature of civil engineering demonstrations requires more than simple visual aids.

The results and interpretations presented herein cannot be generalized for other programs within the college nor the institution. Moreover, only two types of surveys were utilized, namely, the faculty and student surveys. The opinions and feedback from administrators were not addressed. In terms of readiness and preparedness to undertake OL, most faculty members and students were new to online courses, and some participants had no prior experience with OL. This may have had a direct influence on the results obtained. Another limitation of the study is that it only discussed the perception of students and faculty members with respect to an emergency OL delivery mode. Other than the two weeks that the institution made available prior to restarting Spring 2020, the faculty and students did not have sufficient time to plan the transformation. Thus, the findings cannot be generalized to other forms of remote or distant learning, including planned online, blended, or televised learning. Additionally, students' performance may have been affected by the short preparation time, which may have impacted their opinion of OL; however, their performance was not categorized based on ethnicity, family background, or country of origin.

Future research may investigate how the perception of students and faculty members in the same program changed after practicing OL for multiple semesters during the COVID-19 pandemic. Meanwhile, it will be interesting to explore how students perceive their performance under emergency OL. Research could also be undertaken to compare students' and faculty members' perceptions across different engineering programs within the same institution. Students from other programs may have different challenges with OL (Liu et al., 2020). By doing so, engineering departments will be able to identify the challenges faced by their students to develop appropriate mitigation measures specific to their programs. Showcases from HEIs

worldwide could form the basis for comparative studies that are needed to elucidate how higher education is influenced by program type, socio-cultural aspects, economic status, institutional readiness, and faculty members' and students' experience with OL. As we learn more about the impact of COVID-19 on higher education, research will be needed to understand how HEIs should reshape their teaching and learning provisions while considering all the aspects that lead to the successful delivery of online courses, including institutional support, technical support for course development and delivery, course structure, teaching/learning process, social and student engagement, faculty support, student support, and process assessment. Indeed, assessment, by itself could form another line of research that could be carried out using well-established frameworks (Pedro & Kumar, 2020) that are intended to evaluate the quality of OL programs and suggest actions for improvement. This will not only help in identifying the challenges that need to be overcome to improve the delivery of OL in future crises, but also helps if a decision is to be taken to continue OL or blended teaching in the aftermath of COVID-19.

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Appendix A

Student Survey Form

We would like to know your views on the online learning of civil engineering courses during Spring 2020. Please note that this survey is solely intended for educational and research purposes. Participants' name or any form of identification is not required to participate.

A. General information

1.	What is your gender? □ Male □ Female
2.	What is your GPA? □ <2 □ 2–2.5 □ 2.5–3 □ 3–3.5 □ >3.5
3.	How many credit hours did you complete before Spring 2020? □ <60 □ 60–80 □ 80–100 □ 100–120 □ >120
4.	How many credit hours were you enrolled in during Spring 2020? □ <12 □ 12–14 □ 15–18 □ >18
5.	Where do you currently reside? ----------

B. Perception about online learning

6.	Do you prefer online classes to a face-to-face classroom setting? □ Yes □ No
7.	How did you feel about online learning when you first heard about the transition owing to COVID-19? □ Good □ Interested □ Neutral □ Not Good □ Afraid
8.	During online classes, did your initial feelings change? □ I started to feel better about it □ It turned out to be the worst □ My feelings remained the same.
9.	If online classes are optional in the coming semester, would you enroll in online classes? □ Yes □ No □ I don't know
10.	Did you enroll in online classes for the summer of 2020? □ Yes □ No
11.	Do you think having online classes can cause difficulties or problems that may handicap your learning process? □ Yes □ No □ I don't know
12.	Do online classes facilitate learning in the same manner as face-to-face classes? □ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree
13.	Online classes enhance comfort and engagement in discussion. □ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree
14.	Do online classes play a significant role in enhancing communication skills? □ Yes □ No □ I don't know
15.	In your opinion, what are the advantages of online classes? (Select all that apply.) □ It allowed students to continue learning during the COVID-19 crisis. □ It provided flexibility for studying and attending classes outside designated class time. □ Availability of recorded material that I can revisit at any time □ It was easier to concentrate at home compared to the classroom.

	□ Online exams are easier. □ Communication with faculty is easier, and responsiveness is faster. □ I find online learning to be very engaging. □ I can stay at home, and I don't have to commute to campus or stay in the dorms.
16.	In your opinion, what are the disadvantages of online classes? (Select all that apply.) □ I miss the social experience with other fellow students. □ It is difficult to study in groups with other classmates. □ It is difficult to conduct required group projects. □ Communication with faculty is more difficult. □ Lack of access to equipped and quiet study spaces □ I find online exams to be more difficult. □ Lack regular/reliable access to the Internet and computing facilities (laptop, iPad, etc.) □ Lack of an engaging in-class experience □ Staying on campus provides more dedication to the learning process, while staying home is distracting.
17.	How did you feel about online learning after you completed your online learning experience in Spring 2020? □ Good □ Satisfied □ Neutral □ Unsatisfied □ Not good
18.	According to your experience in Spring 2020, rate the following from 1 to 10, where 1 means not favored at all and 10 means strongly favored. □ Pre-recorded videos provided before class □ Synchronous live lectures □ Faculty meetings (office hours) □ Online laboratory demonstrations □ In-class learning quizzes (provided within each learning module) □ Trial quizzes not contributing to grades □ Graded assessment tools (quizzes, midterm, and final exam)

C. Facilities and support for online learning

19.	Did you have access to the following?		
	Computer with webcam	□ Yes	□ No
	Spare computer for emergency	□ Yes	□ No
	Printer	□ Yes	□ No
	Reliable Wi-Fi internet connection	□ Yes	□ No
	Reliable cellular internet connection (4g)	□ Yes	□ No
	A quiet dedicated place to study and take exams	□ Yes	□ No
	Emotional support from family members	□ Yes	□ No
	Technical support from the university	□ Yes	□ No
	Support from the course instructor	□ Yes	□ No

D. Comments

20.	Please add any comment that describes your experience of online learning and/or how to improve the process.

Appendix B

Instructor Survey Form

We would like to know your views on the online teaching of civil engineering courses during Spring 2020. Please note that this survey is solely intended for educational and research purposes. Participants' private information will not be revealed or shared, and no name or any form of identification is required to participate.

1. What experience did you have with online teaching before Spring 2020?
   □ Extensive □ Acceptable □ Limited □ None

2. What attitude did you have toward online teaching before Spring 2020?
   □ Positive attitude □ Neutral □ Negative attitude

3. What was your overall teaching and administrative load in Spring 2020?
   □ <6 □ 6–9 □ 10–12 □ >12

4. What was your undergraduate teaching load in Spring 2020?
   □ <6 □ 6–9 □ 10–12 □ >12

5. What was your graduate teaching load (other than thesis supervision) in Spring 2020?
   □ 0 □ 1 □ 2 □ 3 □ >3

6. How many different courses did you teach online in Spring 2020? *Please do not count multiple sections of the same course or thesis supervision.*
   □ 0 □ 1 □ 2 □ 3 □ >3

7. How would you describe the transition to online teaching in Spring 2020?
   □ Very difficult □ Difficult □ Acceptable □ Easy □ Very easy

8. Compared to face-to-face teaching, how would you describe the effort you allocated to online teaching in Spring 2020 in the following aspects?

Aspect	Much less	Less	Same	More	Much more	Not applicable
A. Preparing lecture material						
B. Preparing lab material						
C. Delivering lecture material						
D. Delivering lab material						
E. Preparing quizzes and exams						
F. Grading quizzes and exam						
G. Overall effort						

9. What technique did you use to transition courses to online settings in Spring 2020? *Select all that apply.*
   □ Institution's LMS
   □ Utilized synchronous video technology
   □ Used other forms of video to record lectures
   □ Used videos from third-party sources
   □ Distributed information using the LMS
   □ Used institution's conference or chat function to communicate with students

10. How did you change the requirements for or expectations of students in the shift to online teaching in Spring 2020? *Select all that apply.*
    □ I changed the kinds of assignments or exams that I give to students.
    □ I lowered my expectations of the amount of work students would be able to do.

<table>
<tr><td></td><td>□ I dropped some assignments or exams.
□ I dropped some of the readings that I originally asked students to do.
□ I lowered my expectations about the quality of work that my students will be able to do.</td></tr>
<tr><td>11.</td><td>What are the challenges you faced in delivering online courses in Spring 2020? Select all that apply.
□ Managing my own time
□ Becoming familiar with the technology
□ Preparing lecture material
□ Preparing laboratory material
□ Delivery method
□ Preparing online exams
□ Grading online exams
□ Assessing students
□ Student engagement in dialogue
□ Assurance of process integrity
□ Coping with the adverse climate caused by the pandemic</td></tr>
<tr><td>12.</td><td>What are the advantages of online classes in Spring 2020? Select all that apply.
□ It allowed students to continue learning during the COVID-19 crisis.
□ It provided flexibility for scheduling class activities.
□ Availability of recorded material that I can use later
□ I find online learning to be very engaging.
□ I can stay at home, and I don’t have to commute to campus.
□ It reduces the effort in case of multiple sections of the same course.</td></tr>
<tr><td>13.</td><td>What methods did you use to examine students during online teaching in Spring 2020? Select all that apply.
□ True/False questions
□ Multiple-choice questions
□ Final answer (in numbers) questions
□ Quantitative solving questions
□ Theory testing questions
□ Submission of a scanned copy of the solution
□ Backtracking is not allowed
□ Single attempt
□ Respondus monitoring with webcam
□ Oral examination
□ Questions appear one at a time</td></tr>
<tr><td>14.</td><td>What kind of attitude do you have toward online teaching now?
□ Positive attitude □ Neutral □ Negative attitude</td></tr>
<tr><td>15.</td><td>To what extent do you agree or disagree with the following statements based on your experience with online teaching in Spring 2020?
<table>
<tr><th>Statement</th><th>Strongly disagree</th><th>Disagree</th><th>Neutral</th><th>Agree</th><th>Strongly agree</th><th>I don’t know</th></tr>
<tr><td>Online classes cause difficulties that handicap your teaching process.</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Online classes facilitate teaching compared to face-to-face classes.</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Resources that were made available to facilitate online teaching were satisfactory.</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table></td></tr>
</table>

	The experience that you gained with online teaching was beneficial.							
	Online teaching could complement face-to-face teaching.							
	Online teaching could substitute face-to-face teaching.							
	Without proctoring, the integrity of online examination is questionable.							

16.	How would you describe the overall students' performance in Spring 2020 as compared to students who took with you the same course(s) with face-to-face instructions? □ Far below □ Below □ Same □ Above □ Far above
17.	Which of the followings is suitable to be delivered through online teaching? *Select all that apply.* □ Lecture materials □ Oral examination □ Tutorial sessions □ Quizzes □ Laboratory sessions □ Office hours □ Exams □ Group meetings □ Thesis supervision
18.	What assistance would you require for online teaching to ensure a better delivery of a quality educational experience to your students? *Select all that apply.* □ Information on how best to support students □ A webcast for students on how to succeed in online classes □ Greater access to online digital materials □ Best practices on how to support faculty for online teaching □ Advice on how to adhere to accessibility requirements when moving online □ Training material for faculty on how to move courses to online □ An online resource hub with links to information about how to quickly transition to online learning □ Webinars hosted by online learning experts for faculty on how to move courses online □ Support for managing organizational change □ Technical support □ One-to-one consultation with online learning experts
19.	Please add any comment that describes your experience of online teaching.
20.	Please add any comment on how to improve online teaching.