Smooth Transition from Face-to-Face to Fully Online Classes

Dr. Duc Hoai Tran, CSULB

I received my bachelor’s degree in electrical engineering from Ho Chi Minh International University (HCMIU) in 2009, and master’s degree in electrical engineering from California State University Long Beach in 2013. I then received my Ph.D. in Engineering and Industrial Applied Mathematics from Claremont Graduate University in 2019.

My research is on the theory and application of internet of things (IoT), distributed optimization and control for cyber physical systems such as: smart grids, smart buildings. I’m also interested in applying digital signal processing techniques for detecting faults in power system.

Prof. Hen-Geul Yeh

Hen-Geul Yeh received the B.S. degree in engineering science from National Chen Kung University, Taiwan, ROC, in 1978, and the M.S. degree in mechanical engineering and the Ph.D. degree in electrical engineering from the University of California, Irvine, in 1979 and 1982, respectively. Since 1983, he has been with the Electrical Engineering department at California State University, Long Beach (CSULB), USA, and served as the department Chair since 2016. In addition to his technical and engineering excellence, he was selected as a NASA JPL Summer Faculty Fellow twice, in 1992 and 2003, respectively, and the Boeing Welliver Faculty Fellow in 2006. His research interests include DSP/Communication/Control algorithms development, and implementation using FPGA and digital signal processors. He has published more than 100 research papers on Signal Processing, Communications, Controls, and Smart Grids. Dr. Yeh is a professional engineer in Electrical and is the recipient of five NASA Tech. Brief and New Technology awards from the NASA, the inventor’s award and other awards at the Aerospace Corporation, the Northrop Grumman Excellence in Teaching award, College of Engineering, CSULB, 2007, the Distinguished Faculty Scholarly and Creative Achievement Award, CSULB, 2009, Outstanding Professor Award, CSULB, 2015, IEEE Region 6, and Outstanding Engineering Educator Award for Outstanding Contribution to the Education of Electrical Engineers in the Areas of Digital Signal Processing, Green Energy, and Smart Systems, 2019. He has received five US patents and patent applications in the area of Signal Processing, Communication and Controls. Since 2010, he has served as the organizer and Conference Chair of IEEE Green Energy and Smart Systems Conference (IGESSC).
Smooth Transition from Face-to-Face to Fully Online Class

Duc H. Tran, and Hen-Geul Yeh
Department of Electrical Engineering
California State University, Long Beach
Long Beach, CA, USA
Duc.Tran@csulb.edu, Henry.Yeh@csulb.edu

Abstract
The Covid-19 pandemic had big impacts on the global higher education system. Most schools around the world have temporarily been closed in an attempt to stop the spread. In addition to transitioning from traditional face-to-face classes to hybrid or fully online classes, universities are also facing many challenges due to the economic degradation while seeking for ways to support their students, lecturers, professors, and employees. At the same time, students, lecturers, and professors need to quickly adapt to distance education since it is the most effective tool in keeping student retention and maintaining access to learning currently. It is true that distance education proposes challenges such as student interactive, technology issues, sense of isolation. It also raises doubt about satisfying the core reason of college or university experience in which students would like to enjoy each other’s company in many ways including social gatherings, sororities, fraternities and clubs. However, distance education offers accessibility of time and place, affordability, efficiency, and most importantly, stops the spread of Covid-19. This paper describes our real experiences and our teaching approach for fully online classes at the Electrical Engineering department of California State University Long Beach during the pandemic period. It discusses how we achieved a successful transition from face-to-face education to fully online education, and how we overcame the difficulties of distance education by improving interactivity and engagement, maintaining academic integrity, and encouraging community building through the proper course design and the integration of available technological tools. A survey was conducted, and its promising result was presented with the aim of showing the effectiveness of the deployed teaching approach for fully online courses and contributing to the development and improvement of online learning and teaching.

Keywords
Online Learning; Covid-19 pandemic; Transition; Teaching Approach; Online Assessment.

Introduction
The Covid-19 pandemic has brought along a special situation and has required many adjustments and transformations of virtual environments for every aspect of our lives. The operation of the higher education section is not an exception. Because of the necessity of social distance to stop the spread of the virus, higher education sector needs to have an immediate adjustment by implementing the unprecedented and rapid migration to distance/online learning.

In the past few years, advances in communication technologies, mobile applications, teaching support digital tools, and online resources have led to the reconsideration of the traditional teaching and learning methods. They also have caused significant changes in distance learning. Distance learning includes different methods:
Blended learning: also referred to as hybrid learning that combines the advantages of both face-to-face and online instructions [1-4].

Flipped learning: students are asked to read the textbook and supporting documents before class, and class time is used for solving problems, conducting in-class activities, and seeking help from instructors [5, 6]. This method can be conducted in both online and face-to-face teaching approaches. It encourages learner-centric activities and assist personalized learning, improve students’ critical thinking ability, as well as accommodating students’ different learning styles [5, 7, 8].

Fully online learning: teaching and learning are conducted completely through online. It offers accessibility of time and place, affordability, efficiency, and most importantly, stops the spread of Covid-19.

Distance learning has been researching and being applied by researchers and educators around the world. It showed promising results based on various measures such as improvement in student grades, student satisfaction, and dropout rate. Hoic-Bozic et al. [9], Djenic et al. [4], and Hussin et al. [10] developed and applied blended learning on teaching web courseware development course, programming course, and semiconductor device course, respectively. A mobile learning system for both online and offline students was developed in [11] which includes many features for polling and communicating.

Flipped learning has been applied to teach various courses and showed remarkable achievements in terms of student’s learning and improvement in test grades and student’s engagement and motivation to learn; for instance, security [12], computer architecture [13, 14], machine learning [15], statistics [16], economics [17], Zhang et al. [18] even designed a computer information system class combining blended and flipped learning and developed a model to examine the impact of influential factors on students’ intention to learn.

Fully online learning also has been deploying in many institutions. Martinez et al. [19] demonstrated a move from face-to-face to fully online learning for the engineering master’s program at their school by adding a parallel online group. Barr et al. [20] discussed the experience of delivering an eight-week undergraduate Software Engineering program when they must switch to fully online learning. Kovecses et al. [21] discussed perceptions regarding the challenges brought up by online education and what they had learned from the experiences gained during that period.

However, it is irrefutable that the transition from face-to-face learning to distance learning has many difficulties since this teaching method requires flexible adaptation from educators and supporting resources (documentation, video maker support, online database, live broadcasting or streaming, online assessment resources, etc.). The general perception of students regarding distance education is that it does not provide a sufficient instructional forethought and planning, as well as raising doubt about satisfying the university experience in which students would like to enjoy each other’s company [22].

The study in [23] pointed out the lack of student interaction in distance learning and indicated that distance learning proposed the negative effects of passive non-participatory learning. Distance education also presents difficulties for academic integrity, especially assessments. Saad
et al. [24] suggested that assessments for distance learning need to be as rigorous as the traditional learning, and Lee-Post et al. [25] suggested that it should have authentication solutions to prevent cheating without compromising online flexibility.

This paper discusses our experiences in coping with challenges raised by teaching fully online classes at the Electrical Engineering department of California State University Long Beach (CSULB) during the pandemic period, what practices we had applied in our teaching approach, and what we had learnt from the experiences. It reports the changes we have made in our teaching for engineering courses during the transition, the tools we have employed, and the results achieved through students’ evaluations.

**Distance Learning Course Design**

Courses offered through fully online learning program will be held virtually where the communication between faculty and student occurs via online resources. Proper course design can be the solution for most concerns in online courses such as academic integrity, community building and course engagement. The overall course grades should be distributed among short quizzes, weekly reflections, course projects and group assignments instead of depending solely on exams to effectively eliminate plagiarism and cheating in an online course. Chances of cheating and plagiarism in online courses can also be reduced by utilizing available technological tools such as quiz randomization and originality checking. Other concerns regarding students’ interaction and engagement can also be addressed with a proper course design. The sense of community in an online course can be promoted through group projects, utilization of discussion board, and the continuous communication between instructor and students via email, new feeds, and discussion tools.

**Online Course Development**

The practice for the development of online education emphasizes the importance of lesson planning from the beginning to the end of the course. A useful practice for higher education regarding online courses is to plan for the entire duration of the course. This kind of planning is relevant because the instructors are no longer in the room to guide students directly or clarify any immediate questions. They have to utilize other online supporting resources and tools to help set up the plan and organize lessons and assignments so that students can complete them with few obstacles.

Backward design can be a helpful plan for organizing the structure of the course and ensuring alignment. With this plan, instructors start with the overall course objectives, then create the weekly lessons or module objectives, then the assessments and activities that students will do to accomplish the objectives.

After developing and creating the course, the next step for instructors is to focus on facilitating it, which includes posting announcements, adding missing or additional resources that enhance the learning. Facilitating the course also include the aspect on the delivery mode of the course in which instructors need to check in on the students’ participation, providing feedback and ensuring there is no confusion on the class’s content or assignments.
When developing an online course, the instructor should be consistent and transparent in designing layout structure of the course, nomenclature for assignments so that students know how the course will be structured and focus on their learning of the content. They should also plan out the course and module objectives, organize layout of the course modules or lessons, instructional materials, as well as making sure to align activities and assignments with all course objectives. Besides, ease of access to all media and instructional materials which are built with accessibility and usability should be provided.

**Course Design’s Elements**

The way that online classes are built will affect the ability for students to learn the content. When planning or designing an online course, instructors should focus on these main elements:

- Course learning outcomes: define what the students are expected to learn by the end of the course
- Module learning outcomes: define what the students are expected to learn by the end of a particular section.
- Practice activities: activities that support the successful completion of the assessment of a particular section.
- Instructional materials: content that supports the successful completion of the assessment of a particular section.
- Accessibility: identify any material in the course that needs other design features added for students with and without identified disabilities to use them.
- Assessments: identify the assignments or activities that will be used to measure the student’s achievement of the module learning outcomes.

A very important part of course design is alignment because it helps ensure that all the course elements directly support the course learning objectives including module learning objectives, assessments, practice activities and instructional materials. Correct connection between these resources increases the probability that students will succeed in achieving the learning objectives. For instance, aligning course learning objectives with module learning objectives can be done by using the pre-defined list of verbs (Bloom’s Taxonomy [26]) which are divided in 6 different levels including level 1 (recalling information), level 2 (explaining ideas or concepts), level 3 (using information in another familiar situation), level 4 (breaking information into parts to explore understandings and relationships), level 5 (justifying a decision or course of action), and level 6 (generating new ideas, products, or ways of viewing things).

It is also important to implement accessibility since there has been a significant increase of students self-identifying as of having a disability. Accessibility also can help students without identified disabilities to success in taking and finish online course because it will accommodate different types of students and empower independent students. The components needed for an accessible online course include easy and consistent navigation, providing clear to understand verbiage, easy to understand module titles and labeling of files, being mindful of color contrast and font, descriptions for images, captions for videos, downloadable transcript file for video and audio files.

**Activities and Assessments**
Assessments

Assessment is viewed as part of pedagogy and student learning since its purpose is formative, and to enhance faculty teaching and student learning. Assessment should be a reflective and engaged process by which students can learn about their own learning, how they learn, what they know.

Indeed, assessment of student learning is a necessary element of effective classroom teaching. There are two main types of assessment: formative assessments and summative assessments. Formative assessments such as weekly quizzes, weekly reflections, content wrap-ups, weekly homework allow instructors to break learning content into smaller pieces. They are great tools to ensure that students are on the right track, and help instructors identify flaws and make adjustments to their instruction. On the other hand, summative assessments such as research paper, term papers, course projects, midterm and final exams help evaluate the overall understanding of topics taught throughout the course. Either it is a formative assessment, summative assessment, or activity, students should receive timely feedback to help students stay on track. Instructors should also consider creating peer feedback opportunities.

It is important to align module level learning outcomes with the module assessments which should measure stated learning outcome. This alignment can be done by selecting the right verbs in the pre-defined list of verbs mentioned previously. For example, instructors can use verbs in the knowledge and comprehension categories which require lower order thinking skills for lower stake weekly assessments such as short quizzes and weekly reflections. For major assessments such as midterm and final exams, term papers, and term projects, verbs which require higher order thinking should be used.

Besides, academic dishonesty can happen in both traditional and distance education. While it might be difficult to prevent cheating entirely, a resourceful action in assessment design can reduce the probability of cheating. The following suggestions can help preserve academic integrity in fully online learning and teaching:

- Purposefully select assessment methods: use online testing particularly objective test that include assessment questions like multiple choice, multiple answer, true/false, etc.
- Mix objective and subjective questions: mix objective tests with short answers or essay questions.
- Randomize questions: randomize assessment questions with a question pool so that students do not get the same questions when taking a test. This also eliminates sharing answers if students are taking the test at the same time.
- Limit feedback: if instructors allow students to repeat the test, it is relevant to limit what type of feedback is displayed to students upon completion of a test.
- Time the assessment: set a timer with an expected completion time. Unprepared students could lose as they spend time going over the material, and risk not having sufficient time to respond to all the test questions.
- Display questions one at a time: Students can still capture pages with single questions being displayed, but it is more time consuming and cumbersome for them to capture and share with others than showing them all questions at the same time.
• Consider proctoring alternatives: proctored remote exam is also one of the options for preventing cheating. However, it also raises many drawbacks such as planning and setup requirements, false positive flags, lack of access to the appropriate technology to use services, privacy concerns about third-party recorded remote proctoring, back-up plan requirement in case the service crashes.

Activities

Course activities, either group or individualized activities, can be in the form of discussion board questions, dropbox assignments, or quiz activities, in-class exercises. Grading these activities serves as a compelling incentive for students to participate and complete them.

A sense of community in online courses can be created by encouraging interactivity and engagement. Formative assessments such as open-ended discussion questions, interactive learning content, assigning discussion facilitation to students and peer reviews are ideal tools to encourage interactivity and engagement in an online course. An example of assigning discussion facilitation to students is weekly assigning discussion leader for each assigned group in the class. The discussion leader of the assigned group during that week will post one well thought-out inquiry, and everyone else must post one response to the inquiry. Instructors should make sure those activities or assessments are aligned with the corresponding week’s or module’s learning outcomes.

Delivery Methods and Content

Delivery Methods

There are two main delivery methods for an online course: synchronous modality and asynchronous modality. While synchronous modality provides students and instructors with some flexibility and requires that all parties meet at the same time online using web conferencing tools, asynchronous modality requires no meeting time for the instructor and students. Asynchronous modality is the most flexible of the modalities since student may complete their work at any time during the day in any time zone as long as they meet the assigned deadlines set by the instructor.

Both modalities require planning based on the course learning outcomes and the calendar schedule of when the course is set to run. Depending on the course’s objectives, instructors can choose the modality that is best suited for their course.

Content

In online courses, content and instructional materials are used interchangeably for the delivery of the course’s lectures, explaining of ideas and concepts to students. This information also includes any other additional materials use to enhance the students’ learning such as supplemental materials.
Breaking down the content or lessons into sub-topics create an opportunity for students to learn at their own pace. They can take breaks in between different topics and easily pick up where they left off.

There are four types of learning styles that most students use when learning something new: auditory (hearing), visual (sight), reading/writing and kinesthetic (hands-on). Students likely use a combination of these in order to learn new subjects. Therefore, various types of mediums that meet the needs of each learning style are recommended when instructors begin to collect or curate content for instruction. Content can come from different resources such as course textbooks, articles, journals, presentations, documents, school’s library streaming media site, and more. As mentioned previously, accessibility and usability should be promoted. For example, videos should have closed captioning, and transcript or audio descriptions (for videos without sound or don’t have any dialog), and other media should include images, publisher materials or websites that pertain to the subject.

The practice of incorporating various types of mediums can help instructors assist students with their learning by addressing each learning style and offer an opportunity for engagement since students are experiencing the new material in various ways.

The tools used for delivering content are typically the Learning Management System (CSULB uses a system called Beachboard), and a web conferencing tool like Zoom. These tools are used to help support and enhance the learning experience for online courses in both synchronous and asynchronous modalities.

The content tools help promote engagement, motivation, self-paced learning, revisited information, active learning, peer-to-peer engagement, collaboration, critical thinking. There are many supplemental tools assisting instructors in breaking down and organizing course content and addressing the learning style such as Learning Glass, PowerPoint, Camtasia, Kaltura Capture, Snaglt, Flicker, Google Images, Pixabay, etc. If the content tools are suitable and makes sense for the lesson, they can also be used in traditional face-to-face course.

**Transition from Face-to-Face to Online Teaching**

*Technology Support*

At our university, Beachboard had been used as the main platform of the Learning Management System for various courses realized personally. The role of this Learning Management System was emphasized more during the pandemic period since all classes were forced to move online. Instructors relied on it to upload different documents and files, create discussion forums, open dropbox folder for assignment submissions, create news and announcements, review and evaluate students’ assignments, etc. This platform can be easily utilized and operated by both the instructors and the students.

Beachboard provides collaboration tools such as Discussion Board, Groups, Lockers, Dropbox to create the opportunity for students to work together and communicate in a digital space (for both synchronous and asynchronous environments). These collaboration tools encourage critical thinking and provoke thought among students, encourage learning from others and produce self-reflection, and help foster a sense of community and engagement among peers.
Beachboard incorporates and integrates tools for the assessments such as Quizzes, Surveys, Dropbox, Rubrics which allow instructors to evaluate the course, check for understanding and help set expectations. It also provides many features for preserving academic integrity such as disabling right click, timing the exam and automatically shutting down when it is over, randomizing answer choices and test questions, displaying questions one at a time, providing Turnitin anti-plagiarism feature, providing Respondus lock-down browser and monitor.

The main web conferencing tool used at CSULB was Zoom [27]. This platform allows the flexibility for synchronous and asynchronous real-time interaction using video, text, audio, promotes active learning and engagement through polls, live chat, breakout groups, surveys, screen sharing. Sessions or lectures can be recorded and archived which allows students to access information anytime.

**Teaching Pedagogy**

In our teaching, students will be the center of the lecture planning process, and we aim to transmit to them our pedagogy that applying what you learn for problem seeking and problem solving is more important than remembering what you learn.

In our classroom, we always strive to create a sense of community by encouraging interactivity and engagement by implementing open-ended discussion questions, group work or group projects, interactive learning content, and assigning discussion facilitation. These community-based learning create opportunities for peer-to-peer learning in online courses. For example, our lectures always contain some in-class exercises or short discussion that will give students extra credits if they solve them correctly or have thoughtful discussion. This not only helps to improve students' interactivity and engagement in our online course, but also makes them be more eager to focus on the lectures and understand the topics at the first time.

Students are the center of our lecture planning, and everyone (including us) will be accompanying and shaping a learning process together. In our class, students can either learn from us (through lectures) or from other students in class (through group labs/projects). We did also learn from students sometime. For instance, in the laboratory section of the Probability and Statistics with Application to Computing class, after suggesting the correct theoretical result, some students could write a more efficient Python code in compare with our code to simulate the assigned question. Hence, it is a bidirectional connection between us and students, and between student to student, rather than a one directional dissemination of knowledge through us as the instructors.

The participation of us, as the instructors, and students in the learning process not only helps achieve successful online courses, but also helps improve the engagement factor for this modality. We become engaged more with students in the online forums (such as Beachboard's discussion forum and Discord channel [28]) than they are in traditional lecture classrooms. We can spend more time communicating with students about the content of the course, thus facilitating the student’s learning, rather than introducing the material. This can open dialog between students and us and assist with the students’ discovery of their own learning.

**Video Production Technique**
In addition to paper-based tutorials, we have also utilized the videos as the instructional materials in the laboratory section of Digital System Design course which requires students to become proficient in using the computer-aided design tool (CAD) for behavioral simulation, and device programming implementation. The lab section of this course offered at CSULB give students practice with Field-Programmable Gate Arrays (FPGAs), the Basys 3 Artix 7 Trainer board [29], through the Xilinx Vivado [30] as the CAD tool.

Since the laboratory of this course requires the students to learn how to use the CAD tool, instructors must prepare tutorials and other reference materials for the students. In previous offering of the course, instructors spent most of the time demonstrating the procedure of using the software and introducing the syntax of the programming language used for that software, while the other documents served as the references for the students. This method offered all students a chance to watch how the instructor completed the required tasks and promoted interaction between the students and the instructor. However, the disadvantage of this method was that it reduced the valuable lab time for the students to work on their tasks and required more time from the instructor to prepare the lab tutorials since the CAD tool interaction is mouse-based with graphical feedback. The students also could not review the instructions in case that they missed any step during the simulation or implementation processes.

Narrated video clips are a natural choice to capture our demonstrations of the CAD tool and to serve as the basis for subsequent and repeated viewing by the students. They precisely capture the mouse-based interactions, show how the CAD tool respond to a simulation, and show how the result of the implementation looks like. The instructional videos provide the reusability and accessibility since students can replay them as many times as needed, and can pause or skip ahead.

The production tools we used to create the instructional video clips include computer with installed CAD tool, headset microphone which allows us to talk and type at the same time and cancel the environment noise in your video clips, and screen capture software (we used TechSmith Camtasia [31] which is provided by CSULB). Camtasia provides many useful and easy-to-use features such as screen and audio recording, PowerPoint integration, media import, annotations, web camera capture, music. Editing the video clip including adding, removing, trimming, or moving sections of videos using Camtasia is very easy. It also provides many options for the video’s format and resolution.

The instructional video clips for the lab section of our Digital System Design course were uploaded online before the lab hours. Students were asked to review them on their own schedule before lab as part of their pre-lab preparations, and the lab time were used for them to work on the assigned projects with their teammates in the break room, and seek help from us if needed. We also shortly explained the main points of the videos, discussed how to implement the code on the FPGA board, what students should be careful when writing the programming language on the CAD tool during lab hours. By utilizing these instructional videos, students were productive during lab period and requested less assistance with the CAD tool.

For each assigned project, students needed to submit a formal report in which they explained the purpose of the lab, the procedure they used to complete the assigned tasks, showed the simulation results, included their programming language for checking, discussed what they
learned from the project and what aspects from lecture they were able to apply, discussed the difficulties they faced when conducting the tasks. This type of formal report will help get students ready for working in industry where they need to deal with technical reports most of the time. In addition to this formal report, students needed to also submit a video clips for the hardware implementation part showing that they have successfully and correctly implemented the code on the FPGA board, or privately showed the hardware implementation to us through Zoom video during lab hours if it is more convenient to them.

Assessment in Online Course

We base on how students apply what they learned for problem seeking and problem solving to assess their ability, rather than testing how they remember what they learned. Hence, our exams are usually open notes and open books (both in face-to-face instruction and online instruction). When they graduate and go to work, they must solve problems with all the tools they have. Therefore, the ability of analyzing problem, accessing available information, and combining knowledge for finding the solutions is the essential ability. This type of testing also somehow helps us to prevent academic dishonesty when our classes moved online because of the pandemic.

In our exams or quizzes, we inclined to use more conceptual questions such as steps in solving the problem, explanation of the hypothesis and definitions, or error identification in a proof or computation. Students must scan and upload their step-by-step work. We avoided using proctoring tool in our assessment method since it is hard to ensure that resource issues such as technology, hardware/software, accessibility, finances do not impact a student’s ability to perform. Moreover, students have the right not to turn on their cameras or share their screen for privacy reasons or cannot share their screens for equity reasons. This makes the utilization of proctoring tools become less effective.

The initial assessment method we used was posting all of the exam’s questions on Beachboard and announcing students about the exam’s schedule. Students needed to access the questions through Beachboard (they can only see the questions a few minutes before the exam time), solve the questions, scan and upload their solutions no later than the assigned time (e.g. 2 hours). We wrote our new questions to make sure that students cannot find the solution anywhere and need to really solve them. However, it had been discovered that after accessing the exam’s questions, some students posted them on the website called Chegg (initially a resource to help with homework but has been abused for cheating) and wait for the solutions during the exam time. The exam duration, which was 2 hours, was long enough for people on Chegg to solve the questions an upload them online. We found out this cheating method because we saw many identical solutions (in terms of demonstration, solving method, variables’ name). It turned out that they just copied the solutions on the website. Besides, this assessment method could not prevent group work during the exam, which was not allowed in our course. Students have worked in groups and had exact errors in their solutions. These are very unfair for others who worked hard and played by the rule.

Therefore, we had to improve our assessment method in order to prevent this dishonesty and preserve academic integrity. Instead of accessing all exam’s questions on Beachboard, students needed to join a class meeting on Zoom to see the questions which were shown one at a time.
The notifications about solving time and submitting time for each question were stated clearly on the screen. We also notified them on real time about how much time they have left for that question, time that they must submit their answers, and late submissions were not accepted. Time for solving each question was properly allocated depending on its complexity and difficulty. Students also had extra 4 minutes to capture their answers for each question and upload them on the dropbox folder on Beachboard where it showed the files’ submission time. We continuously checked online during the exam to see if students posted any question on any website for help.

This improved method also helped reduce the likelihood of working in groups since students needed to submit their step-by-step works and answers with only the final result just received half of the credits for that question. It prevented students from copying the results from each other. They need to show their unique and correct work or solution to earn full credit. Also, under time pressure, students are more likely to make mistakes, which will tell me who worked in group if they had the same errors.

This assessment method also has some disadvantages, for instance, it gives students more pressure and students cannot skip questions and come back later. However, since proctoring tools was not effective and this assessment method’s advantages in preventing dishonesty outweigh those mentioned disadvantages, it is a considerable assessment method for quantitative exams or high stakes exams in online courses.

**Evaluation**

The effectiveness of the implemented teaching approach in our online courses was investigated based on students’ voluntary and anonymous evaluations. The evaluated courses were Digital System Design course (2 sections) and Probability and Statistic with Application in Computing course (3 sections), which were offered in Spring 2020 and Fall 2020 semesters. These courses are junior level, and each course include both seminar section and laboratory section. They were taught through synchronous mode during fully online instruction. There was a total of 135 students attending these courses with 55% average responding rate, meaning that there were 74 students responding to the courses' survey.

The survey's gathered data, Table I, sought to evaluate the quality and effectiveness of our implemented teaching approach, and provide insight into how students felt about our online courses. The likert scale used in the survey was 1-6, where 1 was strongly disagreed and 6 was strongly agreed. The average mean scores were high suggesting that students enjoyed the online learning experience.

**Table 1. Survey questions and descriptive analysis.**

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Question Text</th>
<th>Respondents</th>
<th>Likert Scale (X-Y)</th>
<th>Mean Score</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Class time was used efficiently.</td>
<td>74</td>
<td>1-6</td>
<td>5.63</td>
<td>0.67</td>
</tr>
</tbody>
</table>
In the survey, students were asked to provide comments about what contributed most to their learning in the course. Here are some comments from the survey:

“The clear explanations and the time the professor took for students to understand material.”

“The lecture contributed the most to my learning for this course because of my professor’s clear and thorough explanations. He was always answering students’ questions and made sure we were grasping his explanations throughout our lecture. The in-class exercises he implemented into the lectures also made them more engaging and made us able to apply our understanding.”

“I like the in-class assignments and how the professor goes over examples thoroughly.”

“The professor explained everything thoroughly and was always available if anyone needed help.”

“The lab’s video clips were very helpful. I was able to overcome the simulation errors by watching them many times to check what I am missing and what I am doing wrong.”

When being asked to provide suggestions and recommendations to help us prepare to teach these courses again, students wrote the following:

“More examples from real world problems where the concepts apply.”

“Make sure students understand the topic before moving on to the next topic. (I feel like the professor went too quick when explaining CMOS transistor gates)”

“Explain how to use Vivado a little bit more.”

“Keep on explaining and taking time to make sure students understand the concepts.”
The limitation of this evaluation is that the result data was collected from junior-level classes offered by CSULB Electrical Engineering department only. The evaluation should also be collected from other levels of students and classes for a more comprehensive result. Besides, future research can develop a more blended teaching approach which combines the advantages of online teaching such as online discussion forums, video production techniques with traditional teaching approach and apply it to different types and levels of classes.

**Conclusion**

The main objective of this paper is to report the changes experienced during the implementation of online courses at CSULB Electrical Engineering department. It shows the changes made in our teaching approach during the transition from face-to-face to online teaching and the tools we have employed for those changes. Through students’ voluntary and anonymous evaluation, it presents how we achieved a smooth transition by improving interactivity and engagement, maintaining academic integrity, and encouraging community buildings.

While the degree of interaction and engagement was limited to in-class questions and answers in the traditional face-to-face teaching, it had been improved in our online courses since students can interact and connect with us in both the synchronous online class meeting and the discussion forums. This improved interaction and engagement had reduced confusion and provided a better flow of information between students. The recorded lecture sent after each synchronous online class meeting also provided a chance for students to review what they missed during the live lecture.

With the video production techniques, instructional video clips for laboratory section had been a useful tool and had met with considerable student acceptance. They do not require high investment of time and equipment and can be conducted by a single instructor. They have proved to help students in our class learn the CAD tool quickly and free valuable lab time for troubleshooting, discussing, team-working, or even learning other course materials. These instructional video clips are also suitable for other laboratory courses of College of Engineering that require students to be proficient in using a set of CAD tools or software applications and should be considered to be utilized in the traditional face-to-face teaching approach.

The probability of cheating in online learning can also be reduced by utilizing resourceful actions and employing available technological tools in assessment method design. In addition, the overall course grades should be distributed among short quizzes, homework, weekly reflections, course projects and group assignments instead of depending solely on high stakes exams to effectively eliminate plagiarism and cheating in online courses.

Overall, this paper contributes to the development of distance education and aims to improve the effectiveness of online teaching and learning. The implemented teaching approach described in this paper may be adapted and applied in a variety of courses from a range of disciplines. The promising evaluation results encourage the continuous improvement in the proposed pedagogical teaching model. The improvement will not only focus on learning content creation, delivery, assessment, but also on constructivist and collaborative learning and teaching methods.
References


Bloom’s Taxonomy, https://www.bloomstaxonomy.net/

Zoom, https://zoom.us/

Discord channel, https://discord.com/

Basyx 3 Artix-7 Trainer board, https://store.digilentinc.com/basyx-3-artix-7-fpga-trainer-board-recommended-for-introductory-users/
