DIFFERENCES, LIMITATIONS AND ADVANTAGES OF EFFECTIVE ONLINE AND FACE-TO-FACE TEACHING METHODS FOR A MEDIA ARTS COURSE

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ABSTRACT
This study assesses the differences, limitations and advantages of online teaching and learning in interactive media arts (IMA) and design education. This research traces the development of alternative methods and activities for effective online teaching and learning during a sudden migration from face-to-face (F2F) to online caused by the outbreak of the COVID-19. Data and reflections were gathered and qualitatively analyzed from media production and programming courses. The courses were conducted with newly developed and adjusted methods including synchronous online lecture, live-coding, discussion and presentation, asynchronous video tutorial, virtual office hours, responsive communication and online exhibition. In addition, various methods of trouble-shooting students' code issues were explored, which included Slack, Google Drive, Atom Teletype, VS Code LiveShare and Zoom ScreenShare. Findings reveal that the adjusted online methods produced similar outcomes to F2F instruction. The results display positive assessments of students' engagement and adaptation to online teaching and learning.
Keywords: Online Teaching, Live-coding, User Testing, Video Tutorials, Virtual Office Hours, Troubleshooting, Responsive Communication

INTRODUCTION

The study was conducted at a university which is a joint US/China international liberal arts undergraduate university placed in Shanghai with half Chinese students and half international students. Located in China, the university was one of the first universities to issue a quick transition in teaching and learning due to COVID-19. In response to the pandemic, the university took several actions to migrate courses online. First, the university delayed the schedule of the Spring 2020 term, which provided two extra weeks for faculty to redesign their courses for online instruction. Moreover, to support faculty move their classroom teaching experience to an online environment smoothly and timely, the Center for Teaching and Learning (CTL) provided a variety of resources, tools and techniques for faculty to adopt in their online courses. Berman, McLaughlin, Bass, Pauly, and Zellman (1977) found that an instructor's belief and support affect their students' performance. Throughout the semester, CTL offered a series of pedagogical support for faculty, including workshops, one-on-one consultation sessions, online class observations/midterm student perceptions, research for online teaching in the form of weekly blogs, a Celebrate Online Teaching Non-Conference, an Introduction to College Teaching Credential Course and an Advanced Course Design Studio (CDS) on Teaching Research to help faculty create an effective and rewarding online teaching environment and further enhance students' online learning experience. This approach mimics the powerful educational backward design model by Wiggins and McTighe (1998), where they encourage instructors to begin with learner outcomes, followed by gathering evidence (assessment), and finally designing the learner active experience. With the support from the university, CTL, faculty and students' creativity and flexibility, the migration of online courses turned out to be a fulfilling experience for both faculty and students. The future development of online courses is facilitated and enhanced by faculty's reflection and students' feedback on the courses' effectiveness.

Teaching online is often considered more challenging and time consuming than traditional face-to-face teaching (Chiasson, Terras, & Smart, 2015; De Gagne, 2009; Freeman, 2013; Lewis & Abdul-Hamid, 2006; Mills, Yanes, & Casebeer, 2009). The Primary Author (PA) had the same experience while the PA migrated his courses online after receiving an announcement from the university to transition to online. Since the PA did not have a prior experience of online teaching and learning, he attempted to accomplish the same learning outcomes with

alternative teaching and learning methods as face-to-face (F2F). In order to meet the same outcomes (Wiggins & McTighe, 1998), various teaching and learning activities and techniques were developed.

This manuscript is written after the whole semester to share the PA's detailed experiences, processes and outcomes and to contribute to research on planning, designing and delivering online courses. The circumstances and issues the PA encountered will be demonstrated and the alternative solutions, resources, tools and techniques will be discussed. Through teaching online courses in the semester, the PA attempted to incorporate a "Teaching as Research" lens to pursue the following research questions.

RESEARCH QUESTIONS (RQ)

What are the differences, limitations and advantages of effective online and F2F teaching methods for a media arts and design course?

1. What are the alternatives for effective online teaching and learning during sudden transition?
2. What is the final outcome, result or product of the alternatives for effective online teaching and learning?
3. How do we capitalize on the perception of limitations for online learning into creating opportunities for all students to engage in the process?

OPERATIONAL DEFINITIONS

In this study, we will interpret the following terms:

Online Teaching is the delivery of instruction using different web-based technologies, from the Internet or an intranet and other communication technologies, that enable students to participate in learning activities beyond the campus, from students' homes to workplaces and other locations (Zhu, Payette, & DeZure, 2003). Online learning is an education that takes place synchronously and/or asynchronously over the Internet.

Live-coding is an approach to teaching programming by writing actual code during class as part of the lectures. In a live-coding session, the instructor thinks aloud while writing code and the students are able to understand the process of programming by observing the thought processes of the instructor (Soosai Raj et al., 2018). It is the process of writing source code that is made visible by projecting or streaming the computer screen in the audience space, with ways of visualizing the code (McLean, Griffiths, Collins, & Wiggins, 2010). It is most prominent as a performing arts form and a creativity technique centered upon the writing of source code and the use of interactive programming in a conversational and improvised way (Magnusson, 2013).

User Testing is a technique used in user-centered interaction design to evaluate a product by testing it on users. This can be seen as an irreplaceable usability practice, since it gives direct input on how real users use the system (Nielsen, 1994). The interface and functions of a product such as a website and application (app), are tested by real users in realistic conditions. Through the process of user testing, the usability of the project is evaluated. The testers interact with the product naturally without specific instructions to identity whether the system and functionalities are intuitive and comfortable enough.

Video Tutorial is an audiovisual learning resource to transform a passive viewing experience into an active learning experience. It is a guide and activity for the students to engage with a subject, make observations, visualize information, follow specific steps of a technique, and challenge with questions related to the topic presented in the video.

Virtual Office Hours (VOH) are similar to in-person office hours although they provide students with greater access, while using the instructor's time more efficiently. Benefits of VOH are increased student use; more availability for students with demanding schedules; increased productivity for instructors and students; small group participation in the same office hour conversation; reduction of the number of individual emails on the same topic.

Troubleshooting is a systematic approach to problem solving that is often used to find and correct issues with complex machines, electronics, computers and software systems (Rouse, 2014). In this study, troubleshooting is a form of assistance that instructors guide learners to solve issues of their projects. It demonstrates the process of identifying a source of a problem, debugging the issue and making their project operational or improved towards their idea.

Responsive Communication is not a set of rules; it is a set of tools. That means that it is always necessary to pick the right tool for the occasion (Scollon & Scollon, 1986). It is an essential source of interaction between an

instructor and students. It prevents isolation during online learning by increasing the presence of instructors. Based on the communication policies and instructor and student preferences, various communication tools are employed to respond to their questions or feedback. Phone calls, synchronous video conference tools, direct messages (DM) or text messages are options to use.

LITERATURE REVIEW

Course Migration and Learning Effectiveness

The spread of COVID-19 has posed new challenges on higher education around the world. Colleges and universities were forced to adjust and make a quick transition to adapt to this unprecedented situation (Bothum, 2020). One of the solutions adopted by many universities is to migrate courses online (Sanger, 2020); therefore, moving F2F courses which most faculty are familiar with to online courses successfully in such a short time has become the prioritized issue for every educators and institutions (Bothum, 2020; Terenko & Ogienko, 2020). Terenko and Ogienko (2020) aimed to identify approaches to teaching online courses in higher education because they found all the faculty in their survey expressed their concerns about whether they could make a complete transition to online instructions. Some of them showed uncertainty about the lack of well-designed curriculum resources, effectiveness of online learning management tools. On the other hand, students were worried about their self-learning skills and the lack of real-time communication with instructors and peers. However, despite all the concerns and uncertainty, both faculty and students agreed that the transition to online instruction was necessary and the only solution to the pandemic, and they were ready to face the difficulties.

To overcome the difficulties, many universities have taken actions to effectively move the college classroom experiences to the online environments (Cruickshank, 2020; Sanger, 2020). At the University of Delaware, they modified their grading options, because research (Moawad, 2020) indicated that among the worries and fears students were experiencing during the pandemic, uncertainty about the exams and assessment was the most intense one in their academic stress. Different online resources, like free virtual tutorial sessions, and wellbeing resources were also provided to support students in different ways. There was assistance for faculty as well. Faculty were encouraged to participate in different workshops which help with creating learning contents, the use of learning management systems (LMS), and assessment. Faculty also showed their flexibility and creativity during the process of migration to online courses. For example, they started a buddy system with a more experienced faculty in online instruction paired with a less experienced one; they created a teaching resources forum, where faculty could share tips, examples and reflections on their teaching experiences online. It showed that in this sudden shift of situation, a support system is extremely important for both faculty and students. Overall, the transition to online instruction and the effective use of e-learning technologies and resources can help us thrive under the impact of the pandemic on our education system.

Online Teaching and Learning: Course Design and Interaction with Students

Online learning, or e-learning has become more and more popular (Huang & Hsiao, 2012) due to several advantages. Bouhnik and Marcus (2006) indicate advantages of e-learning, including freedom to decide when and where to learn the content; freedom to express ideas and ask questions: accessibility to course materials based on students' own interest. In summary, e-learning uses online technologies to "create, foster, deliver, and facilitate learning, anytime and anywhere" (Liaw, 2008, p. 864). E-learning effectiveness can be influenced by course design, multimedia learning content, interactive learning activities and the quality of LMS (Liaw, 2008). There are also many studies related to students' learning outcomes and perceived satisfaction to online learning. Kang and Im (2013) found that interaction is the most important factor in predicting students' learning outcomes. Their research examined what element in learner-instructor interaction can predict the learning outcomes in an online learning environment. Firat, et al. (2019) investigated causal correlation between engagement time and learners' academic achievement. The result showed that academic achievement increased significantly when learners engage more with the online learning materials. Krause and Coates (2008) also noted the association between students' engagement and high quality in learning outcomes. In other words, learners' engagement with learning content and their interaction with instructors and peers are essential to obtain an effective online learning experience, and eventually reach desired learning outcomes.

Therefore, how to facilitate student engagement with learning materials and student interaction in the virtual setting are significant in online course design. There are many techniques and activities to enhance student engagement and interaction. The two major formats in online instruction are asynchronous online learning, where students can learn the online materials anytime and anywhere and synchronous online learning, where requires real-time interaction between students and instructors, and among students (Casey, Shaw, Whittingham, & Gallavan, 2018). Some of the technology tools used for asynchronous instruction include downloadable pre-recorded lectures, forums and discussion boards, email communication, Google drive and other collaborative platforms (Casey, Shaw, Whittingham, & Gallavan, 2018). Research has recognized the effectiveness of

asynchronous instruction to foster student learning (Huang & Hsiao, 2012; AbuSeileek & Qatawneh, 2013; Hrastinski, 2008; Murphy, Rodríguez-Manzanares, & Barbour, 2011). It has been observed that asynchronous communication could facilitate in-depth learning and critical thinking because students have more time to process information and form the knowledge (Benbunan-Fich & Hiltz, 1999). However, in asynchronous learning environments, one of the main drawbacks is the delayed feedback provided to students. Moreover, learners may easily feel separation in the learning process due to the lack of social interactions (Branon & Essex, 2001). The mode of synchronous communication can make up for the limitation of asynchronous communication. Through affordable and advanced tools, like web-conference, live chat, and virtual office hours, instructors can provide feedback to students easily and promptly, and encourage live participation and interaction between students and instructors and among peers (Casey et al., 2018; Huang & Hsiao, 2012). This feature has a positive impact on building connections and a supportive learning community online.

How Creativity Often Stems from Limitations and Obstacles

In the article written by Jacobs (2016), the author believes constraints stimulate people's creativity. The examples in filmmaking and advertisement show that “the creativity works better with obstruction”. The research conducted by Metha and Zhu (2016) examined how resource availability has an impact on people’s creativity of using resources. They found that when resources are available sufficiently, people simply do not use them in innovative ways. However, if people face shortage of resources, this challenge makes them utilize the resources creatively. As Oppong (2017) noted, constraints force people to think, so at the same time constraints bring out people’s potential and creativity. This idea echoes with pedagogy in education. One of the e-learning benefits which Capper (2001) proposes is “new educational approaches". In other words, due to different opportunities and limitations, online instruction creates many new options and learning strategies which are not found in F2F instruction. Especially during the pandemic, faculty need to incorporate practical resources and tools into their teaching. Cruickshank (2020) suggests that educators should think creatively to design learning activities and assessment using existing resources. On the other hand, students also have to learn the content and complete assignments remotely without easy-accessible software or hardware, so it is a valuable opportunity for students to think outside of the box and inspire their creativity to face different challenges.

METHODS

This study was conducted at a small private research university with a US/China partnership. The design is a single participant (instructor) case study of instructor reflections on courses that he taught pre and post pandemic conditions. The participant is one male Assistant Professor, who has taught in higher education for the past four years. He holds a graduate degree from an Interactive Telecommunications Program and started his educational career as a Research Resident. He has taught foundation courses, including Interaction Lab, Communications Lab, Creative Coding Lab. He has also taught elective courses, Kinetic Interfaces, Nature of Code and Machine Learning for New Interfaces.

Data was collected during the spring semester, 2020 and compared to data from the prior spring and fall term, 2019. The data focuses on two courses, Communications Lab and Nature of Code, which consisted of students between the ages of 18-27 with various majors, years and mixed cultural identity differences. The description and demographic are as follows.

Communications Lab (CommLab) is a foundation course designed to provide students with a framework to effectively communicate through digital means, students explore the possibilities of digital media by producing projects that make use of digital images, audio, video, and the Web. Students learn in a laboratory context of hands-on experimentation, and principles of interpersonal communications, media theory, and human factors will be introduced in readings and investigated through discussion. Students learn the principles of digital imaging, recording and editing video and audio with Adobe Photoshop, Audition, and Premiere, and the basics of fundamental web languages hypertext mark-up language (HTML), Cascading Style Sheets (CSS) and JavaScript (JS) to establish a diverse digital toolkit. Both traditional and experimental outputs, including online and interactive media platforms, will be explored. Weekly assignments, group and independent projects, and project reports will be assigned in each of the core areas of study.

Nature of Code (NoC) is an intermediate elective course designed based on Daniel Shiffman’s (2012) The Nature of Code course, adjusted for students of undergraduate studies. This course explores the fundamentals of programming, such as Object-Oriented Programming (OOP), and application of simple principles of mathematics and physics to recreate natural behaviors in a digital environment. Throughout the course, students will learn to add layers of physical complexity to make programmed behaviors of Objects more realistic and systematic. Students will integrate their programming skills with diverse topics in Computer Science, Mathematics and Physics, and expand the concepts by utilizing new and interdisciplinary media.

Table 1: Demographic Data.

Course and Term	CommLab Spring 2020	CommLab Fall 2019	NoC Spring 2020	NoC Fall 2019
Total Number of Students	12	14	12	17
Freshman	8	2	1	0
Sophomore	3	5	8	9
Junior	0	5	1	1
Senior	1	2	2	7
Majors				
Interactive Media Arts / Interactive Media & Business	0	4	6	10
Computer Science	3	0	2	4
Social Science	1	2	2	0
Business and Finance / Business & Marketing	1	4	1	0
Biology	0	1	0	0
Global Liberal Studies	0	1	0	0
Media, Culture, and Communication	0	1	0	0
Neural Science	0	0	0	1
Undecided	7	1	1	0

PROCEDURE

In late January, 2020, due to an outbreak of the COVID-19, the university announced that the spring semester classes were postponed for two weeks and soon online learning was adapted. In collaboration with three other instructors in the department, the PA redesigned the course content of CommLab and NoC and created a new online learning experience that accommodated students and the course learning outcomes.

On 30th January, 2020, the PA and three other CommLab instructors held their first meeting to restructure and revamp current education practices, methods and models. A mix of synchronous and asynchronous methods, which include live streaming presentations and discussions, personal tutorials and live-coding support, step-by-step tutorials (slides and videos) were established, as well as repositories with specifically-designed reading and coding resources. These meetings were carried out until mid-February, the instructors developed a new delivery strategy that consisted of various tools for online learning experience, such as Zoom, Slack, Discord, Atom Teletype, VS LiveShare, LMS for Streaming Service and a Youtube channel. They also restructured the course WordPress (WP) blog including Google Calendar to facilitate students in different time zones.

For the NoC course, the PA used similar strategies as CommLab. The PA focused on bringing live-coding to the online setting as the main teaching and learning model of the course. Online live-coding with Atom Teletype was used throughout the semester, which created an online environment similar to those previously taught F2F. A new, useful tool was identified through online teaching that allowed easy annotating and drawing on the screen and was integrated with the live-coding method.

In March 2020, the CommLab instructors discussed their online teaching experience and its effective and ineffective methods. After the first main project Interactive Story, it was noticed that students needed additional time and support to finish all aspects on time because of the challenging situation of migrating online quickly. New adjustments to an online learning setting, different time zones and increased anxiety impacted students' performance. After a discussion between the Instructors and fellows, responsive communication methods were developed for students to receive sufficient advice and support. The PA held frequent virtual office hours via Zoom and successfully troubleshooted students' issues.

In addition, there were major changes in two other main projects of CommLab, Soundscapes and Interactive Documentary. Since students were unable to use the university check-out system for professional recording and filming equipment, such as Tascam audio recorder and Canon 6D, an alternative option using their phone for recording audio and video was suggested. To provide an engaging and rewarding learning experience with phone recording and shooting, guest speakers in the field were invited to offer workshops via Zoom video conference. User testing and presentation of those two projects were particularly challenging due to the technical limitation of Zoom. Adapted methods for online user testing and presentation were also developed.

The department has a tradition of offering a campus-wide end of the semester show highlighting students' works. Classrooms are transformed into a large exhibition space for a one-day exhibition. This exhibition is a perfect opportunity for students to engage in authentic experiences, proudly promoting and explaining their creations. However, due to COVID-19 pandemic, the F2F show could not be held at the end of the spring 2020 semester. In response to the issue, faculty across three campuses brainstormed to create an alternative virtual event. The event created was a two-day exhibition of recent creative interactive student projects. The projects were uploaded to the web and accessible to the campus community. There were also live events in which students presented their projects in real time via Zoom.

As the online class progressed, the teaching methods and activities stabilized and students displayed signs of adaptation and engagement based on their positive outcomes, feedback and instructor evaluations.

Synchronous Online Lecture with Zoom

The CommLab and NoC courses were conducted as a synchronous online course via Zoom.

- Shared lecture notes and video tutorials were provided on the course WP blog in advance.
- The PA started a class with a micro-lecture for 10-15 minutes with shared presentations and emphasized essential points of the class and exercises.
- He used the remainder of the time for synchronous activities with video tutorials.
- Micro-lecture was to maximize time for students to follow synchronous activities developed through video tutorials.
- Students had the option to finish the activities asynchronously by following the video tutorials at their convenient time.
- Online live-coding method was utilized for programming concepts and techniques, such as HTML, CSS, JavaScript in CommLab and most topics of NoC.
- NoC Lectures were recorded and provided to view asynchronous.
- The PA simultaneously monitored his lecture streamed via Zoom ScreenShare with a tablet to check issues of online streaming.
- Annotations used for complex concepts allowed students to engage more with the topics and apply in real time.
- The PA frequently encouraged students to respond with a short word or emoji in the class Slack channel during the online lecture to capture the mood of the class.
- Online discussions were organized with a live document and Zoom breakout Rooms.
- Online presentations were operated with adapted methods to Zoom.

Synchronous and Asynchronous Video Tutorials on Youtube Channel

The CommLab instructors created video tutorials that highlight the essential components of each class and provide knowledge and instructions for in-class activities. The video tutorials were uploaded to Youtube before the synchronous session started. There was a discussion about choosing a video streaming platform between Youtube and the university LMS for Streaming Service. It was decided to use a Youtube channel because of its stability. Each instructor produced seven to eight videos (15-25 minutes) based on their expertise.

The video tutorials were designed and quickly developed to provide students more relatable, immediate activities to the topics and learning outcomes rather than to convey technical information via a polished video or blog post. Students were able to access the tutorials from the course WP blog asynchronously and had the option to follow updates.

Online Live-coding with Atom Teletype

The PA offered the NoC classes using live-coding with Atom Teletype and Zoom ScreenShare. Atom Teletype allowed students to watch and edit the instructor’s writing during the class. With the key teaching method, live-coding, the PA taught programming by writing codes from scratch to a completed one integrated with lecture. The PA designed, implemented and thought aloud while writing codes and students were encouraged to follow the process of programming by coding along and observing the instructor’s thought processes. The PA intentionally made mistakes to help students understand the process of debugging. His live-coding allowed students to understand every step of programming, and how to combine diverse programming concepts as a whole. Furthermore, it enabled the students to feel less intimidated by a complex reference on the Internet, and develop a way of decomposing the concepts into accessible pieces.

Annotations and Drawings on Screen with Zoom Toolkit

The PA identified that hand-drawn annotations on the streaming screen was particularly useful to improve students' attention and engagement. In addition, he displayed keystrokes to demonstrate frequently-used

shortcuts utilizing applications. The methods received positive student feedback. Thus, the PA applied the method extensively to his lecture, live-coding, one-on-one meeting and video recordings.

Monitoring Zoom ScreenShare with a tablet

The other useful method identified is monitoring Zoom ScreenShare with a tablet. It allowed the PA to immediately notice mistakes or unstable issues during synchronous sessions. In addition, an electronic pencil on a tablet can be used with the annotation feature on the Zoom toolkit. Writing and drawing with an e-pencil was more convenient than annotating with a mouse or trackpad on the computer. A computer can be only used for streaming class materials while a tablet is dedicated to monitoring and annotation.

Developing a Method to Obtain Frequent Responses during Synchronous Online Session

One of the confusing and challenging aspects of synchronous online teaching was not being able to receive sufficient student feedback and perceive the class atmosphere. The PA constantly encouraged and requested students to share short responses in the Slack channel, including brief answers and various emojis. The method enabled the PA to detect real-time student perceptions.

Online Real-time Discussion (Synchronous Discussion)

Only a few students were actively engaged and led in-class discussion while many other students remained quiet. It has been challenging to receive frequent and adequate responses from all students in a class, especially for a discussion. Therefore, the PA created a discussion activity that enables everyone to participate. The approach included:

1. The PA shares a set of slides in advance that include discussion prompts and empty slides that students can edit during the discussion.
2. Students are distributed into Zoom breakout rooms, which consists of three or four students.
3. Each student initially discusses in their small group for five minutes. Each student is asked to write their key points on the empty slides shared during the conversation.
4. Afterwards, the PA brings all students back to the main meeting room. The whole class continues the discussion.
5. Every student is encouraged to share their ideas and reflections by utilizing a summary of their discussion from the breakout room discussion. The PA streams the slides with the key points the student wrote (link to example slides).

The PA has observed that this approach allows students to present their ideas confidently since they have already discussed in a small group with less pressure.

Online User Testing

In prior semesters, for the main CommLab project, a User Testing day has been arranged a few days before the presentation. It provided opportunities for students to experience and evaluate their project in realistic conditions, share comments, and apply feedback. In addition, it prevented students from finishing their project just before the deadline since the project should be executable during the user testing session.

The CommLab instructors brainstormed and tried to bring a similar user testing activity online by utilizing Zoom breakout rooms. The details include:

1. In a similar way of online discussion, the PA shares slides that include instructions of user testing and arrangement of groups (link to example slides).
2. The PA divides students into breakout rooms.
3. In each group, there are one presenter and multiple testers.
4. One of the testers, a primary tester, shares his/her screen and explores the presenter's project on their own, describing how he/she approached the project.
5. Other testers can provide additional feedback while the primary tester is interacting with the project.
6. The presenter observes the process and takes notes, avoiding unnecessary explanations.
7. Presenter, primary tester and tester roles are rearranged after eight minutes and the process is repeated.

Online Presentations

There were a number of technical limitations for online presentations via Zoom. For instance, Zoom does not deliver audio content with proper quality because it automatically downsamples the audio quality and converts stereo channels to a mono. Additionally, when a video or programming sketch is being streamed over Zoom, there is a significant framerate drop. Therefore, the PA and CommLab instructors developed new presentation methods to address these issues.

1. Students upload their project to the university's network-attached storage (NAS).

2. The instructor creates a set of slides that contains links to the students' projects (link to example slides).
3. The slides are shared with students and guest critics.
4. Students are suggested to modify the slides with additional information that might help viewers to understand their project.
5. A student presents their project.
    a. For 30 seconds, the presenter introduces themself and provides essential instructions to explore the project briefly;
    b. for three minutes, the instructor, peer students and guest critics explore the presenter's project on their own;
    c. for one minute, the presenter offers additional clarification and discussion, and;
    d. for the remainder of the time, the instructor, students and guests share feedback.

Overall, the methods were effective with the audio projects and programming sketches. For video projects, viewers experienced latency of video streaming since a number of people tried to access the same file and increased the traffic on the server.

Responsive Communication

Interaction between instructors and students is critical. To facilitate online communication with students, and student to student, various collaboration applications were employed. The collaboration tools included:

- Zoom for Virtual Office Hours;
- Discord for Virtual Studio, where students casually ask questions to anyone in the department;
- Slack for in-class communication and direct message; and
- Google Drive for sharing project materials and source codes.

Class Workspace and Channels via Slack was identified the most useful, considering the frequency and amount of conversation between the instructor and students. Students direct-messaged (DM) the PA at any time. The rate of receiving DMs was more frequent than emails and F2F office hours.

Virtual Studio via Discord created a studio-like environment since it provided a space where students, staff and instructors can have a quick voice-chat with one-click.

Immediate Responses: Additionally, the PA and CommLab instructors consistently shared their experience of online teaching and solicited student feedback. Based on the feedback, it was recognized that two or three students per section requested additional online support for their main projects. The following support methods were developed:

1. The PA was more responsive in Slack using the following approach:
    a. Try to respond immediately.
    b. If available, answer the question as soon as possible.
    c. If not available,
        i. Inform the student that he is not available and when he will be available.
        ii. Provide guidance to students on resources, such as available fellows or online references.
2. Fellows developed a plan to regularly announce their availability in Slack.

Designing Social Interaction Platform: The PA and CommLab Instructors also attempted to reduce students' burden and provide more opportunities for students to engage, interact, learn and inspire each other. Students were encouraged to post screenshots and short descriptions of their assignments in a Slack channel, rather than write a full reflection. They extended the idea and created a channel called "commlab-gallery" where students could share their projects and socially engage.

Virtual Office Hours (VOH)

As mentioned in Responsive Communication, the PA tried to create a welcoming environment that allows students to freely reach out to their instructor and ask questions via DM. The PA was consistently available on Zoom, Slack and Discord for VOH. It was an experiment as he understood it would not be sustainable.

The form of VOH varied:

- Mostly, Slack DM was frequently utilized. Students asked questions, sharing their issues with screenshots and/or sample codes. The PA answered via DM, sometimes providing example codes.
- Zoom Meeting was employed when in-depth discussion or ScreenShare was required.
- Live Share features of text editors were utilized for complex programming concepts and troubleshooting.

Troubleshooting students' codes via Zoom and Atom Teletype
The PA tried various methods of troubleshooting students' code issues, using Slack DM, Google Drive, Atom Teletype, VS Code LiveShare and Zoom ScreenShare. Through Zoom meeting or Slack DM, initial guidance was given to students with pseudo-codes that described specific steps to resolve issues. If a student still could not find a solution, the PA troubleshot the student's codes in a reverse form of F2F conventional methods by following steps:

- Ask a student to share their source code through Slack or Google Drive.
- Open the source code in **the instructor's** text editor and execute the code on **the instructor's** laptop.
- Share the instructor's screen with the student's code open in the instructor text editor.
- Show the instructor's troubleshooting process via ScreenShare and explain not only how to particularly fix the issue but also debugging techniques in general.
- Leave comments about what the instructor modified.
- Send back the fixed code to the student.

At times, the PA portion was modified intentionally and students were encouraged to re-develop the part on their own.

Frequently Asked Questions (FAQs)
The PA has answered a number of questions sent via Slack DM. Since all questions were answered with text, the PA was able to accumulate FAQs and develop answers, which were shared with all students. This approach was found to be an advantage of online teaching.

Virtual End of Semester Show
A two-day online exhibition of recent creative interactive student projects was held across three campuses. The 2020 Spring Showcase website was created for the audience to visit, navigate and view student projects and links. The student projects were uploaded to department servers or Amazon Simple Storage Service (S3) buckets and they were accessible to the campus community and the public.

Live Events in which students presented their projects in real time via Zoom were the main event for the two-day exhibition. Each course was given 20 minutes for their real time presentation. The schedule was well-guided in the website for the audience, highlighting the current presentations.

The PA used two different strategies for his courses. Since the CommLab was arranged as a first live event, there was no information for the PA and CommLab instructors to anticipate how many audiences would join the live session. Thus, they developed a number of backup plans, utilizing Zoom breakout rooms. The PA organized the Zoom session with four breakout rooms for each CommLab section and 24 extra breakout rooms for individual meetings between a student and audience. The Zoom session was protected by a password and audiences were only able to join the session via the link posted on the website. Twenty-two students and more than 40 audiences participated in the event simultaneously. The PA stayed in the main meeting room and was in charge of introducing the event and distributing the audience to the breakout rooms evenly. Students were well-prepared and the audience showed their engagement on presentations.

Overall, the PA received positive feedback from students, however there was an issue while operating the session with breakout rooms. People from the community who were not familiar with Zoom, such as parents and friends were confused and unintentionally dropped their connection. Also, the PA believed it was not ideal for visitors to have another step to join the actual presentations. Therefore, the PA redeveloped the presentation methods, minimizing the complexities.

For the NoC course live event, a Pecha-Kucha (PK) style presentation method was utilized. The PA created a Google slides template and asked students to insert their PK. Prompts to follow the PK were provided and students prepared slides with only one video and three to five images. During the presentation, the PA screen-shared the slides via Zoom. Students presented their project as the PA proceeded to the next slides. Also, audiences provided questions and feedback in the Zoom chat and often encouraged the presenter with emojis. The PK presentation structure allowed the event to proceed smoothly and finish on time.

RESULTS

Comparison between Online and Prior F2F

Data was collected during the spring semester, 2020 and compared to data from the prior tems, CommLab Fall 2019 and NoC Spring 2019. The goal was to examine potential differences in the teaching modes through teaching method modifications and minor changes of assignments.

Table 2: Communications Lab Learning Outcomes (remained the same for both terms).

Online (Spring 2020) and Prior F2F (Fall 2019) Class
Upon completion of this course, students will be able to: • demonstrate a broad knowledge and experience in Communications (in the context of the Internet), and digital media design; • recognize the context in which digital media operates, both historically, socially, and in current practices; • utilize comprehensively fundamentals of web development and apply HTML, CSS and JavaScript to digital projects; • practice and produce digital content, i.e. audio, photo, video, and develop filming, recording, and mastering skills; • combine web programming with media production techniques to produce creative works; • compose and construct narrative storytelling specifically made for web or mobile platforms; • develop meaningful and effective user interactions, and • produce internet artworks and/or practical web applications by utilizing a combination of concepts and techniques discussed and demonstrated throughout the duration of the course.

Table 3: Communications Lab Assessment on Assignments and Activities.

	Online (Spring 2020)	**Prior F2F (Fall 2019)**
Assignments and Activities	20% Web Collage 20% Interactive Story 20% Soundscapes 20% Interactive Documentary	10% Basic HTML & CSS Website [1] 15% Interactive Comic 15% Soundscapes 15% Interactive Film 15% Internet Art [2] 10% Project Documentations [3]
Weekly Assignments	10% Blog posts Reflection on exercises Responses to readings, viewings	10% Blog posts Reflection on exercises Responses to readings, viewings
Engagement	10% Attendance & Participation	10% Attendance & Participation

Note: Assignments and activities were offered almost the same for both semesters. Modifications in Assessment from F2F to Online **was not due to teaching online**, but a prior conversation took place to **combine assessments**.

[1] Basic HTML & CSS Website in Prior F2F was redesigned as Web Collage which contains in-class exercises.

[2] Internet Art, one of the main projects in prior F2F, was removed to reduce students' burden and allow them to have more time on other projects. It is not due to online teaching as it was already planned in the previous semester.

[3] Project Documentations were included to the assessment of the main projects.

Table 4: Nature of Code Learning Outcomes (remained the same for both terms).

Online (Spring 2020) and Prior F2F (Spring 2019)
Upon completion of this course, students will be able to: • practice and produce the fundamentals of programming; • demonstrate object-oriented programming and integrate why/how to use the concept into practical applications; • apply mathematics and physics in their software environment to create an artifact; • visualize and simulate systematic shapes or movement in natural phenomenon; and • create generative art by using a combination of concepts discussed over the course.

Table 5: Nature of Code Assessment on Assignments and Activities.

	Online (2020 Spring)	**Prior F2F (2019 Fall)**
Assignments and Activities	25% Midterm Project • Simulation of Force & Oscillation 30% Final Project • Creating Interactive Experience utilizing OOP, Force, Oscillation, Autonomous Agents and/or Fractal concepts.	15% Midterm Project • Simulation of Force & Oscillation 35% Final Project • Creating Interactive Experience utilizing OOP, Force, Oscillation, Autonomous Agents and/or Fractal concepts.
Weekly Assignments	25% Blog posts • Reflection on exercises • Responses to readings, viewings • Writing on case studies	25% Blog posts • Reflection on exercises • Responses to readings, viewings • Writing on case studies
Engagement	20% Attendance & Participation [1]	25% Attendance & Participation

Note: Likewise Communications Lab, projects, assignments and activities were offered almost the same as the prior semester.

[1] Modifications in assessment from F2F to Online was to reduce the rate of attendance.

Differences of Instructional Methods in Online and Prior F2F

The methods listed below are online alternative teaching approaches the PA used to achieve the same learning outcomes. The major differences of instructional methods are addressed.

Table 6: Comparison of Teaching Methods between Online and Prior F2F.

	Online (2020 Spring)	**Prior F2F (2019 Fall)**
Lectures	• Micro-lecture (10-15 minutes) with shared lecture notes • Zoom recordings provided after each class	• Lecture (30-45 minutes) with shared lecture notes
Tutorials for technical skills	• Pre-recorded video tutorials • Asynchronous options for students to follow the exercise during class time or at their convenient time	• Live-demo during class time • In-class exercises that were conducted after the demonstration
Live-coding for programming concept and techniques	• Online Live-coding with Zoom and Atom Teletype • Zoom recordings for asynchronous options	• Live-coding during class time
Discussion	• Online synchronous discussions with a shared interactive document via Zoom and breakout rooms	• In-class discussions with shared an interactive document
Individual support	• Scheduled (or by appointment) virtual office hours via Zoom • One-on-one assistance via Slack and Zoom at any time	• Scheduled (or by appointment) Office hours • Casual and Individual F2F meetings
Communication and Engagement between the department community	• Discord, Virtual Studio designed for social interaction and casual questions amongst community • Slack channels for students to share references and inspirations	• Department studio for students to stay and actively engage with peer students and faculty/staff members
Audio Project	• Audio Recording with Phone	• Audio Recording with a professional recorder and microphone (Tascam, Shotgun Mic)
Video Project	• Video Shooting with Phone	• Video Shooting with a professional camera and relevant equipment, such as Canon 6D, lightings, tripod •

Equipment for Interactive Installation	• No equipment provided from University's check-out system	• Equipment for advanced interactive methods (KinectV2 - Depth Camera, IMU Wearable Motion Capture Device, OptiTrack Motion Capture system, Brainwave headset reader) provided via University check-out system
The End of Semester Show	• Virtual show across three campuses	• F2F Show held in a physical space

The following are assessments based on students' projects and documentations during online and F2F semesters.

Table 7: Evaluation of Communications Lab Student Projects.

Course and Term	CommLab Spring 2020	CommLab Fall 2019
Total Number of Students	12	14
Exceeded expectations [1]	41.7% (5/12)	21.4% (3/14)
Met Expectations [2]	58.3% (7/12)	71.4% (10/14)
Below expectations [3]	0%	7.1% (1/14)

[1] Exceeds expectations: Students fulfilled course requirements and exceeded expectations with excellent performance. **They accomplished all learning outcomes**.
[2] Met expectations: Students fulfilled course requirements and met expectations with good-performance. **They accomplished all learning outcomes**.
[3] Below expectations: Students did not fulfill course requirements and expectations with poor performance. They failed to accomplish some or all learning outcomes.

Table 8: Evaluation of Nature of Code (NoC) Student Projects.

Course and Term	NoC Spring 2020	NoC Spring 2019
Total Number of Students	12	17
Exceeded expectations [1]	75% (9/12)	35.3% (6/17)
Met Expectations [2]	8.4% (1/12)	64.7% (11/17)
Below expectations [3]	16.6% (2/12)	0%

[1] Exceeds expectations: Students fulfilled course requirements and exceeded expectations with excellent performance. **They accomplished all learning outcomes**.
[2] Met expectations: Students fulfilled course requirements and met expectations with good-performance. **They accomplished all learning outcomes**.
[3] Below expectations: Students did not fulfill course requirements and expectations with poor performance. They failed to accomplish some or all learning outcomes.

Student Projects Presented at the Virtual End of Semester Show

In spite of the challenging circumstances, an unexpectedly large number of student participation was noticed in the virtual end of semester show. Data on student projects and participation are provided:

Table 9: Communications Lab (CommLab): Virtual End of Semester Show.

Course and Term	CommLab Spring 2020	CommLab Fall 2019
Total Number of students	12	15
Number of students participated	7	12
Rate of participation	75%	80%
Number of projects presented	9 [1]	11
Student projects	2 x Interactive Story 3 x Soundscapes 4 x Interactive Documentary	3 x Interactive Story 1 x Soundscapes 3 x Interactive Video 4 x Internet Art

[1] Students were given options to submit multiple projects.

Table 10: Nature of Code (NoC): Virtual End of Semester Show.

Course and Term	NoC Spring 2020	NoC Spring 2019
Total Number of students	12	17 [2]
Number of students participated	8	8
Rate of participation	66%	47% [3]
Number of projects presented	10 [1]	10 [1]
Student projects	2 x Music video and Storytelling with Generative Visuals 2 x Interactive Performance 1 x Generative Visuals 2 x Interactive Video Installation based on motion tracking 1 x Real Time Audio Visualization 1 x Interactive Portrait 1 x Interactive 3D Space Visualization	1 x Storytelling with Generative Visuals 1 x Interactive Dance Performance 1 x Generative Arts with Chinese painting style 4 x Simulations of natural phenomenon with educational purposes 1 x Interactive Video Installation 1 x Real Time Audio Visualization 1 x Interactive visuals based on brain wave

[1] Students were given options to submit multiple projects.
[2] Maximum class size was 16; the PA had more students during the Spring 2019 term.
[3] There was a limitation of space so some of the students could not exhibit their project even though they were willing to participate.

DISCUSSION

Overall, we did not notice major differences in the data between the F2F and online course session. Students constructed similar accomplishments through the alternative methods which the PA adapted to create effective online teaching and learning experience.

RQ 1. What are the alternatives for effective online teaching and learning during sudden transition?

The PA conducted his synchronous online lecture with newly developed online teaching and learning methods, including online live-coding with Atom Teletype, online discussion, online user testing and online presentations via Zoom. The PA actively used annotations and drawings on screen with Zoom Toolkit to draw students' attention and describe complex concepts and techniques. He also developed a method to obtain frequent responses during his synchronous sessions. Additionally video tutorials on a Youtube channel were offered for in-class exercises and asynchronous options.

Live-coding and troubleshooting with a LiveShare feature of text editors and methods for responsive communication are particularly identified as effective and transferable methods to next term. The PA requested feedback on live-coding with Atom Teletype in his NoC course. Ten out of the twelve (83%) students were absolutely positive on the method. Regarding responsive communication, in the course evaluations, 88% of CommLab students and 57% of NoC students shared positive comments on the welcoming environment to ask questions and the PA's instant responses. The communication methods the PA attempted is assessed to be helpful for students to keep up with their study in distanced and isolated situations, increasing the presence of instructors.

Virtual End of Semester Show is also recognized as a transferable online teaching and learning activity. The PA noticed the potential of online exhibitions and live events. As the details are provided in [Table 9 and 10], the participation rate of students was unexpectedly high and similar to the rate of prior physical exhibitions. More audiences were able to participate in the online show because it required no physical traveling and it was easily accessible to those who were not able to be on campus. For example, the live event of Capstone projects had approximately 90 people online simultaneously. The number of audiences was more than the usual in-person capstone presentations. In prior F2F, there were approximately 30 students to present their project and five to ten instructors for evaluation and guest critics. There was a conversation about a blended mode presentation to combine online and F2F presentation and extend to a larger audience in the future. It is expected that an online exhibition will provide instructors with the ability to not only broaden audience participation but also improve student learning outcomes. More inclusive and accessible learning opportunities can be advantageous to design and implement effective online learning outcomes (Hargis, 2014). Learning experience through real-world applications, public demonstration of competence and receiving constructive feedback can be some of the key features to improve student learning outcomes (Hargis, Yuan & Wu, 2020).

RQ 2. What is the final outcome, result or product of the alternatives for effective online teaching and learning?

RQ 2a. Both students in an online setting and F2F achieved learning outcomes.

- Instruments: Syllabus where the LOs were provided for both F2F and Online were exactly the same. Similar projects and exercises were assigned, although the teaching and assessment methods differed between F2F and online.

The PA's initial goal to accomplish the same learning outcomes as F2F was successful. Students, in the both groups exceeded and met expectations, fulfilled course requirements and accomplished all learning outcomes. According to [Table 7 and 8], during the online semester, **100% of CommLab students** exceeded (41.7%) or met (58.3%) the expectations and **91% of NoC students** exceeded (75.0%) or met (8.4%) the expectations. The rates of students who achieved learning outcomes is close to the rates from F2F semesters. Ninety two percent of the students in CommLab fall 2019 and 100% in NoC spring 2019 exceeded or met the course expectations. Below expectations in online settings was caused by asynchronous options. It is noticed that the asynchronous methods need to be improved to motivate students more.

RQ 2b. Both students in an online setting and F2F show similar satisfaction on their projects, according to the rate of participation in the End of Semester show.

- Instruments: comparison of student participation data between online and normal the End of Semester show.

The Virtual End of Semester Show was experimentally organized in a short amount of time. There were a number of discussions about how to motivate students as we initially expected low participation. However, a higher number of students than anticipated volunteered to attend the show. The rates of participation between online and F2F appear similar based on [Table 9 and 10]. **Seventy five percent of the CommLab students** participated in the Virtual End of Semester Show while **80%** joined the show in the prior F2F semester. **Sixty six percent of the NoC students** participated in the online exhibition while **47%** joined the previous show. As mentioned above, the reason that the participation rate is relatively low by 47% was due to space limitation.

The students who participated in the show consistently displayed a high level of engagement throughout the semester and during the live event of the virtual exhibition. As Skinner and Pitzer (2012) explain that engagement is explicitly associated with student achievement, their accomplishment exceeded the course expectations and based on the course evaluation, the level of those students' satisfaction on the course appeared considerably high. Learner satisfaction is one of the key factors for the success of the courses. Moreover, participant satisfaction levels along with their performance are indicators of the formation of online learning environments (Altun, 2008). The result on the student engagement level, participation rate and degree of completion of their projects were similar between online and F2F. It was identified that the online courses and online exhibition were successful.

RQ 2c. The degree of diversity of student projects between online and F2F is similar.

- Instruments: Analysis between student projects between F2F and online by categorizing each group of student projects using areas such as story-telling with Generative Visuals, 3D visualization, simulation, Interactive Portrait, Interactive Dance Performance, Generative Arts, Interactive Video Installation, Interactive Visuals based on brainwave.

Although teaching methods and activities were limited and altered by the online setting, students still produced diverse projects with various ideas, according to the student projects appearing in [Table 9 and 10]. CommLab projects were well-distributed amongst the main projects. In the NoC course, despite isolation and limited resources, students freely explored their own interests and ideas and developed generative arts, storytelling with generative visuals, music videos with algorithmic animation, real time audio visualization, interactive dance performances and interactive portraiture.

RQ 3. How do we capitalize on the perception of limitations for online learning into creating opportunities for all students to engage in the process?

RQ3a. How creativity often stems from limitations and obstacles?

- Instruments: For F2F, students used advanced equipment, such as depth cameras for motion tracking from the stockroom. However, for online, they used common devices such as webcams mounted on their laptops or cellphones.

Online teaching provided students an opportunity to adjust their ideas accordingly, think about alternative and feasible solutions, and attempt new methods to develop their projects (at times) more creatively.

For the final NoC project, students were strongly encouraged to explore all possibilities and not be limited to the confinement of the screen, which could include other media and expanded visuals. In previous semesters, successful projects were created in various forms, such as dance with motion tracking and projection mapping. However students this term were not able to access the equipment, use a studio space and identify collaborators.

Initially, it appeared that the student might have been underserved in the online course. However, the limitations stimulated student perspective, which resulted in considering alternative experimental methods and technologies. Using basic equipment, they produced similar high-quality outcomes as they did in a F2F setting with less resources available.

For instance, one NoC student developed an interactive audiovisual performance called *Digital Shaman* inspired by Korean exorcism ritual and shaman vision. Although he was ambitious to create a real time performance and interactive visuals with large scale projection, he could not secure the proper resources in his home. So he decided to perform and record himself performing. The limited resources created an opportunity for the student to be engaged as a performer for the first time. Another NoC student had an idea to create an interactive portraiture, employing a depth camera and its facial expression recognition feature. Since she also could not use advanced devices, she used machine learning models that allowed her to track body and skeletal data with a common webcam.

CommLab students displayed similar creativity with limited resources. For the video project, students used their phone camera more experimentally, shooting with diverse angles that were not possible with a bulky professional camera. For the audio project, since they were not able to record high quality audio so they explored more on audio editing than recording to produce quality outcomes. There were more audio projects presented during the Virtual End of Semester Show than in prior terms.

Conclusion and Interpretations

There have been hindrances and limitations in online teaching and learning, but also a number of advantages and potentials are found. Hargis (2020) mentioned in his article, "We should take this opportunity to completely rethink education, especially to be more inclusive and accessible to all of our students." Although the PA and his collaborators have developed "alternatives" due to the pandemic circumstances and limitations, the PA believes that they were to expand our teaching and learning methods with newly adjusted online activities and techniques. Most are transferable and can be blended to the foundational F2F teaching and learning methods.

- Online discussion, user testing for validation of prototypes and presentation can be adapted and applied to an online as an asynchronous peer review session;
- Annotation on screen can be more effective to engage and maintain students' attention;
- Responsive communications can reduce the distance between the instructor and student, as well as between students by;
    - further stimulating informal conversations;
    - offering a humanistic environment; and
    - feeling a sense of presence and community with each other.
- Virtual Office Hours (VOH) increased the engagement and level of questions, which students came prepared with, in addition to more students taking advantage of VOH;
- The LiveShare feature is identified as an effective method for live-coding and trouble-shooting as well as collaborative programming between students; and
- Offering virtual exhibitions provided a platform for extended student participation and interaction.

Limitations of Study

Throughout this study, we identified several variables, which include a difference in semesters; modes of teaching; background and number of students; time zones; teaching tools and resources; and expectations, assessments, learning outcomes, and teaching methods. We attempted to minimize the variables, by collecting pre-assessment data, realizing the differences and adding additional support when possible.

Further Work

The PA is currently developing two new courses, Creative Coding Lab and Web Page to Web Space.

Creative Coding Lab (CCLab) is a new foundation course that focuses on the fundamentals of computation, software design, and web technologies, through a series of creative projects. The course is intended to equip students with the skills to develop artistic and business projects that include a significant computational component. Basic topics such as variables, functions, components, and functional and reactive programming will be brought together to create interactive applications, generative art, data visualization, and other domains. Within the framework of these creative projects, students will develop a greater understanding of how computer programs operate, be exposed to various concepts used to create experiences and interactions, and become more familiar with some of the technologies that constitute the internet. This course is intended for students with no prior programming background.

Web Page to Web Space is an elective course that explores virtual interactive experience in the context of Virtual Embodiment, Visual Space and Telepresence. Students will investigate new possible ways of using the Web to create new immersive environments in a web platform, by utilizing algorithmic 3D animation and server-side programming. This is an advanced course with technically challenging concepts with three.js and node.js and suitable for students with prior knowledge in visual programming.

The PA is planning how to research teaching and learning for these courses, attending to:

1. creating activities instead of lectures by offering in-class exercises after micro lectures;
2. identifying the differences, limitations and advantages between online, blended (mixed) and in-person (F2F) modes; and
    a. There are three sections of CCLab and each section will be offered online, blended and in-person mode respectively.
3. exploring new tools for new online teaching and learning activity, such as Google Jamboard, Glitch, Mural and Miro.

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