Integrating Microsoft Teams to Promote Active Learning in Online Lecture and Lab Courses

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***Abstract*—Online teaching has imposed great challenges for student engagement during the pandemic. Building a virtual classroom with active student participation is our approach to address some of the concerns and make online learning more effective. In this paper, Microsoft Teams is introduced as a virtual study room with many virtual tables (channels), where each table (channel) serves as an integrated platform for group meetings. Within MS Teams, Learner-learner interaction is boosted by virtual meetings, group poster boards, the "mention" function, and emojis. By integrating MS Teams with Zoom meetings, we can offer a zero blackout, fully interactive learning environment. The paper includes a detailed description of the required technologies for such a delivery, time requirements for the design and delivery of such an approach, and faculty assessment and perspective of the methodology. Finally, a summary of the advantages, disadvantages, and student feedback is included in the paper.**

Keywords—Microsoft Teams, Zoom, Active Learning, Online Classroom, Student Engagement

I. INTRODUCTION

In the fall of 2008, the University of Wisconsin-Platteville (UW-Platt) began offering its undergraduate electrical engineering program to students throughout the state. The distance program has allowed place-bound students to complete their entire four-year program on a part-time basis. As part of our collaborative agreement, students have been able to complete an associate's degree at their local school and to take their engineering coursework via streaming video. These distance students are enrolled in the same course as their on-campus counterparts with the same requirements. All course content has been made available via the course webpage. Lectures, which have been offered in-person to local students on the main campus, are available in real-time and have been recorded and posted on the class webpage for access by all students at their convenience. All assignments and laboratory reports have been submitted and returned via an electronic dropbox. All exams have been proctored (either on the main campus or at a regional site) [1-5].

One of the strengths of our electrical engineering major has been our integrated laboratory and design throughout the program. In order to give our distance students the same experience as on the main campus, we used to utilize traveling lab managers to facilitate the offering of the same labs at regional sites throughout the state on a biweekly schedule. The lab managers were trained to access the proper usage of lab equipment and to evaluate the construction and performance of simple circuits. For mid-to upper-level coursework, the student and faculty member have met online using webcams and web-conferencing software to complete laboratory check-offs.[3]. As technology improved, we have incorporated improvements into our distance offerings. For example, the addition of analog discovery into the program several years ago greatly reduced the need for lab manager travel throughout the state.

Due to our many years of prior experience with distance education prior to the pandemic, the shut-down and switching to online learning did not impact us as much as many other universities. We already had the infrastructure in place for both offering content online, providing remote office hours, and basic lab content remotely.

Our instructors are tech-savvy in video recording and processing. We are familiar with the online learning software and equipment for lecture recording, including but not limited to CANVAS, Kaltura, Adobe Premier Suite, MS Video Editor, MS Teams (OneDrive), Google Drive, etc. Due to our department's extensive background with distance students, our faculty members have provided in-house training to other departments at UW-Platt.

Our lectures are composed of online-learning-friendly content. Our lectures are prepared to be taken both synchronously and asynchronously. Besides the lectures, we also record the in-class discussion sessions. The distance students consider this posted content very helpful. We also require students to have a certain number of off-class discussions through online methods, e.g., phone call meetings, emails, Facetime, MS Teams, discord, etc.

We provide flexible office hours and other helpful material. We have been offering flexible office hours, including evening hours to help the distance students who may have to work during the daytime.

We also record and post short videos in addition to the recorded lectures for challenging knowledge points, examples, and homework questions. Some software and hardware introductions are also recorded.

During the pandemic, our biggest problems were that of scaling our procedures from having roughly 10-15% of our students remote to 100% remote, obtaining the required resources, and figuring out alternative ways to offer the portions of our courses that had previously only been offered in-person via groups. In this paper, we will look at two lab-concentrated courses that incorporated group work as a major part of the class

prior to the pandemic and how we utilized Microsoft Teams to create a similar working environment online. The paper explores the advantages of using Microsoft Teams to support active learning for distance engineering education, based on past feedback from the needs of professors and students.

II. Problem Description and Initial Practice

A. INITIAL PRACTICE

In 2019, we have switched our learning management system (LMS) to CANVAS [6]. It has many features and functionalities, including a class syllabus/calendar, class documents, assignments, quizzes, and many others. Especially after the integration with external apps, like Zoom, CANVAS seems to be able to satisfy all face-to-face teaching expectations. However, during the pandemic, we found its functionality to be somewhat limited in several areas.

Firstly, CANVAS is primarily designed as a teacher-to-student one-direction LMS and lacks student-to-student interactive tools and functions. Students can interact with each other on the group homepage, but it is deeply hidden in the menus and tabs within CANVAS. (People->group ->group homepage.)

Initially, students were picking the communication tools they preferred, including phone calls, short messages, discord. However, those selections required learning different tools and changing communication preferences. Many students complained about the lack of communication from their team members, especially during lab projects and final projects. Therefore, we needed to find an online tool to allow students to communicate smoothly and efficiently.

Secondly, we needed an online tool to help students collaborate. During the first semester of fully online teaching, Zoom breakrooms were used for small group activities and labs. We encountered many issues that will be described from students' and instructors' perspectives.

1) From the student's perspective we identified four needs:

Although Ad hoc groups can introduce students to fellow classmates, sstudents' activities need the structure of dedicated groups. Our scaffolding design process and the group assignments require continuous efforts in dedicated groups. Using Zoom, the breakroom members can be assigned either automatically and randomly to each breakroom, or manually by the instructor. However, to assign each student manually to their dedicated groups, for a class size of 40 students, would take an additional three to five minutes. This added time, altered the original plan of having 2 to 3 discussion activities in the lectures to engage students in one. Therefore, an online platform allowing students to enter their preassigned breakrooms would be beneficial logistically.

Moreover, students needed a better collaboration platform. In Zoom breakrooms, students can only collaborate with screen sharing or by writing on a shared whiteboard. Neither method is efficient for circuit or logic design. A more agile and versatile simultaneously collaborating platform is necessary to facilitate the students' collaboration. The students need an online equivalent of sitting together in an open lab so that they can work together to develop a breadboard design, to debug a program, to draft a lab report, and to practice presentations.

Students needed the ability to auto-save their collaborative work. Zoom's breakroom doesn't keep the chat history unless saved manually. Also, it is a hassle to find the whiteboard record and share it among all group members. Students have complained about the loss of discussion records, which can be very frustrating. Therefore, we were searching for an online meeting platform that can automatically save and share the discussion records and the whiteboard.

Finally, students need a common place to share materials. Since we do not have an official method of sharing files, students have been using CANVAS, Email, Google Drive, MS One-Drive, Dropbox, etc. Collecting all different versions of the work file and synchronize them is labor-intensive. By limiting the number of technologies, it will reduce confusion and improve efficiency to have one common file sharing platform with version control.

2) From the instructor's perspective, two additional features are required.

Firstly, the most important feature that would help an instructor to organize online discussions and lab is transparency. As we can supervise all groups' activities around each table in the lab, we would like to monitor the progress of the group activities of the whole class without joining each breakroom. Without that feature, we had to spend several minutes entering each breakroom, either experiencing embarrassing silence or interrupting students' discussions, inquiring about their progress, and leaving the room just to find that group did not need any help while keeping the other groups unattended. The transparency of the group progress will boost the instructor's efficiency in facilitating the discussions and the labs.

Secondly, we would prefer to be accessible to the students during the complete class time as we can see the raised hands from any corner in the real lab. Students in the Zoom breakroom don't have an instant method to request help, like raising hands and asking for help in the real classroom/lab. If a group of students needs help from the instructor, who is not in their breakroom, they have to leave their breakroom, and patiently wait in the main room until the instructor returns.

3) From both the instructor's and the student's perspectives, two features will enhance the online learning experience.

First, it's important to explore a low-bandwidth synchronous collaboration platform to improve accessibility, especially for the students with low network bandwidth to participate in real-time collaboration activities.

Second, a backup lecturing technology will reduce the anxiety of tech failure. During the pandemic, Zoom has been the only synchronous lecturing tool. Technologies are great when they work, and Zoom has been working well, but with occasional hiccups. Especially with the massive adoption during the pandemic, several times we were kicked out of a Zoom meeting due to slow connections even when we were using 100Mbps cable internet connections. Therefore, alternative synchronous lecturing tools are being researched.

B. *Intro to MS Teams Features and Comparison to Zoom and Google Classroom*

During Summer 2020, we researched and experimented with many different platforms other than Zoom. Two platforms rose to the top of the final list: Google Classroom and MS Teams. Both offer a complete platform with file sharing, instant meetings, offline messaging, grouping, etc.

Both of the solutions are offered by a top tech company and have similar functions. By selecting either of them, you can't make a mistake. We selected MS Teams for the following reasons.

MS Teams offers a complete collaborative teaching & learning toolset, including instant meetings, online and offline messaging, file sharing, etc. In addition, MS Teams is integrated with the MS Office suite, e.g., Word, Excel, PowerPoint, and OneNote. Students can collaborate on editing a document in the build-in office applications synchronously. Everyone can view which parts the others are working on and see their changes in real-time. The instructor can also visit the collaboration files to check the current work progress and the file history to identify the individual contributions.

Additionally, MS Teams has many intuitive functions and interface designs as the popular MS Office suite. And since it is a subscription service of our university it has better IT support than Google Classroom.

Furthermore, MS Teams is backed up with Microsoft for online safety and security. Unlike Zoom, which is open to everyone, the MS Teams members are limited to those within the organization (my university). Authentication and authorization are automatically set up for all instructors and students, therefore, ensuring all resources are accessed by the right people.

MS Teams can also help students build an entrepreneurial mindset and skillset. MS Teams is widely adopted by more than 650,000 organizations: 93 Fortune 100 companies use Teams; 53 languages are supported in Teams (by 2020). Collaborating through MS Teams becomes a transferrable life skill to adapt to the future career of international collaboration. Learning how to use MS Teams helps to prepare the students for the global job market.

Finally, MS Teams offers accessibility and availability. MS Teams' accessibility functions make learning inclusive. Students can change text sizes, spacing, fonts, and colors according to their learning preferences. The fonts featured on Teams have been designed by Microsoft to be helpful for readers with dyslexia. MS Teams has the in-line translation, and live captions in meetings, especially helpful for students with hearing impairment. MS Teams app is also available on various devices, like desktops, laptops, smartphones, tablets, and across different operating systems, e.g., Windows system, Android system, MAC systems. The cloud-based MS Teams can also be visited with various browsers like Chrome, Firefox, and Edge.

We first implemented the MS Teams group activities in Engineering Projects and tools, and the Logic and Digital Design in fall 2020. We expanded the method to the spring 2021 offerings of the Intro to Microprocessor and Independent Study Courses. In the following section, we will use examples, mostly from the Logic and Digital Design course to explain the detailed implementation of MS Teams as a virtual classroom to host personalized learning, collaborative working, and streamlined communication, especially for small group activities and labs.

III. ZOOM AND MS TEAMS FEATURE AND IMPLEMENTATION IN CLASSROOM

By integrating MS Teams with Zoom meetings, we can offer a zero blackout, fully interactive learning environment. MS Teams also provides statistics of the activities in each channel to help instructors track class activities and provide more targeted support to students. In a class of 60 students, MS Teams recorded about 400 posts, more than 1500 interaction messages during the last 60 days of the class, not counting the instant meetings. The multiple communication methods in MS Teams offer equal opportunities for students with different learning preferences and accommodations and allows us to create a learning experience similar to that found in an in-person classroom or lab. Finally, by using MS Teams in our courses, we provide students a working knowledge of one of the most popular communication tools in the workplace.

A. *Set up MS Teams and channels.*

The following are the detailed steps in for the Logic and Digital Design class.

Step 1. Prepare software.

MS Teams can be run either with a desktop app or by using the browser to visit the link https://www.microsoft.com/en-us/microsoft-teams/log-in. The desktop app is more stable and has a more functions, while the web browser client takes fewer system resources and refreshes faster. You need your organization's username and password to log in.

Step 2. Create a team.

Creating and joining a team use the same button on the upper right corner of the home screen.

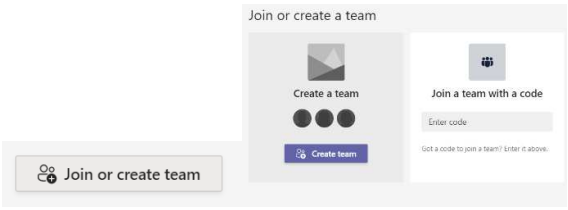

Fig. 1. Creating a Team

Create your team for a class to utilize the class template and role authorization. After clicking the Create team button, select team type to be ***Class***. Then set the class name and let everything else as default.

Step 3. Send Team code or Team link to recruit students. Each student needs either a team link or team code to join your team (class).

To generate a link, click the three dots "**…**" following your team's name on your team homepage and select the ***Get link to team*** option. Then send the link to your students. You must admit the students enrolled with the link.

Alternatively, you can generate a team code to recruit students without admitting each individual, if you have a large class size.

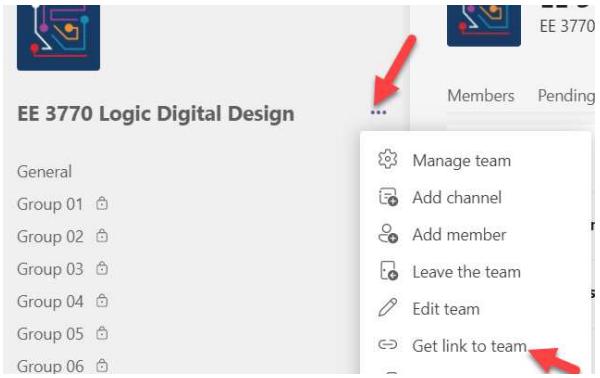

Fig. 2. Managing a team

The team code can be generated by clicking the manage team option after clicking the three dots. Then in the right-side panel, click ***Settings->Team code***.

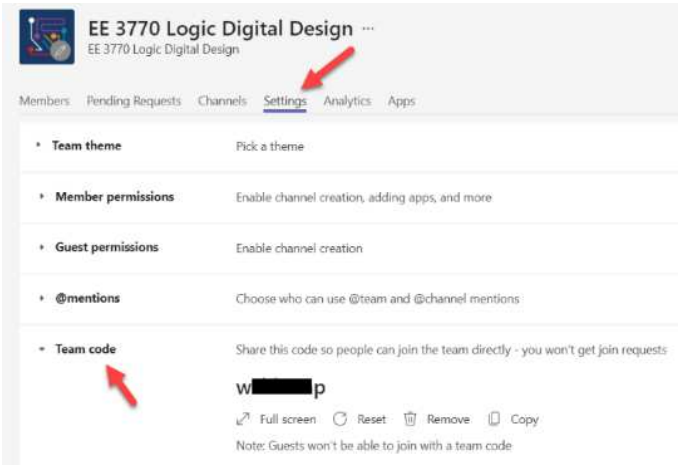

Fig 3. Team Code

The students can use the code you provided to join the team. You can view your team members on the Manage team page by clicking the Members tab. You can promote your teaching assistants to the owner group to help you organize the class.

Step 4. Create channels.

There are two types of channels. The standard channel works like a public room, which can be accessed by all team members. It is suitable for open discussion topics like muddiest points discussion, innovation project idea discussion, etc. The other type of channel is private, which is similar to private rooms that can only be visited by its members and the owners. It's used for group assignments discussion and completion. For each group, a private channel needs to be created. And the students to each private group need to be assigned manually by the team owners.

To create a channel, on the Team management page, click the Channel tab and click add channel button in the upper right corner.

To admit a student to a private channel, click the three dots following the channel and select Add members. You can only add members that belong to the Team. It is critical to require students to enroll in the team before you can assign them to any channel.

The MS Teams setup is complete. Now all the students are enrolled in the MS Teams with the proper roles, and all student groups have their own private channel space.

Fig. 4. Creating a channel

B. Classroom Practice in Logic and Digital Design

MS Teams can be employed for online/offline student group activities. In the following sessions, we will introduce our practice in using MS Teams for group activities in a Logic and Digital Design class.

The Logic and Digital Design class is an introduction to digital logic; Boolean algebra; Medium-Scale Integration (MSI) and Large-Scale Integration (LSI), combinational and sequential network design, prototyping, and testing; state machine design and implementation. It includes 5 virtual labs, 4 physical labs, and one final project. This course has a heavy focus on design and lab work, which requires students' teamwork. The student learning outcomes (SLO) of this class are listed in Section IV, Table 4.

1) File Tab functions.

MS Teams is a cloud-based hub, which integrated Word, Excel, PowerPoint, and OneNote. The instructor prepares the handouts in the aforementioned MS Office formats and uploads them to the ***general channel ->file->Class Material folder***. All team members have access to the contents in the folder but only owners can modify them.

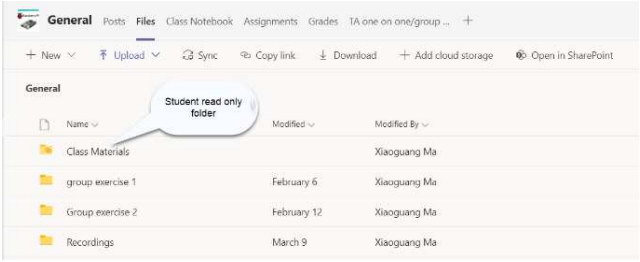

Fig. 5. Accessing a folder

Students need to upload their collaboration files to their ***private channel->Files folder***.

Students can collaborate on any of the aforementioned file types synchronously.

Students' initials will be shown to the file locations they are editing. The following figure shows the students and the instructor working on a shared PowerPoint file. Their initial dots indicated which part of the file they were working on.

The instructor can also visit the file to check the work progress and the file history to identify the individual contribution. An example is shown below. (The students' names are covered to protect privacy).

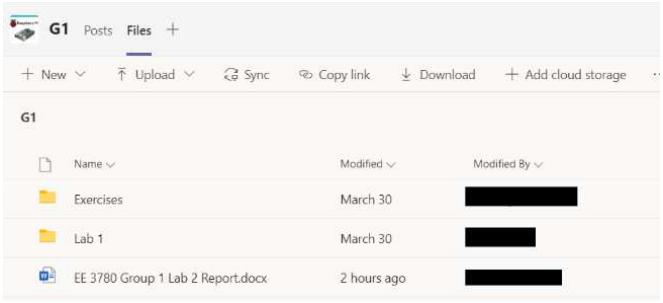

Fig. 6. Work progress

The file history can be view as below:

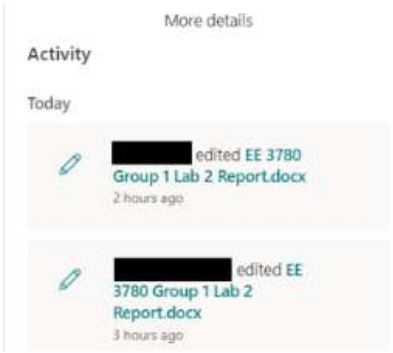

Fig. 7. File history

2) Posts tab functions:

The Posts tab works as the channel activity display board. Many key features of the Posts tab make it a powerful virtual group activity platform for many activities including:

a. Channel conversation.

b. Reply, @ mention, and emoji

c. Video conferencing

d. Post pictures, links with the review.

e. Post MS office files

Those features are being actively used by students for communication. Following is an example captured from one of the private group channels:

For each channel, the members can use video conferencing to hold group meetings. The meetings can be initialized with the meeting button in the upper right corner. Within the video conferencing, students can share webcam videos, their screens, an online whiteboard, etc. I would like to mention some great features of video conferencing in Teams.

Information transparency is the most important feature. The participants' initials icons are shown outside the meeting. Therefore, the instructor does not need to join the meeting to know who is in the meeting. This feature can be used for documenting class attendance. The instructor can send messages to the meeting through channel conversation and view their actual progress without joining the meeting. Secondly, group members can be preassigned. Once the students are assigned to the private channels at the beginning of the class, they will stay there unless the owners move them.

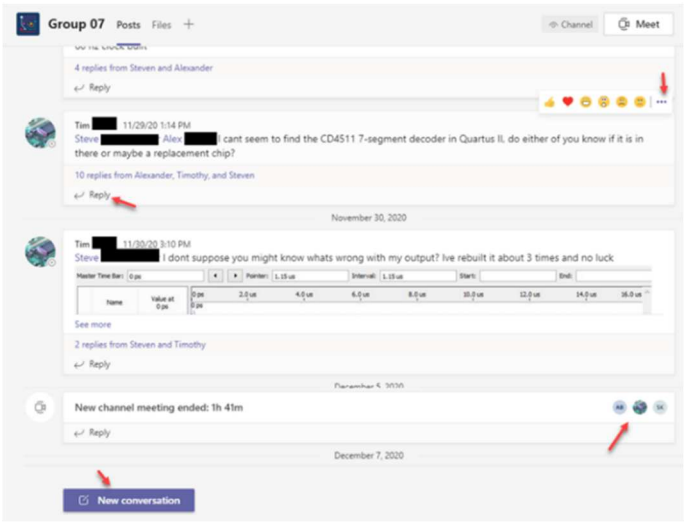

Fig. 8. Sending messages

Thirdly, MS Teams provides recording and statistics. The students have full control to record a meeting. All the conversations can be live captioned and the typed messages in the meeting will be posted in the channel post. The sharing whiteboard will also be saved automatically. After the meeting, the meeting length and participating members will be shown in the meeting summary.

Last semester, in the Logic and Digital Design Team, the class of 60 students made more than 1500 channel posts and replies during the second half of the semester, which indicates strong communication among students on this platform.

3) Instant private messaging Function

The instant messaging system allows students to send private messages to the instructor. It helps the instructor and students reduce the feeling of isolation. Especially during the group activities in class and office hours, each student can obtain the instructor's attention immediately.

4) Team Statistics Function

The **manage team ->Analytics** tab offers analytics of the whole team or each channel. The size of files, meetings, apps, posts, replies, mentions, reactions, active users, and top inactive channels. This will greatly help the instructor understand the usage report of each group and the whole class. The statistics of the whole class and one group are shown in the two figures.

The top inactive channels' statistics need to be carefully checked for the reason of lacking communication. It is common that if some students prefer to communicate through channel meetings than posting topics and replies. This may cause their channel to be identified as the top inactive channel. In this case, if the working progress is satisfactory, no action is necessary.

For example, Group 01 only has 20 posts and 10 replies, while Group 08 has 45 posts and 216 replies. After carefully checking their discussion details. It is found that Group 01 prefers to use instant meetings for discussion, while Group 08 enjoys offline messaging. Both groups have completed their assignments on time.

This case demonstrates the MS Teams can adapt to different students' communication needs.

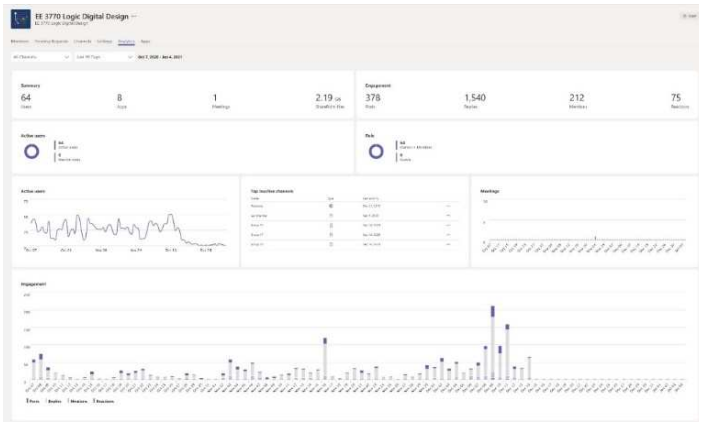

Fig. 9. User statistics

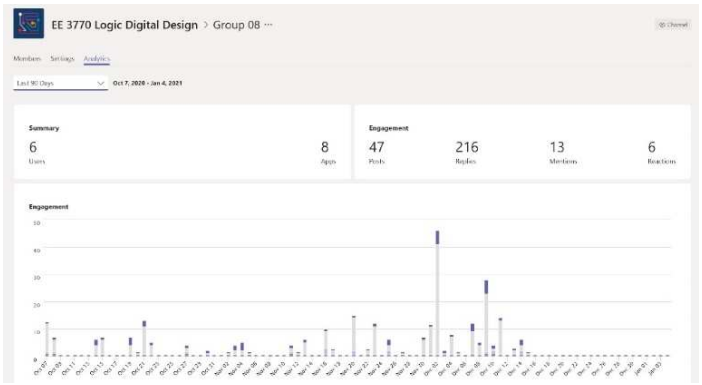

Fig. 10. Group statistics

C. *Classroom Practice in EE Projects and Tools*

Electrical engineering project and tools (EE 1020 EE project and tools) is a hands-on laboratory course for freshman students on the main campus. This course is an introduction to the tools that are used in the field of electrical engineering. Students are introduced to the use of the tools through the development of several projects. The laboratory experience will include measurements and/or fabrication. The pre-pandemic objectives and expected learning outcomes of this course are summarized in Tables 1 and 2 below.

TABLE 1. Objectives of EE1020 prior to the pandemic

Objectives of EE1020
1. To introduce students to electrical engineering
2. To help students to better understand the electrical engineering program at our university
3. To help students learn to use the basic electrical engineering tools such as power supplies, breadboards, function generators, oscilloscopes, soldering station, etc.
4. To help students to understand the main steps involved in completing projects and to complete several projects in different areas of electrical engineering

TABLE 2. EE1020 Expected Learning Outcomes

Expected Learning Outcomes of EE1020
1. The ability to use the digital multimeter (DMM) to measure the resistance of resistors, the voltages of DC/AC voltage sources or the voltages across circuit elements.
2. The ability to use the function generator to produce sinusoidal, square, and triangle waveforms with different frequencies and magnitudes, with or without DC offset.
3. The ability to use the oscilloscope to display and measure electrical voltage signals.
4. The ability to use the DC power supply to produce a constant DC voltage.
5. The ability to prototype and test electric circuits on a breadboard.
6. The ability to solder the electrical devices onto a circuit board.
7. The understanding that frequency and time are different and both time- and frequency-domain representations have a place in our comprehension of signals.
8. Appreciation of the capabilities of the Matlab programming environment and a modern digital signal processor.
9. Familiarity with a project report format that meets EE standards.
10. Familiarity with the EE department emphases, available laboratory resources, and EE student organizations.

During the latter half of the summer of 2020 COVID-19 restrictions were announced for all classes for the Fall 2020 semester which included 25% occupancy of all lecture spaces and 50% occupancy with cleaning procedures for all lab spaces. Since EE1020 typically has 32 students with 2 students per lab bench for the weekly 2-hour lab session, it was clear that most of the content needed to be converted to online.

The first step in the development of this course was to rewrite all the existing labs so that they could be completed online. Background information, which included lab instructions, short videos, online links, and some pre-collected lab data were loaded to the CANVAS course website in advance. Since the department only had a limited supply of analog discovery units and they were reserved for sophomore and junior-level courses, we had to come up with another way to introduce our students to basic lab equipment, simple circuits, and troubleshooting.

We decided to use TinkerCad from Autodesk [7] for creating simple designs from scratch and quickly modifying existing designs. It's a free online design program that you can use in your web browser without downloading any software. In addition, Tinkercad is compatible with most computers and browsers [8].

In order to improve the students' understanding of basic test equipment, we used virtual function generators and oscilloscopes (See Fig. 11). One of the circuits that we introduced students to was a resistor LED circuit (See Figure 12). This allowed students to collect data current-voltage data for an LED.

We also introduce students to a 555 timer in EE1020. This was able to be implemented using Tinkercad (Fig. 13). Such labs gave students an introduction to applications of electrical engineering in their freshman year.

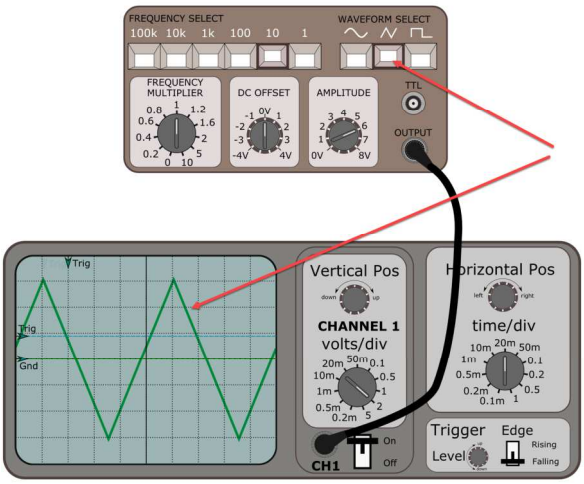

Fig. 11 virtual oscilloscope

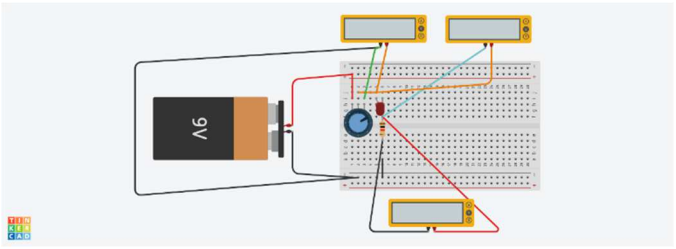

Fig. 12 DC LED Circuit for creating the I-V Characteristics Curve of an LED

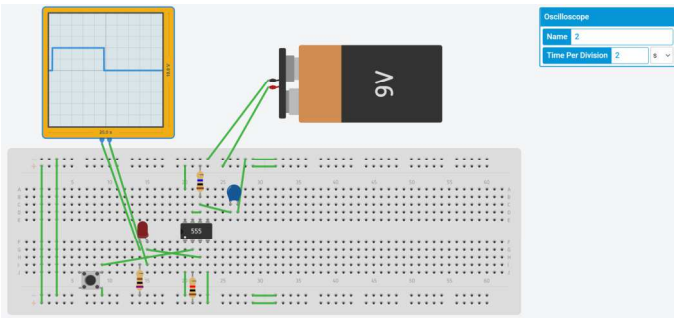

Fig. 13 Implementation of a 555-timer circuit with Tinkercad

Through our prior experience of offering our core EE courses to distance students, we had EE software already available for remote access via VMware [9]. Therefore, we could introduce students to basic DC circuit simulations using PSPICE [10]. We also could have students plot their laboratory results using Matlab and use Matlab to record and analyze audio waveforms. Thus, we were able to convert the main content of this course, except for soldering (due to safety reasons), to our online students.

The other aspect of EE1020 that also had to be converted to the online environment was working together in groups collaboratively. This was accomplished through the combination of Zoom and Microsoft Teams. Each week, we would start the two-hour lab with a project introduction just like we would do in an in-person offering of the class, except we used Zoom. This introduction was recorded and posted in CANVAS in case students wanted to go back to it later. Afterward, the students broke off into their preassigned groups. Instead of sitting together at the same lab bench to complete their work in pairs of 2-3, they collaborated in a shared environment in Microsoft Teams. The best aspect of using Microsoft Teams was that the instructor could virtually drop by each group's "virtual lab bench" and see how they were doing and if they needed assistance. In addition, the student could request that the instructor come to their virtual lab environment as needed at any point during the lab (just like students in an in-person lab raise their hand for help at their lab bench).
Overall, we felt that the interactive group environment with Microsoft Teams helped us create an engaging and fun learning environment in this Freshman course and allowed us to provide an equivalent "hands-on" learning experience for our online students.

D. MS Teams Advanced Applications

MS Teams can be utilized with Zoom for synergy. During the group discussion and lab time. we use Zoom to hold a meeting for the whole class while each group of students will have their channel meeting. It simulates the scenario before the pandemic in the classroom: each group of students will have a table to sit together and work on the project collaboratively; the instructor has a front whiteboard to demonstrate the common issues, and also can walk to the table of each group to participate in the discussion providing directions and guidance.

This setup requires the instructor to equip two webcams. MS Teams and Zoom can share the microphone and the headphones/speakers but not the webcam. The internal webcam from the tablet computer is assigned to MS Teams, while a USB webcam was used for Zoom.

When the class starts, the students need to log in to both Zoom and MS Teams. The class began with a lecture in Zoom talking about the instructions and common issues. After that, students start their channel meeting, and the Zoom meeting is muted. With the transparency of MS Teams, the instructor watches the students' progress through their channel message and their shared collaboration file.

The instructor can join a channel meeting to participate in students' discussions and help the groups with difficulties. If a common issue is found in a group's activity, the instructor can unmute himself/herself, share the group's activity through Zoom, and call all students to pay attention to the Zoom meeting.

If students have questions, they can send a private message to the Instructor in MS Teams or through the Zoom chat window. During the whole class, students have connections to the instructor. This dramatically reduces isolation anxiety during online learning.

As we can require students to make demos in the class, the instructor can share the MS Teams' channel meeting through Zoom. Then the group of students can demonstrate to the whole class without leaving their channel meeting. This greatly reduces the meeting preparation and moderator's work.

E. Other Tips for Using the MS Teams

Firstly, even though MS Teams is intuitive to use, don't assume students know how to use all the functions in MS Teams. Several short videos showing students how to use those functions could be of great help to get them started.

Use one lecture for team building. You can use some creative games to encourage communication within groups and between groups. Things will run much smoother after the students get to know each other.

Secondly, MS Teams can also be used as an alternative lecture method if Zoom is broken. MS Teams is integrated with CANVAS to offer students easy-to-follow links for the lecture. The MS Teams meeting can be scheduled through CANVAS->external apps.

Overall, the Zoom and MS Teams combination embodies how the new generation uses technology and the global trend in the industry. The above practices are recommended for adoption into our daily teaching practices after the pandemic.

IV. Student Results

A. Student Feedback

We have a poll of students' preference between MS Teams and the Zoom breakroom in the EE 3780 Intro to Microprocessor class: "Please let me know how you like the pair/team coding in Microsoft Teams comparing with the Zoom breakroom.
I will select either Zoom breakroom or continue using MS Teams as the coding practice software. Or if you have other suggestions, please let me know." The result is as follows:

Prefer MS Teams	Neutral	Prefer Zoom Breakroom
77%	9%	14%

Students enjoyed the collaboration and labs with the MS Teams platform. This tool allows you to conduct collaboration seamlessly without focusing on the technology. Some selected students' feedbacks are listed below:

TABLE 3. Sample student feedback.

"In-class participation helped students stay engaged and do well. The online book was very helpful and did a very good job of teaching us the content."
The professor gave good examples in class and encouraged student participation using the built-in annotation tools on zoom which I found incredibly engaging and helpful. Additionally, we often had group work in class that helped reinforce my understanding of the material.
The instructor did an excellent job connecting students through group exercises/labs.
I think it was well adapted to suit the online format. The virtual labs were most helpful in seeing how the logic circuits work. I enjoyed using both Logic.ly and Tinkercad for simulations and would recommend them to others. I thought the professor taught the material very well using labs which help people like me who are hands-on learners. I also thought the stuff presented in class correlated with what was in the exams very well.
Very open to questions and concerns. There are no bad questions in this class. When explaining concepts, the professor rhetorically asks questions that help explain why this concept exists. It helps deepen the understanding of the applications.
The professor did a good job engaging the class even with the zoom meetings. Professor has a clear grasp of the material.
He did well at demonstrating course topics using Tinkercad, Logic.ly, and annotations.
He did well in eliciting feedback from the class about their understanding of his lessons. He adapted very well to the online course environment, planning new assignments and lessons accordingly (ex. new virtual labs and Zybook as a study tool).

B. Student Learning Outcomes Feedback

The student learning outcomes feedback for the Logic and Digital Design is provided in table 4. Without any exception, all of our courses, which did not include an intervention to make the course more interactive, such as using MS Teams, have shown a decline in SLO ratings. The only exceptions have been the courses that faculty have added technology to make an active learning environment.

TABLE 4. Student Learning Outcome (SLO)

SLO Items	**Semesters**	
	2019 Fall Before COVID	***2020 Fall During COVID***
Understanding of binary and hexadecimal number systems and two's complement arithmetic.	4.58	4.81
Understanding of Boolean Algebra and proficiency in the use of theorems and laws to manipulate Boolean expressions.	4.38	4.69
Understanding of digital systems, logic gates, truth tables, and combinational circuit design.	4.54	4.88
Ability to design, simplify, build, and test combinational circuits.	4.46	4.57
Ability to design and build circuits using medium-scale integration components such as Multiplexer, Decoder, and Adder.	4.29	4.69
Understanding of flip-flops. Ability to derive state table and state diagram.	3.92	4
Ability to implement a state machine using CAD tools for schematic capture and simulation.	3.83	4.06
Ability to design a simple state machine.	3.71	4.19
Ability to write proposals, progress reports, and test reports.	3.83	4.33
Average	4.17	4.47

V. Summary

The COVID-19 pandemic has forced educational institutions and many industries to move to an online communication model. The disturbance seems to be more manageable for the lecture-based courses than the laboratory classes. This paper presents our teaching approach for electrical engineering courses with lab components. We have provided a process that can be used to teach some of the required labs in an online format. We have also demonstrated the advantages of using MS Teams and the Zoom software for synchronous online delivery. We believe technologies should serve as supplemental methods to keep students engaged, improve accessibility, and help to customize delivery methods. Finally, our efforts show the benefits of a "dynamic" delivery system that involves student participation, which is the base for active learning.

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