



Shall We Keep Using Zoom etc. after the Pandemic?

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Online learning has been studied long before the pandemic. Some educators were concerned about online learning. The COVID-19 pandemic changed everything. During the earlier part of the pandemic (Spring 2020), many universities were locked down. Every course had to be switched to online delivery mode. This imposed quite a challenge for some courses. For example, how would you conduct labs which needed to use lab equipment? How would the students work together on their capstone projects? The successes and lessons learned during the pandemic are an important part of the effort to take advantage of online learning.

Many of the practices forced upon us during the pandemic are useful even after the pandemic. Online presentation, use of GitHub for software development, use of Google documents/directory, Google form for team evaluation and peer evaluation are a few things that can be adopted after pandemic to improve student learning. In this paper, successes and lessons learned will be shared regarding the use of Zoom in lectures, laboratories, and help sessions, homework and quizzes in Canvas, virtual presentation for Mini-Maker Faire, feedback from students, and capstone projects.

1. Introduction

Online learning has been studied long before the pandemic [1,2,4,5,6,11,19,20,21,22,23]. In mid 90s, as the internet increased its popularity, educators started to investigate the feasibility of online education [22]. In his article published in 1995 [29], Postman cautioned us about the pitfalls of online education. He pointed out that as technology evolves educational institutions may be of no use and online education itself cannot solve all the issues that are disturbing the society. In fact, it may lead to the escalation of some social problems such as digital inequality created by technology.

As broadband internet became widely available in the late 2000s, online courses offered by universities increased greatly [18, 23]. Online education clearly has its advantages; however, many people had concerns about potential problems with online education [1,2,4]. The concerns from faculty members, students, and industry included the quality of education, integrity, assessment, lack of interactions, and job security for faculty members, among others. Many of these and other concerns were discussed in the literature [5, 21]. Interestingly, faculty reported more concerns and administrators were extremely optimistic [21].

Due to the increasing demands for education and budgetary constraints for many universities, online education has been steadily increasing. The push towards online education received some resistance in engineering and engineering technology mainly because laboratory experience is required for students in most engineering and engineering technology courses. While some educators were concerned about the limitations of online education, the hybrid format became popular [19, 20]. Despite the increasing interest, online education did not grow as fast as people expected. Gwynn and Zavala presented data in their paper that states only 19% of academic programs focused on distance education and 16% used hybrid format [10].

The Covid-19 pandemic changed everything. During the earlier part of the pandemic in Spring 2020, many universities were locked down. Every course had to be switched to online format. The same questions that stopped many courses from online delivery before the pandemic had to be answered: How do you conduct labs which need to use lab equipment? How do the students work together on their capstone projects? There was no other choice. It was up to each department and each faculty member to figure out the answers to these questions. Higher education institutions were one of the hardest hit areas by the pandemic. There are many papers about online education during pandemic [7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 24, 25, 26, 27, 28].

Educators world-wide are devising innovative ways to minimize the impact of the pandemic on student learning [13]. Mosher et al. [18] discusses the impact of Covid-19 from a historical perspective and how technology influenced our response to the pandemic comparing to other historical events such as the 1918 Flu pandemic, Tuberculosis, Ebola, AIDS, and SARS. Nordin and Barton [8] compared the pre-pandemic and post-pandemic approaches in a course ethical theory and practice were taught to engineering students. Butler and Reid [9] presented how plant visits and design review with companies were changed to online format without sacrificing the valuable experience of exposure and interaction to industry. While it is relatively straightforward to switch theoretical contents to online [14], hands-on experience is more difficult to be converted to online format. Laboratories for engineering courses are challenging to convert to online. Javaid et al. [12] discussed how engineering laboratories were switched to online format. Seven courses were evaluated, and majority of their laboratories showed no difference between the online format and the face-to-face labs in terms of student learning. Even after universities

were opened in Fall 2020 and Spring 2021, some restrictions such as social distancing might still apply. It was still a difficult situation to run the laboratories and required innovative ideas to make it work [15]. Computer Aided Design was widely used in mechanical engineering programs during the pandemic [16]. Capstone design courses were also a big challenge during the pandemic [17]. Zhan et al. discussed how a Mini-Maker Faire was ran during the pandemic [30]. Village et al. presented their lessons learned for their Makerspace during pandemic [25].

Reading the literatures is very helpful, it allows us to see how everybody has been dealing with the challenges brought to us by the pandemic. There are many things that were done in the same or similar ways by faculty members at different universities. There are also unique ways that faculty members come up with for their specific courses. Some may be applicable to similar courses, others may be applicable in general. These experiences are valuable lessons learned during the pandemic. The impact of pandemic on higher education institutions are so big that we must get ready for future pandemics [24].

This paper does not contain deep theory and thorough assessment. Instead, we will present changes that were made in our courses during the pandemic, in particular, the ones that may be beneficial to student learning after the pandemic. Some of these changes seem to be minor; however, they are included in this paper as long as the implementation of the changes can potentially bring positive impact on student learning. The successes and lessons learned during the pandemic are important parts of the effort to take full advantage of online learning. Some of the practices forced upon us during the pandemic are useful even after the pandemic. Many expect the pandemic to wind down this year. Regardless of the correctness of this prediction, it is not too early to think about the post-pandemic education. Many educators are looking forward to pushing past pandemic pedagogy [3], we would like to contribute to this important topic.

2. Virtual learning during pandemic

During Covid-19, many universities were locked down. We had no choice but to figure out how to provide education to students by doing everything online. Some of the things were done to survive and the results might not be as good as face-to-face delivery; however, there were things that worked the same or even better with online format. We will present some online delivery of course activities that may be useful after the pandemic.

2.1 Laboratories

How to convert laboratories to online format is probably one of the big challenges faced by engineering and engineering technology programs. There are several different methods implemented during the pandemic.

First one was to convert everything to simulation. We did this conversion on the fly in Spring 2020. The drawback of this method is clear: the hands-on experience is lacking, which can be a problem for engineering technology student in particular. The advantage is also clear: There is no requirement for lab equipment usage. Standard software packages such as MATLAB are free for our student since the university has a site license. It provides student opportunity to become more familiar with software.

The second method was to combine simulation and real experiments. To motivate students to do simulation, we posted instructions for setting up an experiment for motor PWM control. A video link for testing the motor from past years was posted. The test data were compared to simulation results. The laboratory assignment included tasks such as fault insertion, which was easy to do in simulation but difficult to do in real motor testing. Students also saw the advantage of simulation when one thousand motor tests were completed for statistical analysis purpose within a few minutes, compared to many hours or days of testing with the actual motors.

We also have some colleagues who had TA showing in the laboratory how to carry out the steps in the laboratory and collect data for students to do further analysis.

In the Spring semester of 2021, even though the campus was reopened, social distancing was still required. In addition to modeling and simulation, we purchased some portable devices such as NI MyDAQ and NI MyRio. Students had the option to check out these portable equipment and do the labs in their own home. Now, we have a combination of simulation and experiment with actual hardware.

In February of 2022, due to the cold weather we were able to tell students to stay home and do the laboratory task in the simulation environment. Later, the university announced that all classes were canceled. But it showed that we were well-prepared for this kind of situation and can switch from one mode to another quickly. We also used these virtual laboratories for students who tested positive for Covid-19 in the Spring semester of 2022. Some students who had official excuses, such as military duty call, traveling for athletic competitions, and other situations, were able to complete the laboratory assignments using these virtual labs.

2.2 Mini-Maker Faire

In one of the courses at Texas A&M University, a Mini-Make Faire is supposed to be held at the end of the semester. Students would present their design and learn from each other. During the pandemic, it was impossible to conduct a Mini-Maker Faire because students were not allowed to meet each other. In Spring of 2020, any project involving hardware design was not practical due to the lockdown of the entire campus. The original hardware focused course projects were switched to something that was of interests to the students. The topics of modeling the number of infected people, the number of hospitalized Covid-19 patients, and the best strategy became the course projects for students. Results of analysis are illustrated in Fig. 1.

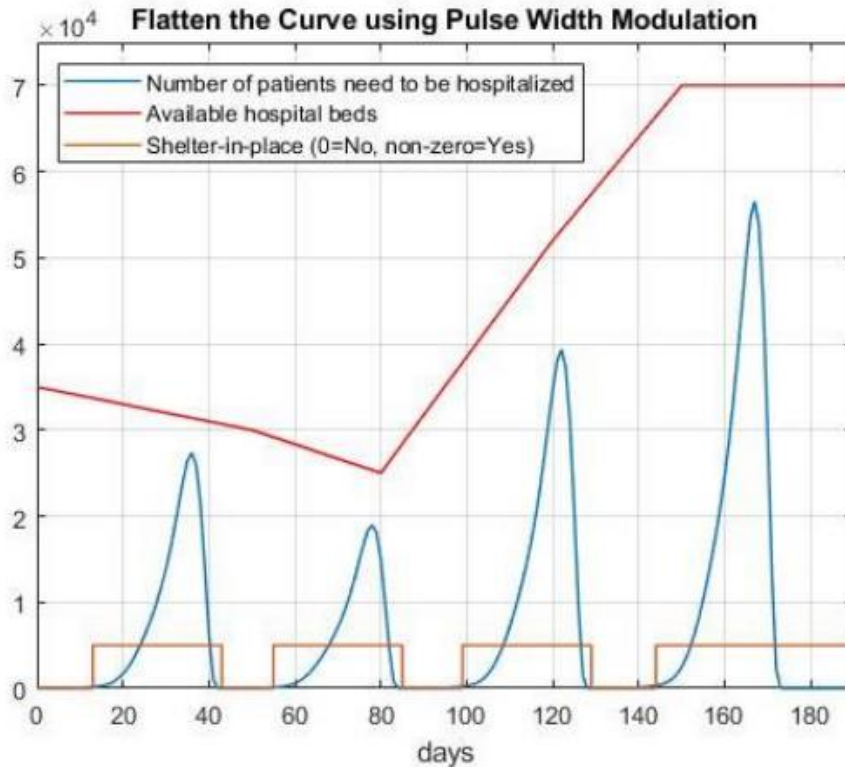


Fig. 1 Modeling of numbers of hospitalized patients

The campus was re-opened in Fall 2020 with mask and social distancing mandatory. Gatherings of large groups were still difficult. We opted for online Mini-Maker Faire, which worked well. The online Mini-Maker Faire allowed us to view the presentations at times that were convenient for us. Due to the increasing number of student teams, online reviewing allowed us to avoid the long time that might take if conducted during lecture time. We also did not need to worry about finding large space for the Mini-Maker Faire. We are also trying to combine the face-to-face and virtual presentation, that is, to have the teams do the demo only in-person. The presentation will be virtual through YouTube.

2.3 Use of Zoom in class and laboratory

The use of Zoom or similar apps was necessary during the Spring semester of 2020 since everything was online. Now, most classes have gone back to in-person, Zoom is still a useful tool.

When software code is discussed in class, sometimes the font size is too small to be seen. For example, you must click on multiple buttons in MATLAB to change the font size. When formulas are displayed in Excel, it is also difficult to see the details of multiple cells. One easy solution is to use Zoom and students can look at their own laptop (by now virtually all students have laptops in class). It is also easy to have students share their screen for the purpose of discussion of debugging software codes.

The use of Zoom in laboratories where software is involved is also very helpful. Many students have similar questions, traditionally the lab instructor would walk around to help individual students by repeating the same answer. By using Zoom, the same question needs to be answered just once and

everybody will see the question and answer. Seeing one student's problem can help other students in the lab.

Lectures are also recorded and students can review the recording at a later time. The video recordings have been helpful in case of students tested positive for Covid-19 and had to miss class for some reason. There is one potential problem, some students would rely completely on the video recordings and did not show up for class.

Another advantage for using Zoom is the use of chat message. Students may not be willing to speak up during the face-to-face lecture or via Zoom, but they are usually very active in sending chat messages to each other. In one of the laboratories, students were asked to install some free software. There are different platforms such as Windows, Mac or Linux and different software versions. Some students had trouble with the installation. The TA only did the installation on his own laptop and did not know all these different combinations for software versions and platforms. But students helped each other out in chat if someone succeeded in the installation.

The social distancing requirement during the pandemic forced us to rotate students to come to the laboratory due to the space limitation. Now we do not have this restriction anymore, but we could choose to have some students doing the laboratory remotely. This could potentially solve the high enrollment problem or short of equipment problem. The labs are so flexible now, we can actually run different labs within the same section on the same day. Let us say, group 1 is working on lab 2 which involves use of hardware. If we don't have enough space or equipment, we would have half of the students working on lab 3 which involve simulation only. The two groups would switch the following week.

2.4 Help sessions

Very few students showed up during office hours; however, it was clear from the grades of homework, quizzes, and exams that some students needed more help. During the pandemic it was noticed that more students asked for help via Zoom. Now we have gone back to in-person mode, we still offer the option of virtual help sessions via Zoom. Virtual help session provides more convenience for faculty members and students in terms of time and location. During daytime, both students and faculty members have classes or labs. Most of the virtual help sessions were now in evening hours or weekends. Students do not have to walk across campus to get help and it is safer during the pandemic. It was observed that the number of students asking for help increased significantly, most of them chose the online option. Sometimes, more than one student have similar questions, let's say, on a homework problem. We can start a Zoom meeting and anybody can join or leave any time. Students usually are OK with video recording the help session. These recordings can be posted so other students can view them. These video recording would have titles such as "Solution to Question 1 in Homework 3", so it is easy for other students to find what they are looking for.

2.5 Capstone projects

Capstone project for Engineering Technology students is a critical component of students' educational experience. The pandemic had significant impact on capstone projects. In Spring of 2020, no one was prepared for the lockdown. As a result, project requirements had to be modified based on the

unavailability of laboratories and the fact that students were not allowed to work together. After that semester, capstone teams are required to have a backup plan for situations like the lock down or social distancing. Now, it is fine to meet in-person, but many meetings, reviews, and discussions are still done via Zoom. Capstone teams are required to create a detailed work breakdown structure such that most of the tasks can be done by individuals and the prototype be passed from one to another. Like the Mini-Maker Faire, most of the presentations are done via Zoom or recorded and posted on YouTube.

2.6 Homework, quizzes, and exams

During the pandemic, homework assignments were completed electronically. This forced faculty members to invest a lot of time to create electronic version of homework and quiz problems. Multiple choice problems became popular, but more complicated methods such as uploading files were also used. Faculty members can reuse these electronic resources after universities are re-opened. We used Canvas for homework and quizzes. There were many issues related to Canvas. Some were due to the users unfamiliar with the software, others are probably software bugs. Copying and pasting assignments may cause serious problems if it is from one semester to another and some students are retaking the course. The scores from last semester can show up in the current semester. Creating a copy of exam for students taking the makeup exam must be done very carefully, it has the risk of losing other students' scores. Displaying Math formulas in homework problem may cause problems. Sometimes the instructor can see the formula without any problem, but the students cannot see it. If the problem is reported by students, then one can make a picture and upload the formulas as a picture or type the formulas in a word file and upload it. Everything needs to be tested first, in particular for exams when you don't have much time to fix things. On a few occasions, students' work was auto-submitted before they finished working on it. It was not clear what caused that to happen.

Exams were held in Canvas; however, this creates the problem for proctoring. Since students were using their laptop or computer during the exam, it was difficult to prevent students from cheating. Students were asked to turn their video on and show their faces, but it was difficult to know whether they were sending messages to each other. Due to the large number of students in class, cost can be an issue if we choose to use outside proctors.

Canvas has many great features, but one needs to be careful before using the unfamiliar features. Any small issue can cause a lot of complaints from students.

Using Canvas for homework, quizzes, and exams has a great advantage, that is, it is easy to do data analysis comparing to the manually graded homework or quizzes. With a few clicks you can find percentage of students selecting the correct/wrong answer. It helps the instructor to identify areas of weakness and make corrections in future lectures. It is a great tool to prepare for ABET evaluation of learning objectives and student outcomes.

One side effect of online assignment is that there are more questions and complaints from students. Before the pandemic, students submitted their work in hard copy and they didn't look at the details closely because after a week they might not remember what they did. With the electronic submission and grading, usually they would immediately respond to a low grade. This is good in the sense that

students are getting feedback from their work, and they are acting on the feedback. The instructor just needs to be prepared that you would have more email to reply to.

2.7 Surveys

Since we have quiz in every lecture, students all have their laptop or cellphone that allow them to have access to the internet. This provides the instructor with an opportunity to get instant feedback from students. At the end of each lecture, students can open a Google survey form and type in the “muddiest point” of the lecture. This information helps the instructor to review the muddiest point in the following lecture. This is much quicker feedback than the end of the semester student evaluation.

We have an ongoing research project that involves life-long learning for students. There are two surveys, one pre- and one post- survey, done in the beginning and end of the semester respectively. Before the pandemic, these were done with hardcopies. Now they are all converted to Google forms. It is easier for students to complete, and it is easier for us to do the data analysis.

We used clickers before the pandemic. There is cost associated with that and students did not like it. Now we use Google forms, and it works without any problem that may come with clickers such as registration problems.

2.7 Team formation and peer evaluation in Google forms etc.

It used to be that students sign up on a piece of paper to form project teams. Now it is all done in Google forms. The Google forms contains the team’s names, members name and is updated throughout the semester to include things like YouTube link and peer evaluation link (another Google form). The document from the last semester is shown to the students so that they know what to expect.

The peer evaluation used to be done in Excel and was time consuming to calculate the averages for all the teams and individual team members. It is now much easier to do in Google forms.

When teams were working on some software development project, GitHub was proposed by students. The instructor never used GitHub before, but students taught each other by posting messages online. Many students thought this was a helpful tool to learn for software development.

3. Conclusions

In this paper, we discuss some practices that were used during the pandemic. Not only these worked well during the pandemic, but also there are benefits for using Zoom and other online tools for many tasks in face-to-face courses. These practices can improve the student learning experience and can be good complement for the regular teaching practices even after the pandemic is over.

The ideas all looked straightforward; however, one needs to be careful in implementation. Any small glitch can cause a major headache. If you have not done something discussed in this paper and would like to try, it is recommended that you test it before large scale implementation.

It is worth mentioning that after the lock down, students were all tired of online delivery. In-person interaction is important and must be maintained at certain level.

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