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Lessons Learned from Teaching Engineering Classes Online during COVID-19

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Abstract

COVID-19 has resulted in the shutdown of schools across the world. As a result, education has changed dramatically, with the distinctive rise of e-learning, whereby teaching is undertaken remotely and on digital platforms. During the COVID-19 pandemic, the synchronous, asynchronous, and hybrid online teaching modalities have been adopted in many engineering colleges and departments. Therefore, there were a lot of challenges, faced teachers specifically teaching engineering courses. As an example, in the spring 2020, fall 2020, and spring 2021 semesters, petroleum engineering at TTU has used all of these online teaching modalities and has experienced the challenge of delivering its engineering courses online. However, a lot of lessons have been learned from that experience. This paper summarizes the lessons learned during teaching petroleum engineering courses online based on feedback collected from faculty members and undergraduate students.

1. Introduction

- **Definitions**

1. Face-to-Face: The term "face-to-face" (F2F) in this section of the report will be any portion of the classroom class or has some F2F engagement. This includes, but is not limited to, in-class lectures, group meetings between classmates, in-class exams, or other in-person components.
2. Online: The term "online" in this section of the report will be any portion of a class that is not F2F engagement. This includes, but is not limited to, courses that are delivered completely online, courses with any recorded content, online group meetings between classmates, or assignments that are submitted online.
3. Hybrid: The term "hybrid" in this report refers to all combinations of F2F and online as defined above within a single course and may include a wide range of instruction modalities.
4. Asynchronous: The term "asynchronous" in this report refers to any content accessed through Texas Tech's online resources at the student's own timeframe and not at a specific time set by an instructor.
5. Synchronous: The term "synchronous" in this report refers to content that has a regularly scheduled meeting day and time, and location (F2F or online) that repeats, and content is delivered by the instructor during such scheduled time. Streaming: The term "streaming" refers to online video content that is shown during the synchronous engagement.

- **Population and sample**

The authors used both quantitative and qualitative methodologies to study lessons learned from COVID-19 during teaching engineering-related classes online during the lockdown period, and after returning to campus. All teachers, junior, and senior students of the petroleum engineering department at TTU were the populations of the study. There were 10 teachers and 116 sophomore, junior and senior students.

- **The procedure of data collection**

The 116 students participated as a sample in a descriptive survey. Interview-based and faculty meeting results were collected from the 10 faculty members.

- **Objectives of the study**

The main objective of this study is to examine the challenges faced by the teachers and students in adapting to the online teaching-learning process during the COVID-19 pandemic. Furthermore, they get a summary of Lessons Learned during teaching engineering-related classes online and try to find the best online teaching practices.

2. The Study Summary

2.1. Synchronous Instruction

Here is a list of lessons learned from adopting synchronous online teaching based on faculty and students' feedback.

- ***Synchronous online teaching helped to***

1. Increase student engagement outside of the classroom
2. Reduce instructor workload through tools for communication and content delivery
3. Reduce course preparation times
4. Potentially increase enrollment due to distance capabilities

However, streaming synchronous lectures in online courses can devolve to less student interaction. Mindset is key to success with classroom engagement. To combat consistent issues regarding online synchronous lectures, the following policies are considered best practices:

1. Students should maintain the same civility/professionalism expected in a F2F setting.
2. Students should not engage in non-class-related activities during class.
3. Instructors should consider disabling chat if the content is off-topic and add that to the professionalism in the class conduct section within their syllabus.
4. Students should turn on their cameras during class.

5. Reasonable exceptions for privacy, technological, or other issues should be made.
6. Utilize participation tools either pre, during, or post online content
7. Live polls keep students engaged and 'catch' students that have left the computer.
8. Surveys of viewed content can help to ensure students have watched
9. Breakout rooms to allow more active engagement with students
10. Encourage discussion through Q&A
11. Include grades for in-class participation in the syllabus

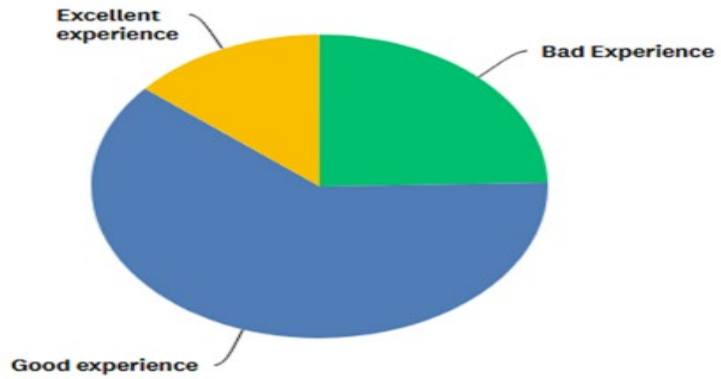
- **Student's feedback on Synchronous Instruction**

A survey was sent to petroleum engineering students, in their sophomore and junior year. All of the sophomore and some of the junior classes were taught using live sessions (synchronous). In the survey, they were asked to give feedback on their experience of the synchronous online teaching adopted during COVID-19.

- **How was your experience with synchronous online teaching adopted during COVID-19?**

This is the summary of the survey results. As shown in Figure1, more than 75 % of the 66 students liked how the classes were delivered. The 71.43% of the students agreed that synchronous online teaching gives them the opportunity to interact with their faculty members and classmates. 66.67% of the 66 students who took the survey stated that they have the same motive to finish their engineering degree if all classes are delivered with this modality (synchronous)

Answered: 65 Skipped: 1



ANSWER CHOICES	RESPONSES	
Bad Experience	24.62%	16
Good experience	61.54%	40
Excellent experience	13.85%	9
TOTAL		65

Figure1: PE students' feedback on synchronous online teaching

- **Attendance during Synchronous Instruction**

With synchronous courses being offered online the inclusion of asynchronous video content, active participation, viewing, and attendance of all content can be difficult to ensure and confusing for students. Here is a list of recommendation to ensure the attendance during synchronous instruction based on faculty member's input.

- The syllabus should reflect the various modes of content delivery. Instructors should have the effects of non-attendance on grading clearly outlined in the syllabus. When group work is involved a clear attendance policy should be outlined for such work
- Make online attendance of synchronous content mandatory. Such attendance can be checked in several active or passive ways,
    1. Engagement through online quizzes
    2. Check synchronous lecture attendance with in-class assignment/quiz/poll submitted at the close of the lecture

2.2. Asynchronous Lecturing

Much of the focus of the PE department committee was on synchronous course modalities. If possible, classes should be taught synchronously to encourage greater interaction with instructors. However, we recognize that asynchronous courses are increasingly found throughout academia and have legitimate educational uses. Here is a list of lessons learned from adopting asynchronous online teaching based on faculty and students' feedback. Based on faculty feedback, it is suggested the adoption of several recommendations to improve the educational outcome of such asynchronous courses. The hallmark of asynchronous education is the delivery of primary educational lectures through recorded videos. Therefore, the content is typically in a longer format.

- **To create a positive experience in these courses, the following policies should be adopted:**

1. Attempts should be made to reduce the length and increase the number of videos in asynchronous courses to improve student attention and retention
2. Content should be posted well before lecture dates and left up for extended periods
3. Pre/Post/During viewing surveys/quizzes should be used to ensure engagement, retention, and comprehension

- **<u>Best practices for the creation of pre-or post-lecture videos include:</u>**

    1. Breaking topics into smaller segments that can be watched in sequence. Limiting videos time to 20 minutes
    2. Focusing content to a specific format (i.e., lectures or example problems, but not both
    3. Reviewing content in class without watching the entire video
    4. Reviewing recording every 2 years
    5. Tracking views/attendance
    6. Captioning videos for accessibility

- **Student's feedback on Asynchronous Instruction**

A survey was sent to petroleum engineering students, in the junior and senior years where some of their classes were taught using an asynchronous online teaching modality. They were asked to give feedback on their experience of the asynchronous online teaching adopted during COVID.

- **How was your experience with PE asynchronous online teaching modality?**

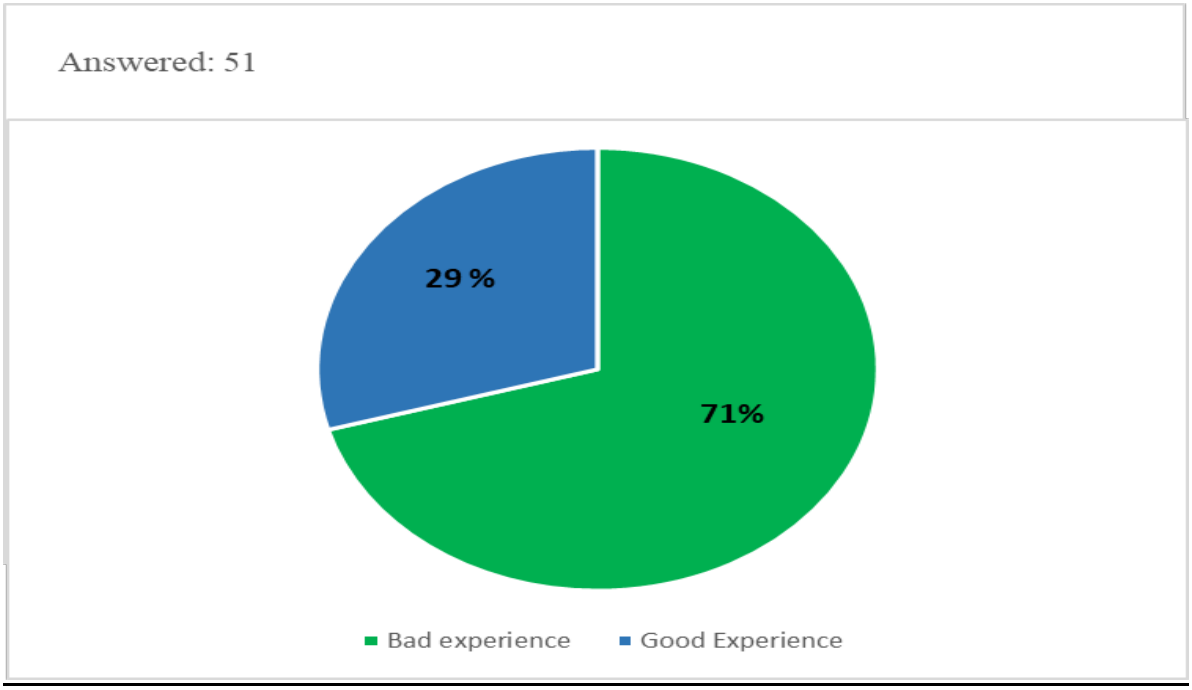


Figure2: Junior and senior years feedback on asynchronous online teaching

As shown in figure 2, about 71 % of the 51 students, who took the survey, did not like how the classes were delivered. When students were asked why they did not like asynchronous online teaching modality. 82% of the 51 students believed they felt disconnected from school and lacked interaction with faculty members and classmates. 69% of the 51 students agreed that recorded videos were long, and it was hard to set down and watch them at one time. On the other hand, 98 % of the 51 students enjoyed having more time to work and spend with family members.

- **Attendance During Asynchronous Instruction**

One major advantage of the availability of asynchronous content is that students can take courses remotely from another city or even state. However, as with other asynchronous online content, attendance can be difficult to monitor. Similar policies should be enacted as stated in section 2.4.

To be specific, online viewing of asynchronous content is mandatory. Such attendance can be checked in several active or passive ways,

- Check asynchronous content engagement through video view counts

- Check asynchronous content engagement through online quizzes
- Instructors should have the effects of non-attendance on grading outlined in the syllabus

In conclusion, petroleum engineering enjoyed the online teaching experience, however, students did not like to finish their degree online. As shown in figure 3, all the petroleum engineering students, 116 students, were asked if they would like to finish their B.Sc. degree online regardless of the adopted online teaching modality, 78% of the 116 who took the survey, said No.

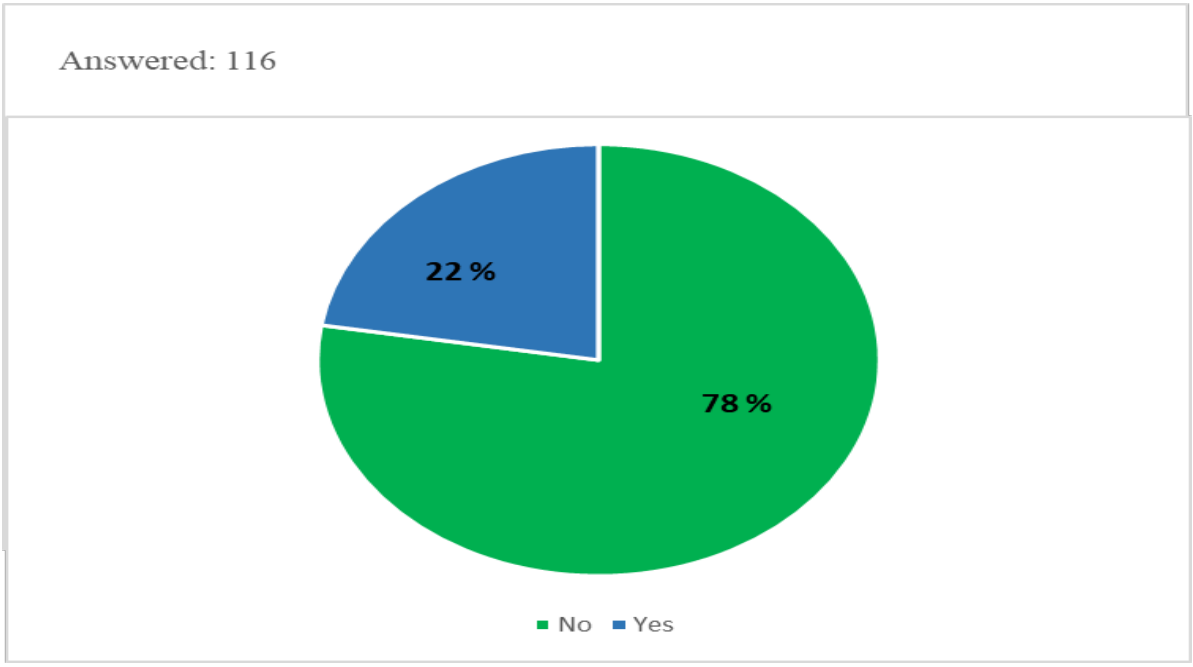


Figure3: Would you like to finish your B.Sc. degree online?

3. Adopted Practices of Teaching Labs

The biggest challenge faced during COVID-19 was teaching labs and hands-on activity classes in a regular way. Here is the list of the solutions adopted by faculty members to overcome this challenge.

- Student class rotation - Divide the class up into smaller groups and teach as normal, but a portion of the class watches via video while one group sits in class. For example, classroom capacity is 25 (at the new designated reduced 50% capacity), class size is 50 and the class meets Tuesday - Thursday at 8 AM. Divide the class into two 25 student groups. The first group comes to the Tuesday class which is videotaped while the second group watches the video. On Thursday, the groups switch. One thought is to have smaller groups gather to watch the experiment and to record at the same time then rotate groups. Some experiments could be conducted individually while other students would observe a TA or Professor run the lab and gather the data.
- Pre-recording all our labs to make them online exercises, as students couldn't meet the social distancing requirements without creating huge numbers of lab sections.

- TA record instructor as if he/she is doing the lab and then prepare a data sheet to hand out to students. Based on this method, students prepared the lab reports.
- The experiments will be conducted (and recorded) by the instructor and TA while the class collects and analyze the generated data.

4. Adopted Practices for Giving Exams During Online Teaching

Online exams are a hot issue right now. Proctoring exams using a combination of Zoom, Mediasite, Blackboard, eCampus, etc. were adopted by many faculty members. However, the biggest challenge was preventing cheating and fair evaluation of student's performance when exams were given online. Here is what was implemented.

1. Respondus lockdown browser app (limited-time exams and students are proctored during the test using their computer camera).
2. Regular take home exams and relying on "honor" and to avoid cheating a mix of multiple exam versions were given

The first option showed better efficiency in preventing cheating, however, technical issues and lose of internet connection created unfair environment for other students. Students liked the second option; however, it created an over loading time for grading the exams, and it has less effectiveness in preventing cheating.

5. Conclusion

- We are still learning about the best online teaching style that fits PE or any other engineering classes; however, online live sessions (Synchronous) seem to be an effective online teaching style compared to asynchronous
- Overall, it was found that most of the teachers somehow encountered similar kinds of challenges and issues.
- The online teaching of labs and hands-on activities courses is the main challenge for teachers to ensure students' courses objectives. Pre-recording of the lab sessions by TA or faculty member making students physically see the equipment without running an experiment, then asking students analysis the pre-collected lab data
- Giving exams during asynchronized online classes was another big challenge for PE faculty members. However, take-home exams with a short time (max 2.5 hrs.) seem to be an effective course assessment method when classes are taught fully online (asynchronized online class).
- Synchronized online classes were well-accepted by the PE engineering students, compared to asynchronized online classes.
- At the end, the findings of this paper cannot be generalized because the survey and analysis were conducted on only petroleum engineering department students, however, other engineering department heads shared the same findings when our data were presented to them. the authors are aware that there must be other potential strengths and weaknesses of provided best online practices in this paper.

6. References

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