

Implementing strategies for virtual engineering education

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Abstract

This paper focuses on implementing different methods to increase student engagement in online classes and innovative ways to educate engineering students. As Covid-19 took over the world in March 2020, schooling moved to the online world. As engineering courses are different, it requires students to be in the lab and work with electronic components, micro-controllers, and other equipment. It has been difficult for students and professors to be focused and have a better outcome. During the 2020 fall session, we have implemented methodologies that have vastly improvised the outcome of students' and teachers' work. The methods implemented have shown that 1. Students were more engaged in class; 2. The output of the course results were positive; 3. Students were working as a team; 4. Students came up with innovative ways to do the classwork; and finally, 6. Students found innovative ways of problem solving while working in a group setting. The same strategies have also been implemented during the summer research program, which has proven beneficial to both student participants as well as high-school teachers. The students who were in different countries due to Covid-19 has had beneficial and more inclusive participation even while being in different time zones. To further assess the efficacy of these methodologies, plans are on the way to implement them at the research laboratory level.

Introduction

Engineering courses are taught face-to-face, and it is considered one of those fundamental disciplines where remote instructions and learning is difficult, if not impossible, due to its reliance on hands-on and experiential learning. One of the primary challenges that online teaching/learning faces is the dependency on access to the internet. Faculty and students prefer being on campus to learn and educate themselves [1] with the traditional pedagogical methodology typically requires students to be seated in a classroom, listen to lectures and take examinations. However, there has been a change of teaching method for a few courses where faculty utilizes electronic medium for disseminating information to students. Nevertheless, a non-trivial percentage of people still utilize the blackboard or canvas for teaching. The labs have always been in person due to their requirements of different machines, components, micro-controllers, and a better understanding of circuits.

The Survey of Online Learning conducted by Babson Survey Research Group and the Alfred P. Sloan Foundation in 2011 reported that in the United States, more than 2,500 colleges and universities, 31% of students were enrolled in at least one online course in 2010 [2] [3]. In March 2020, all the classes were online due to the pandemic, and professors had a very short amount of time to learn and then teach the courses online, not in the traditional way. This change in method was not an easy transition, and in the beginning, students and the faculty struggled with it.

Covid-19 pandemic

On January 30, 2020, the World Health Organization designated the Covid -19 virus as a public health emergency of international concern, and on March 11, 2020, the infectious disease has declared a pandemic [4]. Covid -19 was first classified as a zoonotic disease, meaning that it can be transmitted from an animal host such as a bat to a human. Covid -19 caused almost 820,000 deaths in the United States and 5,595,590 deaths overall in the world.

Covid -19 Teaching Methods

When the world went on lockdown due to the pandemic, schools and universities had moved to online teaching, however, most universities were not prepared for online teaching. Thus, the transition from traditional means of instruction to a system more tailored to the limitations of the Covid-19 era was extremely challenging to figure out. To mitigate the struggles associated with the transition certain methods were implemented which – tentatively - resulted in good outcomes from students as measured by final grades as well as a non-standardized word-of-mouth survey. The methods implemented are:

Attendance:

Attendance was the most crucial step during online education. For most of the courses, attendance has not been an essential factor that has given the students the leniency of missing the classes. However, during Covid-19, attendance was given 10% of the overall final grade to have students attend the classes. The students would get 3 (informed leaves), which they can utilize throughout the semester, but they must email the professor about missing the class. If they miss more than five classes due to an emergency, internet issue, or any other personal issue without prior notice, they will either get a "C" or fail the class. As the classes were online and recorded, marking attendance was simple for the professor and did not require spending time to take attendance during the class time. The students who were in different time zones were excused from this rule. This rule has helped professors keep students from missing classes, and students were forced to attend and participate in classes.

Engagement in class and no harassment:

Usually, most of the students do not engage in class, ignore questions even though they have answers, or clarify any doubts they have, which increased during online teaching. Therefore, a 5 % of the overall grade was assigned to class engagement in order to address this reduced engagement environment that online learning had created. This was effective as students answered

questions, had their cameras on, and asked questions when in doubt. Most students aim to get an “A” grade and losing 5% of the grade would decrease their chances.

Another aspect to consider in engagement axis was that students are afraid of harassment when asking fundamental questions and as such limit their in-class interaction in. In fact, a student was harassed for asking a fundamental question during Fall 2020, which resulted in a strict no harassment policy which stipulated that if any student is caught harassing or bullying any other student, then that student would meet with strict and severe disciplinary repercussions which can include failing the class or being reported to the chair of the department. Social media also plays a role in harassment and bullying, as most of the days, there have been new challenges and jokes going viral on social media platforms. Unfortunately, many students have fallen for those pranks and suffered consequences. This policy was implemented to reduce (and potentially eliminate) the instances of harassment and bullying or do any pranks in the class.

Team Projects:

Students meet each other on class days during in-person classes and become friends, acquaintances, or know each other. Meeting people in person helps to understand their perspective and is considered better than knowing a person online. As the teaching methods changed, students met only during class time and did not get ample time to get to know one another. To help students bridge this limited interaction, team projects were given every 2-3 weeks which required students to work in groups of 2 or 3 which forced a situation of increased communication even in the online environment. These projects were 15% of the overall final grade and were based on the concepts taught in the class, which would usually be a combination of 2 topics, and the students had to submit a weekly report of the project. This report was a simple documentation which described what they did that week and their future work. Due to these deadlines, students had to engage and work together every week. Students usually spend upwards of 3 - 4 hours every week on these projects. This method has helped students set up meetings time and brainstorm ideas on how to complete the projects and ultimately helped them with improving their time-management strategies.

Small group activities:

Each class is at least 3 hours per week, usually divided into 2 or 3 sessions. As the classes are divided into sessions, having one session of 30 minutes dedicated for students to work on group activities has helped them feel in class and know the professor and other students. During this time, the students can discuss anything like Covid-19, their plans, their feelings, what they like and dislike about the online teaching, pandemic, family or friends, and other topics. This activity gave students a space to discuss topics that would be easy to discuss during in-person classes. The students thoroughly enjoyed these sessions as it allowed them the space and avenue to delve into topics that would otherwise be impossible to address during traditional class structure.

Having this kind of session helped the students see that a professor is willing to accommodate their education and as well as their mental health.

Come up with Final Project:

The regular in-person classes have mid-term and final exams or projects, but a different method of grading students was implemented due to the pandemic: Students were asked to pick their team members for the mid-term and final project and develop a research question/topic related to the course at least two weeks before mid-term. Once the research topic was approved, students worked together to write the program and submit a report for the mid-term. Then, using the same research topic, they were asked to implement other topics taught in class and build on their main idea for their final project, which was 30% of the overall grade. This method helped students research, implement and allowed for innovative expression of their work. Finally, on final exam day, students submitted a detailed report and presented their final projects, which often contained fully developed research that was planned and executed by the students and their cohorts. This ultimately gave them a sense of accomplishment that was palpable as measured by a non-standardized word-of-mouth survey, but a follow up study with more stringent evaluation criteria has been planned to further explore this methodology.

Meeting time:

Most professors prefer in-person classes, and there has been a debate about this in the early 2000s that nothing could replace face-to-face instruction and that anything else was inferior. When the pandemic started, professors were mainly concerned about changing their teaching methods and learning new teaching techniques. Most professors used technology such as blackboard, canvas, and others to teach; they required handwritten homework, taking notes was also restricted, no devices were allowed during class or exams. Moving from this to complete online teaching was a challenge to be learned in a week or two. Due to this professor could not give time to students as it would be in-person. To resolve this, the strategy implemented was to provide 30 minutes of office hours at least three days a week. This also had the rule of taking an appointment, so all the students do not show up simultaneously.

To make this smooth for professors, they could create a calendar for students and have their meeting time on its schedule. Then, students can pick the time they require for the meeting, say 5 minutes, and block it. Furthermore, this will send a meeting link to the students and inform the professor about the meeting. This method can be handy to professors and students as they do not have to go back and forth to set up a meeting time or have other students crash their meetings.

Recording lecture:

Recording the classes and meetings was one of the essential methods implemented. If a student has missed class due to an emergency, they had access to the recorded lecture, which helped them learn the topic before approaching the professor. In this way, the professor did not have to rehash the lecture to the student again and focus on clarifying the doubts.

Summer REU/RET Program 2020:

This methodology was implemented during the Summer REU/RET program, which helped students with their research work, implementation, and time management skills. The group met with their mentor every day to discuss the task for the next day, and students would stay back in

the meeting and work together. Meeting every day has helped students solve the problems and

finish the project on time. Time Management was a big issue as one of the students was from a different time zone, and students usually wanted to work as per their availability, but there were fixed times to accommodate everyone. Twice a week during meetings, students were allowed to speak about anything they would like to discuss. Most students talked about their future, pandemic, entrepreneurship, and other things. This improved student camaraderie and increased work output while working as a team.

Students worked on the same projects, but they could implement their research work and see the results. After seeing the implementation of all the members, the best approach was selected, and the next steps were implemented. This helped students to work as an individual and in a team.

Summary and Conclusion

The change in the teaching method was quick and gave little to no time to learn new ways to do it. This drastic change made it clear that anything could change in the world in a moment. Implementing these methods as a mentor, faculty and TA has helped to engage students, teach them how to manage their time, be helpful to other students, participate in class and be mentors to other students. Most students are now comfortable with online teaching, meetings, and working on projects with other students. Furthermore, the increased level of independence due to the change of methodology also came coupled with a need for more advanced time-management strategies which the methodology accounted for. Finally, attendance and group activities were implemented as crucial learning modalities which forced students to be in class and foster open communication with other students, for which they must be extremely attentive during online learning sessions.

As mentioned previously, these highlighted methods will be implemented during the upcoming semesters, and a more structured comparative study, including surveys, will be done at the end of the semester to more completely assess the effectiveness of this new hybrid and online classes methodology.

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