Online education is here to stay---COVID-19 has mandated this. While the growth of video streaming helped online education gain considerable traction over the past two decades, the current pandemic has made it an absolute necessity. While many individuals feel that online education can never be a substitute for in-person teaching and interaction, and this is only temporary change, I would like to argue that the change is permanent. Only time will determine the extent to which online education will alter university and school education, but looking back into history, it is clear that automation and pricing advantage have driven change in all industries (e.g., manufacturing, automobiles) and there is no reason to believe that today’s highly expensive education industry will not follow the same trend.

Having argued the need to take online education seriously, in this paper, I discuss two important issues. Firstly, I discuss how the disease will disproportionately impact the teaching quality at various kinds of institutions (Research 1 (R1), Research 2 (R2), and Teaching). The main reason I say disproportionately and not just differentially is that even during normal times, resources available (e.g., grading or teaching support, technical support) per course offered is lower at small public schools in comparison to well-funded ones (I have personally seen this having been associated with R1, R2, and teaching institutes). The pandemic is likely to stretch the limited resources at small public schools thinner, thus worsening the situation for faculty at these universities. Secondly, given that faculty at all schools have to teach online in some form or the other, I provide some tips on designing high-quality educational videos from the comfort of one’s home.

Before proceeding, I would like to establish why I am well positioned to answer these two questions. I obtained my MS and PhD from University of Massachusetts Amherst, an R1 institution. I then joined the computer science department at CSU Monterey Bay, a small teaching university as an assistant professor. I worked there for two and half years before joining SUNY Binghamton (a smaller research school), where I am currently a fourth year assistant professor. I obtained my Bachelors from a state university in India and hence, I am aware of some of the challenges faced by faculty and students in developing countries as well. During my time as assistant professor, I have developed and taught multiple online courses and certificates (greater than ten) including computer networks, probability, introductory programming and algorithms and would like to share the learning from those experiences. To make computer science education accessible to all, I also maintain a YouTube education channel [3] and a computer science educational initiative CSEdu4All.org [2].

Understanding the Difference in Challenges by Institutions

In the United States there are more than 200 doctoral granting research institutions and hundreds of four-year teaching university and community colleges. While research institutes are classified as R1 and R2 (based on the Carnegie Classification), in this paper, I refer to universities that have strong and widely recognized PhD programs as R1 institutions and the remaining set of research universities as R2. While the issues discussed below are mainly based on my teaching experience in the United States, I believe similar issues will exist in countries around the world. Though many universities in the US are planning to hold in-person classes in the Fall, the discussion below is primarily focused on online teaching.
At the very beginning, I would like to acknowledge that R1, R2, and teaching institutions all play an equally important (albeit different) role in society and the prosperity of these various institutions is critical to the growth and well-being of society. The need to emphasize the importance of the role played by these different institutions here is primarily due to the fact that society and media generally focus their attention on top universities and the issues faced by smaller schools do not receive similar coverage. Moreover, I have also heard arguments that with the growth of online education, free courses created by top universities will decrease the relevance of smaller schools. I believe that this ‘one-size-fits-all’ argument is flawed as it ignores the perspectives, needs, and voices of the less-privileged sections of society. While R1 institutions are well-known, primarily due to their research contributions and the outstanding research credentials of their faculty, from a teaching/educational perspective, R2 and teaching universities educate a significant portion of the student population. The preparedness and goals of students attending various kinds of institutions (R1, R2 and teaching) is different and therefore, a course created at one university will not serve the needs of all kinds of students. The well-being of R2 and teaching universities is crucial for society as they cater to students from certain regions, backgrounds, and ethnicities who are unable to attend an R1 university. In recent years, a number of small colleges have been forced into bankruptcy and the pandemic is likely to force some other schools to permanently close as well [9, 10]. The survival and growth of smaller public schools is of paramount importance to society as they are key to improving educational reach, inclusivity, diversity, and accessibility to education. I draw the attention of the reader to R2 and teaching universities because we will see from the discussion below that they are likely to be more adversely impacted by the pandemic. We need to adopt a panoramic view and consider all educational institutions because regardless of the viewing lens, this pandemic is going to hurt certain students more than others, which is unfair and goes against principles of open education.

I first discuss the differences in the teaching load at the various institutions and then delve into the specific challenges. The discussions here are mainly centered on computer science courses though the general principles should be applicable to other scientific disciplines as well. Let us first consider tenure-track faculty. At R1 institutions, faculty generally teach one course per semester and have considerable teaching assistantship (TA) support. Faculty primarily deliver lectures while TAs hold discussion sessions and help with grading. Faculty also have the opportunity to teach graduate level seminars that help students explore a variety of new research areas. Students attending these institutions are also usually better prepared. At R2 universities, faculty generally teach one to two courses a semester and while TA support is available, the amount of support and the preparedness of the TAs is usually less, thus requiring more intervention from the faculty [8]. In comparison, faculty at teaching universities teach three to four courses a semester. There is generally no TA support, in most cases even undergraduate grading assistants are not unavailable; this means that the faculty is responsible for managing all the discussion sessions and doing all the grading [8]. Faculty at R2 and teaching institutions also teach a variety of different courses. Of course, faculty at R1 and R2 institutes have commensurate research responsibilities to compensate for the lower teaching load.

In addition to tenure-track faculty, a substantial amount of teaching responsibilities across all types of institutions is taken care of by lecturers, adjunct professors, and postdocs. Lecturers usually have more teaching responsibilities than tenure-track faculty as they are not actively involved in research. The teaching load and the TA support for lecturers follows a similar pattern as tenure-track faculty at their institutions as such resource-related issues are generally institutional in nature.

- While high teaching load has always been a concern at teaching universities, COVID-19 has exacerbated the problem. Expecting a faculty to deliver three or more high quality online courses each semester is a tall order. Teaching a high quality course online for the first one or two offerings requires a significantly higher amount of effort than teaching in person [7]. While at the first glance, it might not be clear why online teaching would require more effort that an in-person lecture, it is important to understand that lecturing may not be the best mode of teaching in an online setting and therefore, it takes more time to set up a good online course.
- While the best practices in online teaching are well documented [5, 6], one good approach is to use pre-recorded videos supplemented with interactive discussion sessions to improve student understanding. Recording high-quality videos requires significant effort and expertise and it is important to understand the time-commitment required for this effort. From my experience,
recording a 30-minute good quality video at home along with processing requires somewhere around 3 – 5 hours, which amounts to 6x -10x more effort (we will talk about this more later). Once a course is fully developed, it should be easier to offer an online course.

- Faculty need to learn how to utilize new tools (e.g., Slack, Piazza) to improve the online learning experience. New assignments may also need to be designed that are better suited for an online environment. Additionally, the amount of effort needed to create good online videos for multiple courses in a semester is non-trivial.
- Lack of TA support at smaller institutions is likely to increase the pressure on faculty as they have to now resolve issues faced by students remotely, which is a significant time commitment.
- Running lab sessions remotely without adequate TA support will increase the burden on faculty at teaching institutions.
- Additionally, students attending teaching schools generally require more attention and guidance thus increasing the faculty workload.
- To compound issues, the learning management portals currently employed by institutions are not well suited for online education (e.g., they are ill-equipped to host large videos and render them seamlessly).

The discussion above thus shows that the more resource-constrained (e.g., lower TA support, higher teaching load) an institution is, its faculty and thus its students are likely to be more adversely affected by this pandemic. This means that with respect to teaching, faculty at teaching universities followed by R2, and then R1 will feel the impact of the pandemic the most. Addressing the above-mentioned issues would require administrative intervention, but here are a few suggestions.

- Recruiting more undergraduate students as TAs will help lessen the burden on faculty, particularly in teaching schools. While this will require a monetary commitment, undergraduate student TAs can be hired on an hourly basis.
- Partnering with other universities that are similar in terms of their students’ preparedness to create shared content (e.g., introduction to data structures, algorithms). In fact, for most undergraduate courses, high-quality content created by one faculty can easily be utilized across institutions that have similar student preparedness. Such an approach can lessen the burden of creating new content and individual faculty can focus more on student learning and outcomes.
- Collaborating with companies such as Coursera, EdX, and Udemy that have better platforms for delivering online content.

Recording High-Quality Videos for Improving Online Teaching

In the previous section, I outlined how COVID-19 could disproportionately impact faculty at institutions with higher teaching load. Regardless of the type of institution, all faculty will have to partake in online teaching as online education becomes an important part of our lives going forward. Therefore, in this section, I discuss how to record high-quality videos from the convenience of one’s home to improve the quality of online teaching based on my teaching experience.

In Spring 2020, when universities were forced to move to online teaching in the middle of the semester, they resorted to online video conferencing tools (e.g., Zoom, Google Meet) to deliver online lectures. While video lecturing was a quick fix for the problem, it is not a great tool for online teaching. Unfortunately, based on discussions with colleagues at various institutions, I have realized that universities have focused most of their attention on getting students back on campus in Fall 2020 and have given limited thought on how to make online learning for students an enjoyable experience. While the ‘centers for teaching and learning’ at all universities have been conducting seminars on improving online teaching and learning, the main approach still appears to be delivering lectures via video conferencing. Retaining attention of students during online lectures is extremely difficult and some great tips for improving online education are provided here [1, 5, 6].
One idea is to adopt a modular approach, where faculty design 15 – 30 minute videos on various topics so that students can consume knowledge in nuggets at their convenience. A high percentage of online courses (e.g., Coursera, EdX, Udacity) are designed in this manner. One can then use lecture time to engage students via interactive discussions and problem solving activities. To ensure that students come prepared to class (i.e., having watched the pre-recorded videos), faculty can conduct a small self-graded quiz at the beginning of each class session. I personally adopt this approach and it is similar to the hybrid classroom approach, albeit in a completely online environment.

While the idea mentioned above is just one online teaching approach, an important component of a majority of online teaching methodologies is developing pre-recorded videos. Recording high-quality educational videos from one’s home requires significant amount of effort and time commitment. Before I describe the different video styles that I have experimented with, I would like to mention the effort needed to record and host a video. My colleague Arti Ramesh and I have started a computer science educational initiative CSEdu4All whose goal is make computer science education accessible to everyone [2]. As part of this initiative, we both maintain YouTube education channels [3, 4] where we post our videos. The key idea is to organize videos according to playlists so that students around the world can easily understand the order in which the content has to be consumed. Creating playlists on YouTube is also important because YouTube’s recommendation system does not naturally recommend videos in order. From my experience, recording a video that is x minutes in duration can easily take at least twice the amount of recording time (i.e., 2x) because one might take multiple attempts at recording. Note that while one needs at least 2x amount of time for recording the content, there is significant overhead associated with arranging the slides, setting up the software and performing post-processing. Depending on the level of sophistication desired, the additional amount of time required varies between 3 to 5 hours. An additional 30 minutes to 1 hour is needed to upload the video on YouTube, write the title and description and to set the parameters of the video on YouTube.

I share examples of the tools and links to the various kinds of videos my colleague Prof. Arti Ramesh and I have developed, as it could be useful for all. I note that we have mainly used Apple products for recording. We have used a variety of software to record our videos. They include iPad, Panapto, Camtasia, and camera for recording and iMovie for processing. One can also use animated videos to attract students (Animaker is a free software). The steps related to ‘how to use these software’ can be easily found online.

For an online course, typically faculty have at least one introductory video where they show their face and introduce themselves to students. For individual lectures, some faculty prefer to speak while showing their face to students, while other like to focus mainly on the content. There are also other recording options where faculty show their faces and have conversations with students for a small duration and then focus on the content for the remainder of the video. Another issue that needs discussion is whether one should write a script for recording the content or speak more naturally. From my experience, the answer lies in the comfort the faculty has with the content that she is teaching. If the faculty has taught the material multiple times before, she may not necessarily need a script, but if it a relatively new course then she would either need to rehearse the material a few times or prepare a script.

**iPad**

- Recording the screen on an iPad while we write on the iPad. This is useful for explaining difficult concepts. We use the Notes software. [https://youtu.be/5hC78GZdnYk](https://youtu.be/5hC78GZdnYk)
- Recording the screen on an iPad and solving example problems that you have in the form of a pdf. We record the screen while we solve the problem on the pdf. This is great for teaching examples. [https://youtu.be/97J6OKMA7ws](https://youtu.be/97J6OKMA7ws)
- Recording the screen on an iPad while we go through previously written notes and annotate them as needed. This is great for explaining concepts through slides. [https://youtu.be/PkJtUB5C-f0](https://youtu.be/PkJtUB5C-f0)
- Sometimes, when one is teaching an algorithm, one may want to split the screen. You can keep the algorithm open as a pdf on the web browser (half of the screen) and use Notes or the same pdf (on the other half) and write/annotate them as needed [https://youtu.be/wfzr5f2TF8c](https://youtu.be/wfzr5f2TF8c)
Panopto/Camtasia

- Recording the slides as we speak (without your face option). It usually makes one less nervous. [https://youtu.be/kRS4J-m5n04](https://youtu.be/kRS4J-m5n04)
- Recording the slides as we speak (with your face option). Personally, it makes me nervous. [https://youtu.be/d8Ib8a3TeN0](https://youtu.be/d8Ib8a3TeN0)
- Sometimes one may want to take advantage of existing online animation to teach concepts (e.g., an algorithm) Recording the screen while putting your browser on full screen. [https://youtu.be/691nxnm7IJQ](https://youtu.be/691nxnm7IJQ)
- The same approach can be used to explain coding concepts. A java example: [https://youtu.be/TwCiq1vWojU](https://youtu.be/TwCiq1vWojU) and a decision tree example: [https://youtu.be/OBJ4ysavvcc](https://youtu.be/OBJ4ysavvcc)

Animated Videos

- We have used Animaker to design animated videos. [https://youtu.be/emsoRMyyBAg](https://youtu.be/emsoRMyyBAg)

Camera

- To introduce yourself to students in an introductory video, one can use
  a) nice camera setup [https://youtu.be/HSbdWJMaRg8](https://youtu.be/HSbdWJMaRg8)
  b) a simple iPhone camera: [https://youtu.be/RWtrDG-6aYA](https://youtu.be/RWtrDG-6aYA)
- With adequate time and editing, it is also possible to record videos with screen splits and graph pop-ups. [https://youtu.be/ExD4jtkb9VI](https://youtu.be/ExD4jtkb9VI)

Playlist

This is an example of a YouTube playlist.

[https://www.youtube.com/playlist?list=PLXDX4vxbgW0CxCkGLQN_2R360ETWJMHi7](https://www.youtube.com/playlist?list=PLXDX4vxbgW0CxCkGLQN_2R360ETWJMHi7)

Conclusion

Before concluding, I would like to share five pieces of advice for faculty for Fall 2020 and beyond based on my online teaching experience.

- Adopt a hybrid model where you use a combination of pre-recorded videos and supplement it with in-person discussions and activities.
- Create a weekly schedule and release material (e.g., videos, notes etc.) on the same day each week (e.g., Monday morning) for the upcoming week. Send an email to students once you release the material. This approach sets the tone for the entire semester and lets students know what to expect from the course.
- Rework your assignments to adhere to a weekly or once in two weeks schedule. This helps students to keep track of assignments despite limited face-to-face interactions and constant reminders.
- Have a small quiz at the beginning of each in-person lecture to make sure that students are prepared for that class. You can also utilize the ‘breakout sessions’ option on Zoom to engage students and encourage teamwork.
- Lastly, send a few personal emails from time-to-time asking students how they are feeling and whether they need any help. Many students are shy of asking for help and this really helps. The entire family of one of the students in my class was infected with COVID-19 and the only way I
able to know that this student was under a lot of stress and needed additional time and support is because of the regular emails I sent to my students.

I hope that this paper generates interesting and important discussions related to faculty teaching loads at various institutions and also provides faculty constructive ideas on how to create engaging educational videos from their homes.

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