Distance learning mediated by technology: some data, issues and thoughts from a Brazilian perspective

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1 Some Lessons learned from the past

Distance learning, or e-learning, has become very popular during the last couple of decades. In Brazil, distance learning has been proposed as a solution to mitigate the gap between the country needs for highly qualified workers and the number of graduates the public universities can deliver. One of the first initiatives in e-learning was the CEDERJ consortium of public universities in the state of Rio de Janeiro [4]. One particular course offered by the CEDERJ consortium is the three-year-long Computer Systems Technology undergraduate course. This course, since its inception, is entirely based on video-lectures, taught by faculty members from both the Federal University of Rio de Janeiro and the Fluminense Federal University. The course started in 2005 and included more than 500 video-lectures specially prepared for it [1]. Almost 700 students have graduated since then, and 38% of those have obtained a Master or PhD degrees or are currently pursuing a graduate program. More than 2,000 students are presently registered and have access to the class material via the CEDERJ site. All classes have been made freely available in the Internet via the National Research and Educational Network (RNP) [1, 2]. A question to be answered is: what can we learn from this experience?

The video-lecture software had measurement capability to record student’s interaction with all video lectures, as soon as a session is started. (each access to a video lecture is recorded as a new session.) We record the following metrics:

- Number of views (which we call “popularity” for short).
- Watch time (WT), defined as the total time a student spends watching a lecture, while in play mode. Only non-overlapping intervals during the session are added, that is, the intervals of time seen more than once are counted as a single interval only;
• Play time (PT), defined as the total time the video session was in play mode;
• The total time of a session which includes both the play-mode time and intervals in which the video was paused;
• The number of jumps. (For instance, a jump to a different topic, rewind to a different position in the video, etc.).

The study was performed using a dataset that contained nearly 700,000 sessions collected over a period of 2 years (from June 2012 to June 2014) from almost 450 video lectures that last approximately between 5 to 150 minutes with mean equal to 45 minutes. (Most lectures are between 15 to 70 minutes.)

As one may expect, some video-lectures were very popular with over 40,000 views during the period studied. The most popular video-lectures have distinctive characteristics: these were either taught by faculty who were also popular while teaching in person at the university, or they included some popular topic, independently of their length. The number of sessions with PT and WT above 60 minutes was relatively low. Many sessions (> 10³) had a considerable number of jumps (> 10) and over 2/3 are forward jumps. Some sessions had even more than 20 jumps. These observations closely match those found in an earlier, smaller scale study [6] of how users interact with stored class material for a computer networking course from a US university.

Observation: Organize a video-lecture in short topics

A simple conclusion can be draw from the data analysis: students do not watch a video-lecture continuously, from the beginning to the end. They prefer to watch only small sections of the lecture and jump from topic to topic. This observation should be taken into account when lecturers prepare their classes. The video-lectures should be organized in self contained short topics, preferable no more than 20 minutes long.

Observation: If a long explanation is necessary, the flow should be broken with some task that students are required to do.

An empirical observation learned from experience with the video-lectures of the CEDERJ Computer Science course is that it is important to break a long explanation flow using exercises or other means. Comments from many students indicate that it is helpful for the learning experience to include, as part of the video-lecture, slides that are programmed with interactive features. For instance, slides with interactive examples/animations, or an area in the slide dedicated to program a small task and to receive feedback interactively.

Observation: It is important to continuous collect measures to understand how students react to a set of video-lectures and give important feedback to faculty.

An important issue is to assess how well students engage a lecture. One simple but useful way is
to extract basic information from simple measures.

The two graphs in Figure 1 are examples of information that can be extracted from simple measures. Figure 1a shows the total length of a lecture (in seconds) versus the expected watch time (WT) as a fraction of the total lecture length for all the video-lectures of the CEDERJ Computer Science course. Each point in Figure 1a indicates these two metrics for a video-lecture. It is easy to observe that students watch a larger fraction of shorter lectures as compared to long lectures.

![Graph](image)

(a) Lecture length versus $E[WT]/$lecture length  
(b) “Popularity” versus $E[WT]/$lecture length

Figure 1: Watch Time and other metrics

Figure 1b shows the number of views (which we call “popularity”) per WT. From the figure, we may infer that popularity is not a good indication of student engagement. Popularity may perhaps be a good indicator that a topic is popular or the student expectation towards the lecture is high. Popularity does not indicate that most of the lecture will be seen. Overall, based on a deeper analysis of the collected data (beyond the scope of this white paper) and on simple metrics like those in Figure 1 one can devise a student engagement model to provide important feedback to lectures [3].

In summary, in pandemic times, this observation is in line with WHO: **Measure, measure, measure.**

**Observation:** Engage students both in the process of lecture preparation as well as during class work. Collaboration is a must for improving success rate.

Fifteen years ago, we made available fellowships for selected students to help faculty in the process of preparing their video-lectures and to master the latest technology. This process worked extremely well and nowadays, after social isolation caused by the Covid-19 pandemic, we are beginning to adopt similar model at COPPE/UFRJ.

Another lesson we learned throughout fifteen years from the CEDERJ consortium in Rio de Janeiro
is that the collaboration among students is essential for the success of a remote class. This lesson has been continuous reported by faculty, students and tutors during meetings. In addition, there is evidence from grades that the students who collaborate with each other are more likely to succeed in class than those who study alone. This observation has been true not only for the Computer Science course, but for other courses as well. Furthermore, collaboration appears to have a greater positive impact for e-learning than for regular classes.

Collaboration has numerous advantages, and another observation can be drawn from our experience with the CEDERJ course as indicated below.

**Observation:** We should collective create a set of lectures for a given topic to expose students to different ways of explaining the same material.

We had limited experience, using a prototype in the laboratory which allows an automatic change of the flow of explanation of a topic when the student was found “confused” about that topic. In other words, the student was presented a different explanation to the same topic after the prototype automatic detected that she/he was having difficulties with that topic. In fact, teachers often try to present an explanation in a different ways in an effort to clarify the topic to the student who do not understand the material after it has been presented a few times. Results from this limited experiment showed the benefits of adopting this strategy.

An issue is to automatically detect when a student is having difficulties to understand a topic in a video-lecture. To tackle this issue, we believe that models can be devised from simple measures. A step in this direction can be found in [3] [5, chapter 12]. As a community, we could largely benefit if we all share video-lectures.

## 2 Students with little or no access to computer or Internet

We must not leave out students with no resources outside the learning environment on the Internet. Since we are a Computer Communications community we have the obligation to tackle this problem. This issue has been a major concern of the public universities in Brazil. In what follows, we present very recent surveys taken from 4 different sources: (a) Graduate School of Engineering (COPPE) of the Federal University of Rio the Janeiro (UFRJ); (b) a different survey for the entire Federal University of Rio the Janeiro; (c) statistics from the distance learning consortium from public universities in the state of Rio; (d) some data from a state public university in the state of São Paulo (UNICAMP).

We start by the Federal University of Rio de Janeiro (UFRJ) and report on a survey for the entire university from April to June 2020 to evaluate Internet access. UFRJ has approximately 66,500 students and it is the largest and oldest of the federal (public) universities. From the total number of students, 55,500 are undergraduate (48,500 regular and 7,000 distance learning) and 11,000 graduate students (ap-
A total of 23,309 students replied the survey: 18,841 undergraduate and 4,310 graduate considering all areas of knowledge. From those who replied, 91% declared to have broadband access to the Internet. From the lower income students (with less than 1.5 times the minimum wage family income) 82% declared to have broadband access. The students with lower family income, 85% have access to smartphones, but only 75% have access to a desktop or laptop. The survey is not conclusive, but one can infer that a non-negligible fraction of students has Internet access only through their smartphones. As a consequence of the survey, since June 26, UFRJ is offering 13,000 Internet kits (smartphone chips or modems) to low income students to use, free of any charges.

The situation is different when we consider only the engineering students from COPPE. The survey ended by late May and 1,706 students replied, which constitutes 75% of the total number of students from 13 graduate engineering programs. 70.5% of the students have broadband access 62.3% use WiFi at home and 44.5% have data access in their cellular. 85% have a laptop or computer at home. However, 29.9% answered that they do not have an adequate space for studying at home! It is interesting to note that 24.5% replied they have never participated in online courses, and 74.5% had participated at least once in online classes. From those, 72% reported to have good learning experience. Almost 65% of the engineering students answered that they will be willing to help other students without Internet access.

As a conclusion, a small but non-negligible fraction of graduate engineering (COPPE) students does not have the minimum necessary conditions to take online courses. However, it is very interesting to note the large amount of students willing to help others.

CEDERJ is a consortium of public universities in the state of Rio de Janeiro and was created to give access to high level education for students in the interior of the state who otherwise would have no access to public universities. Students have access to laboratories, library, computers, Internet, and local lectures (given by tutors trained by the universities of the consortium) at 34 buildings spread through different cities. CEDERJ has a total of 34,000 registered undergraduate students and 9,104 of those replied to the survey. On noticeable point is that 6% replied that already had COVID-19 and 60% had a close relative or friend with COVID-19. This indicates an additional issue to worry about. The survey indicates that 65% have WiFi at home, but 44% have access to the Internet only via cellular and 2.3% have access to Internet only at work or no access at all. The survey includes additional questions about the online exams taken during the period of isolation, but this is beyond the scope of this first draft, though the issue is important to be addressed.

The State University of Campinas (UNICAMP) has approximately 34,500 registered students. The university did not conduct a large survey as UFRJ, but they collected informally data from their departments in order to take very quick actions. They were able to rapidly distributed smart phone chips to 400 students, not only in the city of Campinas region but also to other regions. More than 600 students were benefited with equipment loan either new or provided by the different university laboratories, centers etc. In addition, UNICAMP distributed fellowships to those in immediate need.

**Observation:** Free access to cellular phone data plan, or very low cost Internet as well as a
low cost laptop is a necessary, but not sufficient, condition to mitigate some of the perverse effect of COVID-19 to poor students.

Observation: We should be able to use students to help colleagues with less resources.

3 Looking Ahead

While our computer-mediated distance learning activities in Brazil have now been underway for more than fifteen years (allowing us, for example to gather data on more than 700,000 distance learning sessions), there is still much work to be done:

• **Measuring learning outcomes.** Our mantra from day one has been “measure, measure, measure!” We have been able to learn much about how students interact with distance learning material, but we have not yet been able to correlate those actions with learning outcomes (e.g., as measured through test scores). That may soon be possible with the advent of online assessment. A longer term challenge is to correlate learning outcomes with the quality of online material, and the availability of supporting computer-mediated structures (office hours with the instructor or teaching assistants, student discussion spaces).

• **Sharing resources.** We believe it is important to share education resources and teaching material in an organized, possibly curated manner. We must build a community of people who are willing to put time and effort to help others, and find the necessary resources to make it happen. Part of this need for sharing is to avoid “reinventing the wheel”, but another part of this need is to make different “wheels” available to learner – different course materials that might help different students learn in different ways, in particular in a way that best suits her/his needs. Course projects are one particular area where we think sharing can be particularly beneficial.

• **Assessment and evaluation.** On-line assessment, both self-assessment by the learner and automated assessment in a graded class will help make use of shared resource scale, and be more broadly used.

• **An international perspective.** Automated translation and captioning of education materials is critically important, if educational resources are to be broadly used, globally. In addition, it will be important to design resources that can scale to the amount of bandwidth and computing required. For example, having multimedia education material that can be accessed with just audio alone, or combined audio and video, would allow this material to be used in broader deployments than if only combined audio and video were available. Similarly, exercises that can be done in an educational server/cloud rather than requiring use of student’s personal computer, would make those exercise more widely usable.
The pandemic has shown that we lose lives if we do not cooperate. Our work over the past fifteen years has been motivated by the conviction that distance learning, mediated by technology, can allow us to reach those students with little means to get good, advanced education. We are also convinced that we can better reach that goal both locally globally by sharing resources and experiences. The benefits for all is clear.

References


