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What Is Zoom Not Telling You: Lessons From an Online Course During COVID-19

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ABSTRACT

Since the beginning of the COVID-19 pandemic, instructors and students worldwide have been faced with the challenges of shifting from face-to-face to remote education. Due to universities short notice closure, synchronous online instruction through videoconferencing platforms has been the favoured choice for most instructors. In this paper, we report on our experience teaching an online course using Zoom videoconferencing platform. We conduct a two-fold analysis of online synchronous teaching. We first compare the feedback features offered by Zoom during online synchronous classes with traditional classroom interactions. We show that transposing some features to traditional face-to-face classroom setting requires additional hardware and software. We then analyze Zoom attention tracker tool and evaluate the effectiveness of the attentiveness score as an effective grading metric. Our results show no apparent relationship between the students' attention as measured by Zoom and their performance.

1 INTRODUCTION & BACKGROUND

In January 2020, as the COVID-19 outbreak was rapidly spreading in the city of Wuhan and other parts of Hubei Province, the decision was taken to impose a strict lockdown of Wuhan, eventually extended to all other 15 cities in Hubei, affecting a total of about 57 million people by January 27. Within the following two weeks, similar measures were taken in other provinces, reaching as of February 12, a total of 207 cities in China. At the same time, the virus had spread to other part of the world and on January 30, the COVID-2019 outbreak was declared a Public Health Emergency of International Concern [2].

Authorities worldwide responded to the COVID-19 pandemic by implementing varying degrees of travel restrictions and containment measures also described as lockdownns, shutdowns, stay-at-home, or shelter-in-place orders. These measures were complemented by the closure of non-essential businesses and production activities, of recreational venues and public places in an attempt to avoid large gatherings. By 26 March, 1.7 billion people worldwide were under some form of lockdown, which increased to 3.9 billion people by the first week of April which represents more than half of the world's population [5].

If lockdowns and restrictions have varied in strictness and duration between and within different countries, a common decision policy makers around the world have implemented is the closure either nationwide or localized of schools, colleges, and universities. As of April 2, 194 countries had closed educational institutions nationwide, affecting 91.3% of the world's student population [1]. Following these closures, instructors and students have been faced with the challenges of shifting from face-to-face teaching to online delivery mode, most often within a few days notice and with no foreseeable limit as to time.

Faculty members were left with the choice of synchronous or asynchronous online delivery or a mix of the two modes. In the synchronous mode, delivery is fully live and interactive and involves the use of a videoconferencing software. Recordings of online classes can be made available for students who cannot attend live transmissions due to time zone differences for instance. Asynchronous delivery relies on course materials prepared ahead and made available for students to access on their own time, during a time frame set by the instructors. Such materials include videos, recorded lectures, or discussion boards.

Synchronous delivery presents the advantages of instant feedback from instructors and fellow learners. It also provides students a regular schedule and a sense of community. However, the limitations of synchronous instruction is equity in access to computers and reliable Internet access. It also requires students to feel comfortable about sharing their surrounding environment on camera. It may also not address individual preferences if instructors and students are scattered across different time zones. At the other end, asynchronous delivery comes with the challenge of creating engaging content and ensuring student offline engagement.

The boom of videoconferencing platforms such as Zoom, Google Hangouts, and Microsoft Teams suggests that synchronous delivery has been favored over asynchronous delivery. This trend can also be explained by the short time frame under which the shift from face-to-face to online teaching was expected to happen.

In this paper, we study Zoom[1], one of the platforms that saw a huge usage increase since the beginning of the COVID-19 pandemic. We present the results we obtained during the Spring term of 2020 for an online course delivered synchronously using Zoom. We analyze the Zoom reports of each meeting. We evaluate the attentiveness score of each participant over a period of seven weeks. We also analyze the recording analytics including the number of offline views for each recorded session. Our results show that student attention varies depending on the type of class whether meeting is a lecture or a tutorial. We find a similar trend regarding the number of views of the recordings depending on the type of class. We also find no apparent correlation between students' attention as measured by Zoom and their performance.

To summarize, our contributions are the following:

- We compare the feedback features offered by videoconferencing systems to in-class interactions.

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[1] https://zoom.us/

- We evaluate the transposability of these features to in-class teaching.
- We evaluate the effectiveness of Zoom's controversial attention tracking tool as a course grading metric.
- We analyze the recording analytics to assess the need for students to have access to offline material.

The rest of this paper is organized as follows. We introduce the basic setup required for online teaching in Section 2. We present Zoom, the videoconferencing platform we used for our online synchronous teachings in Section 3. We describe the features that students can use to send their feedback to the instructor and to interact with the rest of the class. In Section 4, we study the transposability of these features in classroom setting. In Section 5, we evaluate the Zoom reports over a period of seven weeks and present our results regarding the attentiveness score. In Section 6, we conclude this paper and suggest which best practices drawn during the COVID-19 pandemic may remain in use as schools and university campuses reopen.

2 ONLINE TEACHING SETUP

The basic setup required for synchronous teaching consists of a computer either a laptop or an all-in-one computer connected to the Internet using an Ethernet cable, WiFi, or to some extend 4G/LTE. Though most modern computers come with integrated webcams, microphones, and speakers, each of these internal peripherals can be replaced or supplemented by external ones as shown in Figure 1. Upgrading to external peripherals allows for different setups, each helping improve teaching delivery. We present three of these alternative setups and the resulting output for instructors and students.

2.1 Picture-in-picture Effect

An external usb-connected webcam or a camera pointing downwards on top of a desk can be used for paper-based teaching. This webcam will show the instructor's hand writing notes on paper. When used in complement of the computer's internal camera, the video captured by the external camera can be used to create a picture-in-picture layout where the notes are shown in a thumbnail playing over the main window showing the instructor talking on the main camera.

A similar effect can be obtained by replacing the external camera with a drawing tablet, not to be confused with a computer tablet, which can be used as a virtual whiteboard. The drawing tablet can be used as an input device that enables the presenter to hand-draw images and graphics or to annotate a document with a stylus.

2.2 Virtual Whiteboard

Videoconferencing softwares allow for screen sharing from a tablet connected wirelessly or via cable to the main device. Coupled to a digital pen, the tablet can be used as a digital whiteboard or to show and annotate presentation slides. This way, the main purpose of the computer is to run the videoconferencing software. Such setup can improve the monitoring of participants' feedback.

2.3 Dual Monitor Display

Instead of screen mirroring, an exterior monitor can be configured to show the shared content while the main monitor displays the list of participants or the participant thumbnail videos arranged in a grid layout. Such setup can improve monitoring of the participants including their nonverbal feedback.

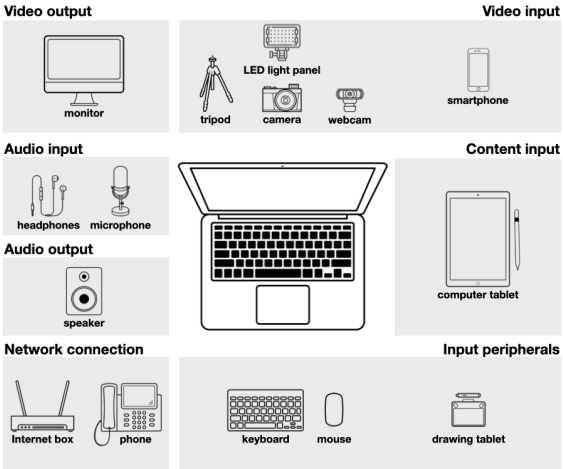

Figure 1: The basic setup for online teaching consists of a computer connected to the Internet. Some internal peripherals can be upgraded with external ones to improve teaching delivery performance.

3 VIDEOCONFERENCING PLATFORM

Zoom is a tech company that provides videotelephony and online chat services through a cloud-based peer-to-peer software platform launched in January 2013. Their platform is designed for teleconferencing, distance education, and social relations. During the COVID-19 pandemic, Zoom saw a major spike in the usage of their platform: As for April 1, Zoom added 2.22 million monthly active users, while in 2019 it added 1.99 million [4]. At that time, their platform was used by 90,000 schools in 20 countries and its usage increased by 67% between January and mid-March 2020 [6].

In the rest of this section, we first present the Zoom interface and how to manage a meeting. We then describe the features relevant for online synchronous teaching with an emphasis on feedback options for participants.

3.1 Zoom Application Window

Figure 2 shows an overview of Zoom's interface. User is presented with a main window surrounded by a control bar across the bottom, the participant panel, and the chat panel. In gallery view, the main window shows the video thumbnails of all participants equally-sized and arranged in a grid layout. In active speaker view, the main window shows the video of the active speaker while the videos of other participants are shown in thumbnails below the active speaker's video. In screen sharing, the video thumbnails of all participants move to a free-floating video panel.

The control bar contains the following clickable icons:

- Mute: control user audio output
- Start Video: control user video output
- Participants: display the participant panel

- Chat: show the chat panel
- Share Screen: share user desktop or specific app window
- Record: start recording the meeting locally or in Zoom's cloud
- Reactions: select one of two emojis

The participants and chat icons will show a badge containing the number of notifications such as the number of nonverbal feedback (e.g., participants who have clicked on a feedback icon) and the number of textual feedback (e.g., unread chat messages). The participant panel contains the list of participants with their names and their profile picture if set up. A host can also see the feedback icon selected by each participant. The participant panel also contains buttons to invite other participants, to mute all participants' audio output, to raise the hand, and to take on the role of host. The chat panel let the user interact with other participant via text messages or by sending files.

The window layout changes depending if Zoom window is in full screen or if a participant is screen sharing. In screen sharing mode, the control bar and the two panels become free-floating or can be hidden by the user. In full screen mode, the control bar remains docked at the bottom while the two panels become free-floating.

3.2 Zoom Meetings

A class is typically implemented as a zoom meeting. Zoom also proposes webinars where participants are view-only attendees who can watch a presentation with no options regarding screen, video, or audio sharing. A Zoom meeting consists of a host in charge of scheduling a one-time or recurring meeting and the participants who need to know the meeting ID in order to join a meeting. The host informs the participants of a meeting by sending them a zoom invite including the meeting's join link and details. A zoom invite can be sent either by email or submitted by creating an event through most popular calendar apps. In the latter, a reminder will be sent to the host or a participant to start or join the meeting, respectively. By clicking the meeting join link, participants will be asked to install the zoom desktop client app if not yet installed. Participants can be hold in a waiting room until the host accepts them one-by-one or all-at-once in the meeting. The host can also put a participant back in the waiting room after joining.

A host can share the hosting privileges with one or more users appointed to help the host manage the meeting participants. A host can split a meeting in sub-meetings called breakout rooms for group discussions or activities. A host can also organize participants in groups and apply the same meeting and recording settings to all members of a group at once.

3.3 Participants' Controls and Feedback

Zoom provides different levels of feedback to meeting participants. In Table 2, we classify Zoom's feedback features depending on whether the feedback is visual, verbal, textual, or click-based. Each feature can be used to serve different purposes during online classes depending on the type of class.

3.3.1 Verbal Feedback. When scheduling a meeting, the host can mute all participants upon entry. Once in meeting, participants can unmute their audio or be requested to do so individually by the host. The host can also mute all or individual participants. By

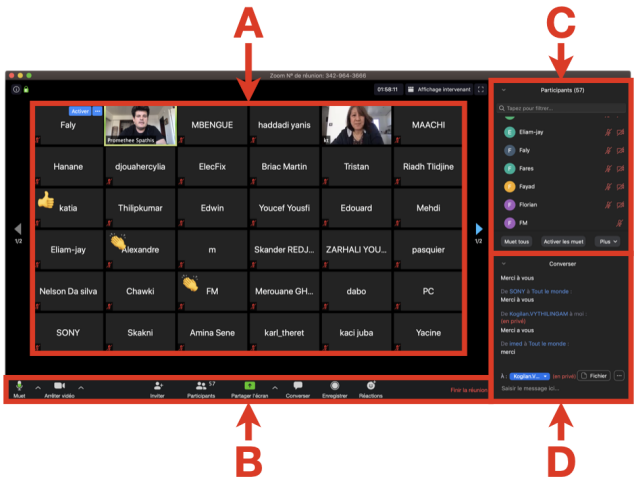

Figure 2: Capture of Zoom application window. A: Gallery View, B: Control Bar, C: Participant Panel, D: Chat Panel.

default, participants to Zoom webinars are view-only attendees. Combined to nonverbal feedback, verbal feedback recreates common in-classroom interaction patterns such as the "raise hand to speak" implicit rule.

3.3.2 Visual Feedback. Visual feedback refers to any feedback received from students without any interruption. These features come in handy especially in large class meetings. They allow instructors to receive quick feedback while avoiding participants talking over one another.

Video sharing. When scheduling a meeting, the host can let participants join with their video off upon entry. Once in meeting, participants can start or stop their video or be asked to do so by the host. By default, participants to Zoom webinars are listen-only mode and cannot share their video.

Screen sharing. In a Zoom meeting, the host and the participants if enabled by the host can share their screen. During a lecture, screen sharing should be enabled only for the host. Presentations shared in slide show view can be shared either in full screen or in a window. The latter allows the presenter to keep other meeting features on screen, including the video panel, the participant panel, or the chat panel. Presentations can also be showed in presenter view but this requires a dual monitor setup with one monitor showing the slide show and the presenter's notes in the second. Screen sharing can be enabled for participants when scheduling office hour meetings, tutorials, or labs in case the instructor needs to view students' screen to better address their questions. Host and participants can share either the entire desktop, a portion of the screen, the window of a specific application. They can also share the screen of a smartphone or tablet and the video captured by a secondary camera, either stand-alone or embedded in a smartphone or tablet.

Screen annotation. The host and participants if enabled by the host can annotate the content shared on the screen. The annotation tools include text, draw (lines, arrows, and shapes), stamp (icons

like a check mark or a star), spotlight (presenter's mouse pointer is displayed within the area being shared to help point out parts of the screen). The host can save the screen with all annotations which will be captured as screenshot images.

In-meeting reactions. During a meeting, a participant can give visual feedback by sending a thumbs up or a clapping emoji that will be shown for 5 seconds in the participant video thumbnail. This feature allows instructors to keep students engaged or draw their attention at specific moments of the class. Instructors can also solicit students' feedback to monitor their attention or understanding by asking checkpoint dual-choice questions.

In-meeting icons. Zoom provides participants with a less intrusive way to give their feedback. Participants can select through a list of icons to express different types of unsolicited or solicited feedback. The list of available icons goes as follow:

- **Solicited**: Yes, No, Agree, Disagree, Thumbs up, Thumbs down.
- **Unsolicited**: Raise Hand, Go Slower, Go Faster, Applause, Coffee, Clock.

Participants can use the unsolicited icons without being prompted or asked by the host. Once clicked, the icon will be shown in the participant panel next to their name. Icons can be removed either by the participant or the host who can remove one or all icons at once. The host also has access to a summary indicating how many participants have selected each icon.

3.3.3 Textual and Click-based Feedback. Textual and click-based feedback require participants to use their keyboard to enter some text or emojis and their mouse to answer multiple choice questions.

In-meeting chat. The in-meeting chat allows the participants to interact by sending instant messages during a meeting. Messages can be sent either to one or all participants. Participants can also send files other participants can choose to download from their chat panel. The host of the meeting can disable this feature or choose who the participants can chat with or to disable chat entirely. The host can select to have all chat messages saved in the meeting settings before the start or during the meeting. Private chat messages can help raise student willingness or motivation to engage, especially for those feeling under peer pressure.

Live polling. A host can submit single choice or multiple choice polling questions during a meeting. Questions are created before and launched during the meeting. The answers are presented to the host who can decide to show the polling results to meeting participants. The host can also save the results by downloading a report available after the meeting. Polls can be conducted anonymously to strip participant information from poll reports.

The polling feature provides a similar tool as classroom clickers, also referred to as classroom response systems without requiring any additional hardware or software to be installed.

3.4 Recording

Zoom allows the meetings to be recorded either to Zoom's cloud or locally on the user's computer. User can be the host or a participant if enabled by the host. Cloud recordings include four files: the video recording of the active speaker with the shared content (mp4 file), the audio only file (m4a file), the audio transcript (vtt text file), and the chat file (txt file). These files are available for download under the recording section of the user's Zoom account. The video recording can also be played in any web browser. Zoom provides analytics regarding the number of views and downloads for each recording.

Table 1: Classification of Zoom feedback features. Features with an asterisk (∗) can be enabled or disabled by the host prior to or during a meeting.

Feedback features	Host	Participant
Visual feedback		
Video sharing	✓	✓*
Screen sharing	✓	✓*
Screen annotation	✓	✓*
In-meeting reactions	✓	✓
In-meeting icons	✓	✓
Verbal feedback		
Audio sharing	✓	✓
Textual and Click-based feedback		
In-meeting chat	✓	✓*
Polling questions	create, start	answer

3.5 Reporting

Zoom generates two type of reports after a meeting. The meeting report lists the information of registered participants including their full name, their email address, the time they joined and left, and their attentiveness score. The poll report lists the participants' answers and the date and time they were submitted for each poll question.

The attendee attention tracker was a feature enabled while a host was sharing its screen. The rationale behind this tool was to give an alternative way for a host to monitor the attention of the participants. The main way for monitoring a class is through video though some students may be reluctant to disclose their surroundings. Monitoring students' attention while sharing a presentation is somehow challenging even when students are sharing their video. In screen sharing mode, most of the Zoom window is taken by the presentation, leaving little or no space on the screen for the video panel which contains the video thumbnails of the students.

Attention tracker. Zoom had a feature that allowed the host to monitor the attention of the participants [3]. If Zoom was not the application in focus on a participant's computer for over 30 seconds, Zoom showed a clock indicator next to the participant name in the participant panel.

Attentiveness score. A summary of the tracker activity was included in the meeting reports through the attentiveness score. Each participant was associated with a score representing the percent of time the participant had Zoom in focus during the meeting.

As of April 2, 2020, the attendee attention tracker was removed from Zoom [6]. The attentiveness scores were retroactively scrapped

from all meeting records. The only way for a host to monitor participants' attention is via their video provided that they are willing to turn on their camera.

4 IN-CLASS TRANSPOSABILITY OF ONLINE TOOLS

In this section, we compare the features offered by a videoconferencing platform and evaluate if they can be made available to instructors during in-class physical face-to-face teaching. In Table 2, we list the Zoom features relevant to online instruction. Each feature is checked in the last column when they can be transposed to in-person instruction. An asterisk indicates what features require additional hardware or software. We assume the same setup as described in Section 2 with the addition of a video projector and a whiteboard.

Managing participants. Managing students attending physical classrooms can be done in a similar way compared to participants attending online meetings. The class instructor can unmute participants by giving them the floor. Though there is no definitive way to keep students silent, signaling the class is usually enough to make a noisy class quiet. Hiding the video of students is obviously not possible unless students are asked to leave the room. A physical class can also be organized in groups for group discussions or activities though the same level of isolation as Zoom's breakout rooms cannot be achieved unless each group can move to separate rooms. The instructor can then apply different rules to each room in a similar way as with Zoom.

Putting a Zoom participant on hold or in a waiting room can be used to organize online office hours as instructor can let students join the meeting one by one to have one-to-one discussions. Using a whiteboard in a classroom is straightforward though whiteboard implemented in Zoom using a tablet and a digital pen offers a similar or even better experience. In Zoom, students can easily share their screen. In-class screen sharing may require classroom video projector to be wireless.

From the above, we can see that managing participants can be achieved with a similar result online and in-class but the latter requires multiple physical rooms available at the same time. Some features such as mute or hide video may be not called for during in-person classes.

Feedback. Getting verbal feedback from students is identical during online classes and regular face-to-face classes. Nonverbal feedback such as thumbs up or clapping emojis is obviously also available to students in classroom setting. However, Zoom provides students with more visual options since they can use one of the in-meeting icons to express more meaningful feedback without interrupting the instructor. Students can also interact by sending chat messages to the class or in private to the instructor. Private chat messages can improve students' engagement, especially for those subject to peer pressure. To implement textual feedback in classroom setting requires participants to install an instant messaging application either on their computer or on another device. The latter will let the instructor check for incoming messages without interrupting the slide show during a lecture.

Click-based feedback refers to Zoom live polling feature. Such feature can be transposed to in-class setting through classroom response systems. These systems require hardware including one clicker per student and a receiver connected to the instructor's computer. Clickers and receiver can be replaced by a software if a computer can be assigned to students during classes. To launch the questions, collect, and process the answers, the instructor needs to install a specific software which requires the instructor to switch application while presenting slides in slide show mode. Some plugins can be used with most popular slide show applications to launch questions and show the results from inside the presentation slides without interrupting the slide show.

Table 2: Transposability of Zoom features in a classroom setting. Features with an asterisk (∗) require installation of additional equipment, devices, or softwares.

Features	Online	In-class
Managing participants		
Mute/unmute	✓	✓*
Show/hide video	✓*	
On hold, waiting room	✓	✓*
Groups, breakout rooms	✓	✓*
Feedback		
Verbal	✓	✓
Nonverbal notifications	✓*	✓
Screen sharing and annotation	✓	
Textual	✓	✓*
Click-based	✓	✓*
Recording		
Video	✓	✓*
Audio-only	✓	✓
Transcript	✓	✓*
Analytics	✓	✓*
Reporting		
Attendance	✓	✓*
Attention	✓*	✓
Poll results	✓	✓*

Recording. It is widely agreed that recording face-to-face classes is cumbersome and complex. It requires to equip classrooms so to turn them in recording studios if video is desired. Sharing the recordings also requires to upload them online while restricting access and dealing with storage limits. Most popular or free hosting solutions also come with limits with regard to engagement or audience analytics.

Zoom offers cloud storage and recording analytics to its paid subscribers. A transcription of the audio recordings is also made available which requires a specific software and high-quality audio recordings in classroom setting.

Reporting. Taking attendance in classroom setting may be time-consuming for large classes. Seating charts or sign in sheets passed

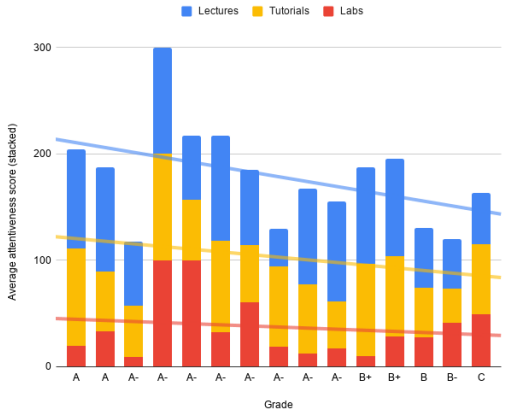

Figure 3: Stacked average attentiveness scores for each type of class and per student. Student are sorted according to their final grade in descending order.

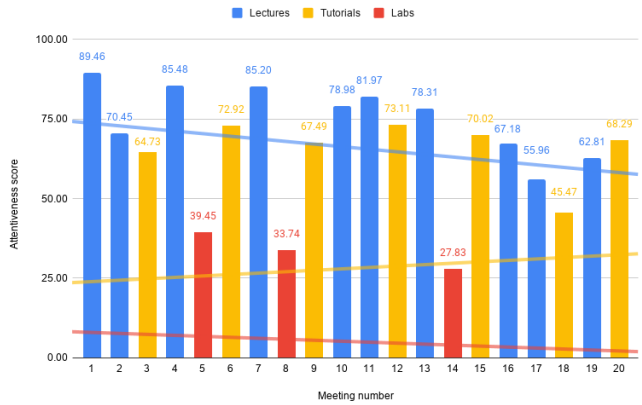

Figure 4: Class average attentiveness score per meeting, sorted in chronological order.

around can help save up some time but come with some inherent challenges or limits. Digital alternatives to traditional roll calls exist but requires the use of biometric identifiers such as fingerprint or RFID ID cards in classrooms equipped with scanners or reader boxes. For classes where students are assigned with a computer, software-based alternatives using GPS and Bluetooth can verify if student signing in are physically present in class. These alternatives can also track the amount of time each student spends in class. These alternatives come with similar concerns regarding privacy as Zoom tracking tool.

In addition to tracking attendance, monitoring student attention provides instructors with crucial feedback to adjust lessons according to the students' needs in near real-time. If instructors can rely on physical observation, monitoring attention becomes cumbersome for large classes preventing instructors from taking informed on-time actions. The same issue arises in online classes. In classroom setting, sensor-based attention-aware systems have been proposed by collecting behavioral information through cameras, motion and eye-tracking sensors, or physiological signals including ECG (Electrocardiogram) and GSR (Galvanic skin response). Due to their intrusive nature, these systems have yet to be rolled out in schools and universities. Similar concerns forced Zoom to remove its attention tracking tool.

5 EVALUATION

In this section, we present the results obtained during the Spring term of 2020 for an online course delivered synchronously on Zoom, to a class of 15 students. The course met 75 minutes, three (3) meetings a week, each meeting being one of three (3) types: Lectures, tutorials, or labs. We analyze the Zoom meeting reports with the objective of assessing if the attentiveness score is an effective course grading metric. We also analyze the recording analytics including the number of views of each meeting recording. To preserve privacy, we have anonymized the dataset by omitting any reference to the course title, the dates and times, and the name of the hosting university. We also removed students' personal information including their names, emails, level, and university id number.

5.1 Student Performance

We first analyze the relationship between the final grade and the average attentiveness score of each student. In Figure 3, we show the average attentiveness scores recorded for each three types of classes. We can see that the students' attentiveness scores tend to decrease with their final scores. This trend is consistent across all three types of classes and is more significant for the lectures. To explain the latter trend, we analyze the recording analytics in Section 5.5. Note that student ranked #4 has a 100% score as this student used his smartphone to join the Zoom meetings while taking notes and doing the labs on a laptop. Same observation applies for student ranked #5 while attending the labs.

In the following section, we investigate the class average attentiveness scores for each type of class.

5.2 Type of Class

In this section, we evaluate the attentiveness score by considering the type of class. Recall that class met three times per week, each meeting being either a lecture, a tutorial, or a lab. Figure 4 shows the average attentiveness score of each meeting sorted in chronological order. We can clearly see two opposing trends when we compare the average attentiveness score of each type of class as the term is progressing. The difference of slope in the trendlines of the lectures and the tutorials shows that the average attention increased for the tutorials while it decreased for the lectures. This result is consistent with the general view that students tend to be more engaged in hands-on classes. As regards the labs, the students were asked to run experiments on their computer preventing them from having the Zoom window active on their screen except for student #4 and #5 as we explained in previous section. The declining trendline shown for the lab meetings also shows the students' familiarization with the software used during the labs.

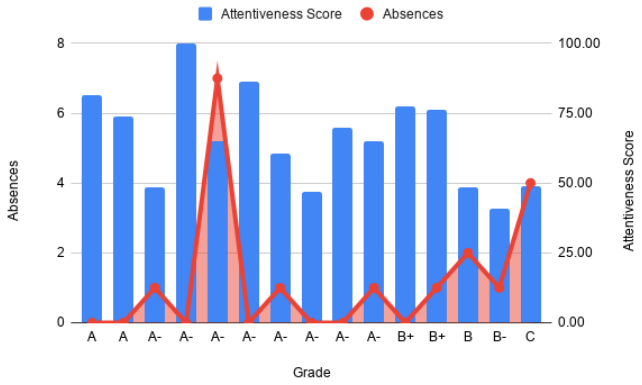

Figure 5: Number of absences per student sorted in descending order by final grade. The bars represent the attentiveness score of each student.

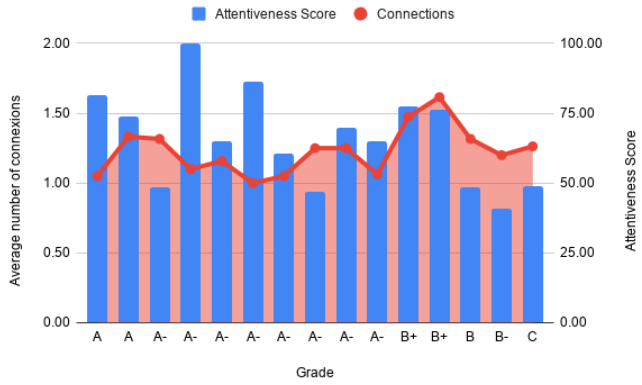

Figure 6: Average number of connections per student, sorted in descending order by final grade. The bars represents the attentiveness score of each student.

5.3 Attendance Record

In this section, we analyze the attendance record as a function of the final score and the attentiveness score for each student. Figure 5 shows the total number of absences versus the final grade and the attentiveness score of each student. We can observe that the number of absences tends to increase as the students' grade decrease for the last tier of the class. We can notice the case of student #5 who managed to get a A- despite failing attending 8 out of 20 classes. We checked in the recording analytics and confirmed this student made up for all missed classes by watching the recordings of these classes. Finally, there is no apparent relationship between students' attendance and their attentiveness score.

5.4 Connection Attempts

Figure 6 shows the average number of connections versus the final grade and the attentiveness score of each student. In the meeting reports, Zoom gives the number of times a participant joined the meeting and how long the participant was connected each time. We can see that the attentiveness score of the top tier of the class are little affected by intermittent disconnections. On the contrary, we can observe a clear correlation for the second and last tiers of the class as students who needed to reconnect instead of giving up have a higher attentiveness score. This indicates that students who tend to be disconnected more often from the meetings had to keep their attention high to make up for their bad Internet access. On the contrary, well-performing students could have been dealing with intermittent disconnections by reviewing the course material in advance.

5.5 Recording Views

In this section, we explore the recording analytics provided by Zoom for each class online meeting. In Figure 7, we plot the number of views of the lecture recordings and the tutorial recordings. The bars show the average attentiveness scores for all meetings sorted by chronological order. We can see that the lectures received two to four times more offline views compared to the tutorials. Moreover,

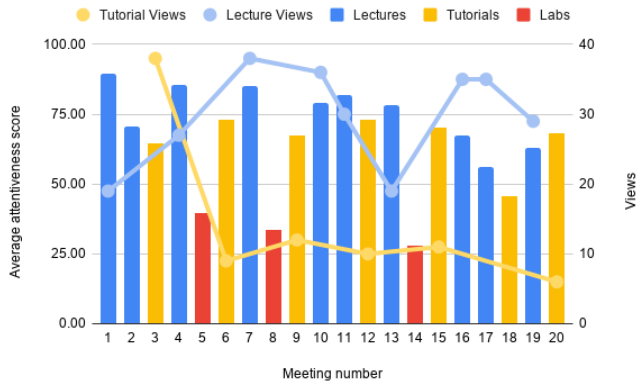

Figure 7: Number of views of the lecture and the tutorial recordings. The bars represent the average attentiveness scores of the corresponding meetings sorted by chronological order.

the number of views of lecture recordings is greater than the number of students indicating that some students may have watched small segments of the lecture recordings at different times, possibly while reviewing the lecture slides or solving homework assignments. Regarding the tutorials, the number of views are lower than the number of students indicating that students may prefer reviewing the written answers posted on the course website. We can also see a declining trend in the number of views of the tutorial recordings while the number of views of the lecture recordings increased over the period of observation.

We can also observe that classes with lower average attentiveness scores did not get more views offline. This indicates that the number of views cannot be inferred based on the average attentiveness score. The opposing trends between the number of views of the lecture and tutorial recording are reversed compared to the attentiveness scores. As we showed in Section 5.2, the attentiveness scores of online lectures decreases as the number of views are increasing for

the lecture recordings whereas the opposite is happening for the tutorials: the attentiveness scores during the online sessions for tutorials increases while the number of views decreases offline. This may indicate that students relaxed their attention during the online lecture meetings as they were planning on viewing the lecture recordings offline.

6 CONCLUSIONS

During the COVID-19 outbreak, universities and schools moved to online education on short notice, leaving little time for preparation. Giving the spike in the usage of popular videoconferencing platforms, synchronous teaching appears to have been the preferred choice among instructors. We study the use of Zoom, a videoconferencing platform for synchronous teaching. Firstly, we list the feedback features offered to Zoom meeting participants and evaluate their transposablity in classroom setting. Furthermore, we identify some specific tools introduced during online teaching that may remain in use as schools and university campuses are re-opening and students return to physical teaching. We show that Zoom presents the advantage of offering a wide variety of tools all available in the same place. To be transposed in face-to-face classroom setting, some of Zoom's features will require additional hardware and software. Secondly, we analyze the Zoom reports of 20 online classes delivered synchronously to 15 students on a period of seven weeks. Our results show that students' attention varies according to the type of meetings, lectures being the classes that captured higher attention compared to tutorials. In addition to joining online sessions, our analysis of recording analytics shows that students resort more extensively to the lecture recordings to review the course material. Our results also show no apparent correlation between students' attentiveness scores as measured by Zoom and their performance. It is expected that for such scores to be a relevant course grading metric, it would require the design of more invasive and thus controversial tracking tools. We believe this paper will help teaching staff make the transition from face-to-face to remote instruction and vice-versa.

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