

My Online Teaching Setup

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1 Introduction

This document covers my setup for online teaching at the University of Utah Eccles School of Business.

In setting it up and tweaking it, I was inspired by the following two videos from Andrew Lo :

<https://www.youtube.com/watch?v=jaFHhQktJiw>

https://www.youtube.com/watch?v=hmGV_c-kriU

My setup is simpler and cheaper, so it may be of interest to others.

Here are two photos of the setup :



Fig. 1: Side View

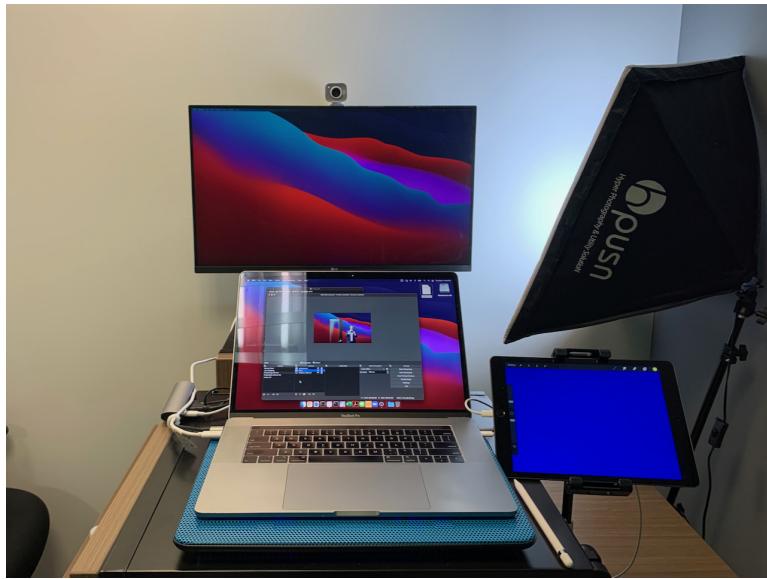


Fig. 2: My POV

The parts are :

- My early-2020 15.6" Macbook Pro (2.2 GHz 6-Core Intel Core i7, 32GB RAM, Radeon Pro 555X 4GB, 4 USB-C ports)
- 32 inch external monitor (\$300)
- Logitech StreamCam (\$200)
- Green screen that covers the wall behind me (\$50)
- iPad and Apple Pencil (\$400)
- Airpods Pro (\$200)
- USB-powered cooling pad for the laptop (\$30)
- Two USB-C hubs with, between them : 1 ethernet port, 2 USB-C ports, 3 USB-B ports, 1 HDMI port (\$50)
- Studio light (\$50)
- Assorted cables (\$50)

Total cost not including my laptop = \$1330. The Eccles School of Business cares a lot about high quality teaching, and paid for the items above.

Wifi on the computer is switched off when I'm lecturing. The computer is physically connected to the office Ethernet through one of the USB-C hubs. This results in fast and stable internet in both directions (upload and download). This is important! When streaming, I quit all other programs and pause syncing on Dropbox.

You need a powerful computer to handle all the inputs and outputs without lagging. My early 2020 Macbook Pro (specs above) is pretty powerful, but on occasion there would be behavior that concerned me, such as the computer would get warm ; excel would be laggy ; Videos would slow down and stutter ; and/or the battery would go from 100% to less than 20% over a 3

hour class, though the computer was plugged into its charger the whole time. I would have qualms about using a computer that was any less powerful.

At one point I switched on "record to local computer" in Zoom. This resulted in a near-freeze of the whole setup, and I had to force-quit and restart Zoom. Thereafter I used "record to cloud" which did not impact performance.

My slides are saved as PDFs, and I open them in Chrome not in Adobe which seems to help. Chrome has a reputation as a memory hog, so maybe a different browser would be even better.

After I sorted out my setup, things were working well, but I still sometimes saw lags in my video. The audio came through great, but the video would get desynced a little more and a little more until it was way out of sync, then would snap back to perfectly synced. It seemed like my Macbook Pro was not quite able to build and encode the video frames in real time, so a slight delay would sometimes build up. I partly solved this issue by tweaking settings in OBS following a couple of video guides :

<https://www.youtube.com/watch?v=Cz1nbD-0y0A>

<https://www.youtube.com/watch?v=jdkvLnVyo7c>

However, I still see a slight lag sometimes in my video which seems to be on the Zoom side, and which I haven't solved yet.

2 Screens

The external monitor displays (see scene 2, "Class with me", below) :

1) 80% of the screen : My lecture slides, video clips, Excel, documents, an

image of a chalkboard that I draw on using the iPad, and any other visuals that I want the students to see

2) 20% of the screen : Zoom in "gallery view" so that I can see the students, and Zoom chat, which students are encouraged to use. I scan the chat and read good comments aloud and respond to them. Chat is a big positive of online teaching. Many students interact via chat in ways, and to an extent, that they never would in a live lecture.

The screen on my laptop displays OBS, Zoom settings, System settings, a checklist of actions to take before during and after class, and anything else that I want to see and adjust but don't want the students to see.

3 Chalkboard

The iPad is plugged into my laptop via USB-C and captured by OBS. That layer is on top of everything except my streamcam image. The iPad is open to the ProCreate app, with a blue background and yellow pen. The OBS layer has a blue chroma-key filter which makes it transparent except for the yellow pen marks.

Writing and drawing on the iPad looks okay on top of videos or slides ; it looks great on top of an image of a chalkboard which I keep open in a Chrome tab.

A big disadvantage is that I draw on the blank iPad screen. Thus, I can't draw accurately on top of a slide, for example to underline a piece of text or circle part of a diagram. I would love to have a way to do that. Because the external monitor is 6 feet away from me under the streamcam, I can't use

an external monitor that is touch-sensitive.

4 Video

Even with a diffuser the studio light was too strong and made me look like an interrogation subject. I ended up pointing it at the white wall in front so the light bounces off the wall back at me. That plus the usual ceiling lights produces a well-lit image.

The StreamCam is about 6 feet from me ; at my eye level ; and right above the upper edge of the external monitor. I lecture standing up, looking at the external monitor (slides or Excel or a video ; students' faces ; chat). This setup feels, from both our perspectives, as if I'm standing at the student's level and looking either at them or just past them depending what I'm looking at on the external monitor. This is another positive aspect of online teaching. In live lectures students in the back rows, who may be introverted or lazy or just arrived late, mostly see me at a distance and I'm seldom looking or talking directly at them.

Video is sent to Zoom using the OBS virtual camera. I have several scenes set up in OBS : (Note that the screenshots below are heavily compressed ; in the actual class the video is in HD and looks quite crisp) :

1) "One on one" :



2) "Class with me" :

A screenshot of a video call during a class session. In the center, a portrait of Jacob Fugger is displayed on a slide. To the right, a video feed shows a man in a dark suit and white shirt. On the left, a slide titled "Module 2 Slides" contains a list of economist book reviews. One review is highlighted in yellow:

- Economist book review:
 - [Jacob Fugger] raised fresh capital for his bank by exploiting savings accounts, which were first introduced in Augsburg and paid 5% a year, contravening the Catholic church's ban on usury. Fugger took his argument directly to Pope Leo X, who had personally benefited from his largesse. The pope was sympathetic and the **ban on usury was conveniently rewritten in 1515** as "profit that is acquired without labour, cost **or risk**". "The modern economy", Mr Steinmetz writes, "was under way."

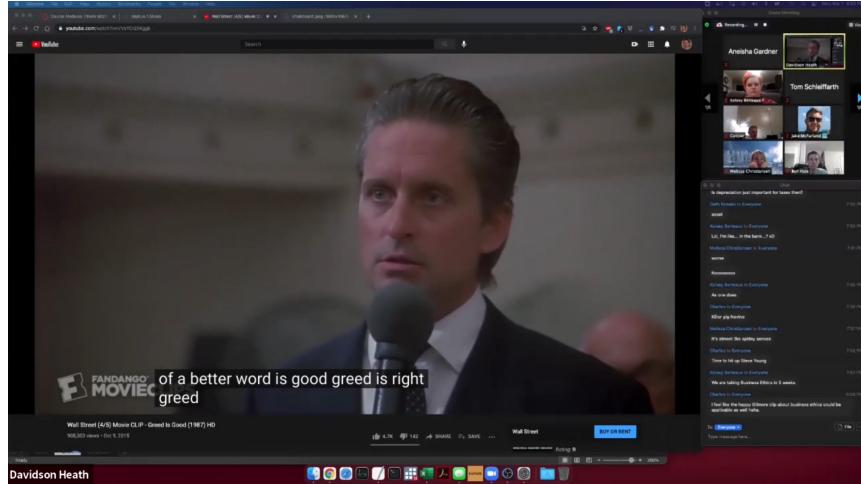
The video has a watermark "Davidson Heath" at the bottom left.

I changed my slides' standard 100%-white background to a light grey color that saves students' eyes. This great idea is direct from Andrew Lo.

A screenshot of a video conference interface. On the left, a Microsoft Excel spreadsheet is open, showing calculations for a financial problem. The spreadsheet includes columns for Year (0, 1, 2, 3), Cash Flow (\$0, \$0, \$0, \$100), Discount rate (3%), and PV_t values (\$91.51, -\$91.51, \$91.51). Below this, there's a section for 'Breakout 1' with a discount rate of 8% and cash flows of -47000, 10000, 20000, 30000. The total PV is calculated as -\$NPV(). On the right, a man in a suit is speaking to the camera. In the bottom right corner of the video frame, there is a small window showing other participants in the call.

A screenshot of a video conference interface. On the left, a chalkboard diagram illustrates a timeline for a financial series. It shows a horizontal line with vertical arrows pointing upwards from the line, labeled 'PMT' above the line and 'FV' at the end of the line. At the beginning of the line, there is a downward-pointing arrow labeled 'PV'. On the right, a man in a suit is speaking to the camera. In the bottom right corner of the video frame, there is a small window showing other participants in the call.

3) "Class without me" :



4) "Pre-class" : This is "Class without me" with a text overlay that says "Finance 6022 : University of Utah PMBA : X :XX Start Time", and playing relaxed but upbeat instrumental music at a low level (Youtube : Search "Chillwave"). The chat and Zoom are active so students can type in the chat or unmute and talk to one another. I start the Zoom meeting and OBS, in this mode, 10-15 minutes before class time.

5 Audio

Audio was the most pernicious challenge. Different routings and settings for the audio led to students not being able to hear me; me not being able to hear them; an increasingly loud and horrible echo; a large time-varying lag in the audio relative to the video; and/or the computer running hot and the video stuttering.

Eventually I arrived at the following approach :

Audio from Zoom goes directly to the Airpods Pro. This lets me hear students or guest speakers.

When I'm speaking, audio goes to Zoom directly from the Airpods Pro microphone.

When I want to show a Youtube clip to the class (or any other desktop audio), or when we are on a break, I change the audio source to Zoom from Airpods Pro to VB-Cable. Before class, I set my MacBook's system audio output to VB-Cable. In Windows, I gather you can just tell Zoom to capture the desktop audio directly.

This setup has two drawbacks. First, I can't hear the audio in the clips. I can see the video, and I turn closed captioning on for the students' and my own benefit. Second, I have to manually switch the audio input to Zoom back and forth mid-stream.

I have to be careful if I remove the Airpods Pro (say, during a break) or if I go so far from my office (say, to the bathroom) that they lose connection with the computer. If the Airpods Pro go to sleep or disconnect, when they reconnect, the computer automatically changes its input and output settings and I have to manually change them back.

I have read complaints of an echo or poor microphone audio when using a Bluetooth headset with earphones and microphone simultaneously. I had no such issues with the Airpods Pro. They produced clear audio both incoming and outgoing, and comfortably lasted 3 hours at a time (going from 100% battery to 20-30%), with me talking constantly and noise cancellation on. Making sure they are charged to 100% before every class is a boldface underlined 24-point-font item on my checklist.

6 Other Notes

The move to online teaching knocked me off my comfortable local maxima in other ways.

Three (or more?) breaks per 3 hour class, each lasting 10 minutes, is better than a single 15 or 20 minute break. This is certainly the case for online lectures. I suspect it's true for in-person lectures too. The students always vote for a single break but I think that's just myopia : They think we will finish faster with a single break. That may or may not be true but by the end of the second 1.5 hour segment, nobody is absorbing anything.

I realized I often talk too fast and attempt to fill pauses when I lecture. It's better to speak slowly, clearly, and emphatically, with plenty of pauses. Having to watch my recorded online lectures – even just skipping through them quickly – made me realize this, and I'm working to speak more slowly and clearly and pause more frequently. The opportunity (or, the painful ordeal) of reviewing your recorded lectures is very helpful to improve your lecturing style.

Students do most of their interacting with the course via the Canvas page. Thus, a well set up Canvas page, with an attractive and consistent look and clear organization, is enormously helpful. It also reduces the deluge of tech-support and “Where do I find X” emails.

I also pre-recorded videos going over core concepts and exercises for each class, with the help of the Eccles School of Business’s Online MBA studio and staff. These were very popular and helpful, because the students can watch them before and/or after class, and can pause or rewind as they work

through them. Students who struggle can watch them repeatedly; students who know the material can skip through them quickly. The up front cost of making these videos was tiny relative to the payoff.

7 **Thanks**

I am greatly indebted to Min Kim; Zander Nash; and especially my amazing TA Samantha Conrow.