Teaching from Home: Some Technical Advice

Dr. Mikio Akagi
Assistant Professor of the History and Philosophy of Science
John V. Roach Honors College, Texas Christian University
Summer 2020

Introduction

Few teachers have been trained to teach students remotely from inside our homes, but that's what many of us have found ourselves doing this year. Many of us will continue to do so for a while.

There are a lot of resources out there about videoconferencing and video-making, but not so many aimed at teachers, specifically. I went down a rabbit hole in spring 2020 trying to learn how to put together reasonably polished and accessible course materials. Now several of my colleagues have asked me how I managed technology during spring 2020, so I thought I'd share what I learned in case it's of use to anyone else.

This document is long, and isn't meant to be read top to bottom. I recommend finding the bits that look helpful and skipping the rest. Generally, each subsection begins with the simplest advice (what might be helpful for most) and progresses to the most elaborate advice (requiring more time or money than most of us have). (**Notes** include details about my own setup or explanations of especially limited interest.)

Some caveats. First, I offer **no advice on pedagogy** here—there are resources on that topic by folks with more experience about distance learning. Second, this guide is meant as a menu of options, **not a prescription** for how others should teach. Of course everyone has their own style and their own local constraints. This advice is meant to be used, adapted, or ignored as appropriate. Finally, I have **no professional background** in technology or video production. My advice is that of an interested amateur.

If you have feedback or suggestions for improving this document, you can reach me at m.akagi@tcu.edu or at @sainsha on Twitter. There is an online version of the document here.

Equipment

A decent webcam-equipped computer should do you fine. But there are many ways to improve on the basic setup, some of them relatively inexpensive and easy. More elaborate apparatus is only practical for those who can obtain funding or equipment from their employers (or who happen to have it lying around?), but a lot can be done with about US $50[1] of investment.

Video calls: audio

It is probably more important to worry about audio quality than video quality. Students and colleagues need to be able to understand you clearly. Good audio is also a **disability** issue—audio processing difficulties are common (and often undiagnosed); clearer audio is the first way to make your class content more accessible to these students.[2] I hear that online audiences are more tolerant of poor video quality than poor audio,[3] so if you want your students un-distracted, focus on audio first.

Be advised that many sounds that are nearly inaudible to your ear may be loud and distracting through a microphone, so you should control your **audio environment** as carefully as possible. Rustling papers, clanking dishes, &c. are best avoided. If you are in a noisy environment (outside, or a home with significant road noise, or a household with children, &c.) you can use the mute function to mitigate distractions.

Note: If you're using Zoom and frequently listening rather than speaking (e.g. in a discussion class), you might leave your audio off most of the time. Zoom has a nifty feature on a laptop or desktop where you can temporarily unmute your audio by holding the space bar, rather than clicking to toggle the mute.

One distracting and common problem on video calls is the **"echo" effect**, where a speaker's voice feeds back from their own speakers into their mic, causing them (and sometimes others) to hear their voice again on a slight delay. This seems to be a less common problem than it was a few years ago but it still happens, especially if you use external speakers (i.e. standalone speakers that aren't integrated into your laptop or desktop).

The surest way to avoid the echo effect is to use **headphones** or **earbuds** of the sort made for use with cellphones, which include a microphone. These can often be found in fine quality for less than $20 (wired). Over-ear models may be more comfortable than earbuds for extended use (and may be less damaging for your hearing in the long term!), and are often similar in price. If you prefer more freedom of movement or less clutter, there are wireless/Bluetooth options, but these tend to be significantly more expensive, more variable in quality, and must be charged before use (another thing to worry about).

Note: For synchronous classes, I used a $40 Bluetooth earbud in one ear—I find it less disorienting to leave the other ear unobstructed. (And for $40 I only found earbuds where the second ear didn't really work. Incidentally, avoid the TOZO T10 model.) Of course, the one-ear trick also works with wired earbuds (you may want to use the ear attached to the mic, to ensure that the mic is close to your mouth and not around noisy clutter).

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[1]   All costs here are in U.S. dollars, since it's what I was working with and because most folks who work in other currencies have a rough idea of their USD exchange rate.

[2]   Incidentally, this is also a reason to use the mic at live events, rather than engaging in the common ritual of asking if everybody can hear you when you shout, then eschewing the mic and proceeding to speak progressively less loudly.

[3]   E.g. Cannell, Sean. (2019, Mar. 12). "Best Budget Equipment for YouTube." Think Media (YouTube). https://www.youtube.com/watch?v=pl9GFyltpm8.

More elaborate microphone setups are also possible; I address them in the section on "Recording: audio" below. If you're using Zoom, you can change your audio devices easily, and use separate devices for audio input and output (click the chevron next to the mute button in the lower-left corner of the window to select options).

> **Note:** If you use noise-canceling headphones, note that the on some models the noise-canceling features interfere with mic, so that you sound muffled and indistinct. This can be remedied by deactivating the noise-canceling features.

Video calls: video and lighting

As an instructor, it is probably advisable to use video, if possible (the main exception being if many of your students lack access to high-speed internet). Again, there are **accessibility** considerations—it is easier for your students to understand what you say if they can see your mouth when you speak.

I found it best to simply use my laptop's **integrated webcam** for synchronous video (especially since the desktop Zoom app is more fully-featured than the mobile app). Besides, setting up an external webcam is complicated on Mac laptops. I explored various other options including virtual webcams, but decided they weren't worth the trouble.

Even if you're using your computer webcam, you might want something to raise its **height**. We usually look down at our laptop screens, but the usual advice is that the most pleasing angles are at eye height or a little higher (anyway, *closer* to eye height is better). Often a stack of books works to raise a laptop or monitor. A more stable option is a collapsible bed table ($25–40) on top of your desk (space permitting). Or you can place your computer on a bookshelf. If you've got tall shelves, you might even be able to stand. (You could also use a tripod; see "Recording: camera placement,"

p. 5). If you use an external webcam (i.e. not integrated into a laptop or monitor), try to place it above your monitor at a suitable height.

If you're not investing in a fancy camera, the main trick for improving video quality is to improve the **lighting**. Natural light is ideal, since it's bright, pleasing, and free. So record near an open window if possible, and try to ensure that your face is brighter than your background (e.g. try to face the window or other lighting, rather than having it behind you so that your face is dark by contrast). Specialized lighting equipment may be helpful, but tends to be expensive and bulky so there should be no need unless you don't have access to good daylight, are teaching at night, or you have such equipment anyway (e.g. for asynchronous lecture videos; see p. 6).

> **Note:** Depending on your setup, you might wish to incorporate more devices (e.g. external monitors, a smartphone, or a second laptop or desktop). See "Presentations on Zoom" (p. 8 below).

Recording: audio

If you are recording asynchronous lectures, or you don't require your students to speak on video calls, you may want a microphone that is not attached to headphones or earbuds. Again, if you're upgrading from a basic setup, audio is probably the most important consideration, to be prioritized before video or lighting.

I recommend an affordable **lavalier mic** (AKA a lapel mic). These mics tend to pick up sound well in a small area, so clip it onto your clothes, close to your face. A lavalier is easy to use if you move around or work in different configurations (sometimes standing, sitting, pacing, &c.). Many come with windscreens for use outside. There are both wired and wireless (e.g. Bluetooth) models.

Note: I used a BOYA BY-M1 wired lavalier mic ($20) for recorded lectures and often for synchronous classes on Zoom. It's got a 6m (20 ft.) audio cable, and requires no batteries if used with a computer or smartphone (for use with cameras that lack a powered audio input port, there is a coin cell battery). It comes with a foam windscreen and a pouch for storage. If you're using a mic with a phone and your phone doesn't have a 3.5 mm audio input, there are variants with different kinds of cables (e.g. Lightning, USB-C).

If you lecture from a desk, you might use a **stand microphone**, though matching for quality these are often more expensive than wired lavaliers (my brother's Fifine K669B was $40 with a 6 cm/.25 in. stand and no pop filter vs. my $20 lav). A *cardioid* microphone picks up sound best from the area around and above the diaphragm; a *shotgun* microphone picks up sound best from the area above the diaphragm, sometimes for a considerable distance (but inexpensive shotgun mics give the best quality sound from nearby).

Keep in mind you'll also need a **stand** on which to mount a microphone (some come with short stands; some require a stand to purchased separately). And also keep in mind when shopping that many microphones that are designed for use with cameras are not compatible with computers or smartphones. If you're speaking directly into the microphone, you may wish to use a **pop filter** that reduces distracting and unpleasant audio artifacts caused by fast moving air (e.g. from /p/ or /s/ sounds).

Note: A stand microphone can be convenient since there's no need to set it up and put it away for each use. But given the potential extra expense of stands and pop filters, an inexpensive lavalier may be the more economical option, even though it requires a little more fuss to put on and take off.

Recording: video and data

Just as with video calls, it's best to incorporate video of yourself into your lecture videos for accessibility reasons. Most students will find it helpful to see your face while you speak. So if possible, incorporate video of yourself into your lecture videos instead of simply recording a slide show with a voiceover.

Note: If visual materials are not essential to your lecture (e.g. you normally lecture without slides, or provide a paper handout for students to follow along), then it might make sense to provide an audio-only version of your lectures that is easier to distribute to students without good internet access. Even if that's you, though, it would be ideal to provide a video (even if it's a low-quality video only of your face) in addition to an audio-only version. You can then export an audiovisual version and an audio-only version of the lecture and give students a choice as to which version they review. This needn't be more labor-intensive than making an audio-only lecture; the main costs are (a) the data storage required to work with video, and (b) extra waiting time to export the video and upload it to a hosting service.

An integrated webcam is perfectly adequate for recording lectures, but it's possible to do better (with just a bit of extra work). Most of us already have expensive, high-quality video cameras integrated into our **phones**. The main limitation of using a phone camera is data storage. If you own an Android phone with removable storage, you can add or upgrade a micro SD card to get more storage. If your phone does not have expandable storage, and you cannot free up more than a half dozen GB per lecture, you can record at modest quality settings (e.g. less than 720p resolution or less than 30 frames per second) or in high-efficiency storage formats (e.g. HEVC).

You may also need local data storage on your computer (although Panopto allows you to record directly to the cloud; see ","). If you don't have around 10 GB or so free on your hard drive (ideally much more), you might think about working with an **external hard drive**. If you'll be storing video files on the external hard drive while you work on them (and not just for archiving), you may want a hard drive capable of fast read/write speeds.

> **Note:** I recorded lectures on my Android phone and saved videos to the micro SD card. When my laptop hard drive became full, I stored video files on a university-owned 500 GB drive rated for 540 MB/sec read/write speeds. That worked fine for me.

If you are interested in a **dedicated camera** that improves on what you can do with a smartphone from the last five years, you're probably looking at a major expense ($300–800). I wouldn't bother. But if you're shopping, keep in mind that not all good photography cameras are good for video. At the less expensive end, there are some **digital camcorders**, though for less than a few hundred dollars you won't likely get something better than your phone. Many modern **digital SLR cameras** take good video, but they're expensive and some struggle to record at 720p/30fps (which is probably the minimum quality you'd want). Many folks now favor **mirrorless cameras** over SLRs for video, but they're also expensive and since high-end mirrorless models are a newer trend, there is a less robust market for used devices.

> **Note:** And if you want to get really fancy, you could invest in a teleprompter or cloth backdrops. I did not look into these options, but you can find resources about these items online, many pitched at aspiring YouTubers.

Recording: camera placement

You might wish to invest in equipment to place your camera at the right **height**. I discussed laptop options above (p. 3), but a pile of books doesn't work so well for a phone.

The usual way to place an unheld camera is with a **tripod**. If you'll be standing, try to get a tripod that expands at least up to your height minus 15cm/6 in. The usual advice for tripods is that they're structurally weakest when fully extended, so you often want a tripod that can be raised higher than you need. But phones are lightweight so the extra height is probably unnecessary unless you intend the tripod for other uses (or you're concerned it might be knocked about by family members, roommates, or pets).

If you use a tripod, you'll need to be sure you can **mount** your camera device on it. Tripods usually feature a standard-sized screw mount (1/4"-20; i.e. .25 in. diameter, 20 threads per inch) that fits most cameras, but you'll need a special mount to attach a computer or phone to the tripod screw. Some tripods come with "universal" camera mounts that may not fit your phone (especially a very small or very large phone, especially a large phone in a case). There are also flat mounts for projectors or computers, if you'd like to put your computer on a tripod (make sure you tighten the tripod head well so your computer doesn't fall off!).

> **Note:** For lecture recording, I used a bookshelf at first and later two tripods: a 72 in. tripod for my phone ($40, by Ravelli), and a 60 in. tripod for my laptop ($35, by Torjim) so I could display my slides right under the camera. The shorter tripod came with a Bluetooth smartphone remote, which turned out to be handy. For my phone, I used an Ulanzi ST-03 smartphone mount ($20). For my laptop, I used a Neewer tray mount ($22) which was big enough for my 16 in. MacBook Pro.

NB: A tripod will generally have a screw mount, but other audiovisual equipment will often feature a "**cold shoe**" mount. This is a common, standard-sized slot mount. If you're mounting your phone on a ring light instead of a tripod, you may need a cold shoe mount instead of a 1/4"-20 screw mount.

Recording: lighting

The last crucial element for video-recording, after audio and video, is lighting. As with teleconferencing, the best option is usually natural sunlight (which is conveniently free). But if you (like me) are not able to do all your lecture recording during daylight hours, and you have the resources from your employer, you might invest in some lights. I would put lights below microphones and tripods in priority, but before a better-than-a-smartphone camera.

A **ring light** is an economical lighting option. Ring lights illuminate your face from various angles, and are favored by many beauty YouTubers. Some ring lights can be mounted on tripods, and some require lighting stands (which have differently-sized fittings—usually a 5/8"/16mm stud topped with a 3/8"-16 screw). A ring light might run anywhere from $35 to over $150, depending on the size, style of light, and whether it comes with a stand. But note that some ring light stands have integrated smart phone mounts (possibly for a cold shoe instead of a 1/4"-20 tripod screw), so you might not need a separate tripod.

Softbox lights are a more elaborate option. They're more versatile than a ring light and possibly better if you'd like more than your face in the frame, but often more expensive and bulkier. Florescent softbox lights will generally cost $50–200, depending on the details (e.g. the number of lights, the number of bulbs on each light, &c.). A standard professional setup involves three lights (two upright and one on a boom overhead), but you can get good results from one or two upright lights.

> **Note:** I used a set of three softbox lights by Fovitec ($190). They served me well, but they are bulky and cannot be set up/taken down easily. They also take a bit of arm strength to assemble. I left them up for the duration of the semester and was quite relieved after exams when I put them into storage and got my living room back. A ring light is probably better for most teaching applications, unless you have a dedicated room for recording and working (I do not).

Too long; didn't read

A laptop or desktop computer with an integrated webcam is perfectly good for most teaching needs, but it's easy to improve that setup inexpensively. **Audio** is most important—headphones (cheap ones will do) and an external microphone (integrated into the headphones is fine). The next step up, especially for recording lectures, is a better mic. I recommend a $20 lavalier mic. For **video**, it's hard to do better than a webcam for video calls or a smartphone for recording, but you should think about how to get your camera to eye height. Stacked books or bookshelves will do for computers, but for a phone you might want a tripod and a phone mount. For **lighting**, daylight is ideal but if you can't count on that then a ring light may be a relatively affordable and convenient option. If you're recording video, you also need to consider how you will store **data**.

Video calls

You may have all the equipment you need, but how do you put it to its best use? Here's what I've figured out so far, anyway.

Setting

You'll want to situate yourself in a space with few auditory distractions, good lighting (natural sunlight if you can swing it), and an acceptable backdrop (an office, clean background, something plain enough to cover with a virtual background, whatever).

Student audio/video

For teachers I recommend using headphones and an external microphone. This often gives better quality audio, and it eliminates the risk of distracting audio artifacts like the echo effect (p. 2). Also, if you've forgotten to turn off audio notifications on your computer, those notifications will play in your ears but not to your students.

Since **headphones** can be relatively inexpensive (many folks already have headphones with integrated mics) I give the same advice to my students. I don't require it, of course—a $20 expenditure is a big ask for some, and cheap earbuds don't work so well for everybody. I also recommend that students mute their audio by default for classes with more than ten students, to cut down on distractions, feedback, and audio artifacts.

I encourage my students to use **video** in discussion classes, but I don't require it. Students with slow internet may wish to connect via audio only, and I don't want a class to invade someone's private space if they're uncomfortable sharing their surroundings.

Gaze direction

Those of us who've been on the job market in the last few years have probably heard this before, but when you look at the people you're talking to on a video call it often appears strange from the other end. You appear to be looking down and away from the person you're talking to instead of at them. So although it feels unnatural, it can be effective to look into the camera rather than at the video feeds of the people you're talking to. Now, teaching is a lower-stakes activity than trying to get an academic job, so I don't think you need to maintain eye contact with the camera at all times. But I try to be mindful of the fact that habits from face-to-face interactions may need tweaking for video calls, and try to spend *some* time looking into the camera instead of at my screen.

Also, the easier way to address the gaze-direction disconnect is simply to position yourself farther from the camera—the difference in gaze-direction is less extreme and less noticeable at greater distances.

Attending to students on Zoom

Since many of my students used video, I preferred the "**Gallery**" view to the "Speaker" view in Zoom (toggle between these views using the button in the upper-right corner of the window). In the gallery view I could see most or all of my students at all times, which helped me to gauge their reactions and manage discussions more naturally. A yellow box appears around the speaker who would be visible in the speaker view, so it's not hard to track who's speaking.

I also used the "Participants" and "Chat" panels to monitor student feedback statuses (e.g. raised hand, go faster, go slower, &c.) and text discussion. These windows are more difficult to monitor in the

mobile app. The Zoom desktop app defaults to a full-screen mode, but I found it best to use it in a (large) window. In a window, you can click the "Participants" and "Chat" buttons to open panels on the side of the window, which don't obstruct your view of the participant gallery. By contrast, in the full-screen mode these windows hover over the gallery and will obstruct your view of some students.

Presentations on Zoom

For lecturing synchronously on Zoom, the usual way to share presentation materials (e.g. slides) is through the **share screen** feature. You can share a desktop (sharing everything on one monitor) or a window (sharing only what is visible in a window, e.g. a PowerPoint presentation or a document).

The default sharing settings are not effective for **sharing videos**, since your computer sound is not shared and the framerate is low. In order to share video, tick the checkboxes at the bottom of the dialogue window where you choose which desktop/window to share (optimize for video and/or share sound). But this may not work for students with poor internet connections.

One of my frustrations with Zoom presentations is that **sharing your screen reduces the number of visible participants** (no more than a handful at once). The problem is worse with PowerPoint and multiple monitors, since by default PowerPoint presentations display as two full-screen windows (the presentation and the presenter view), and the slides can only be advanced when these windows are on top (i.e. when the Zoom window is not visible).

One way to avoid this problem is to prevent PowerPoint slides from displaying full-screen. Do this by accessing the "Set Up Slide Show" options and selecting "Browsed by an individual

(window)." You can then share the PowerPoint window on Zoom, and leave it on top to advance the slides while leaving space on screen to see a full gallery of students.

> **Note:** I believed at first that this configuration disabled access to nonverbal feedback features (e.g. "raise hand") and chat, but I was mistaken. Both of these features can still be accessed from the screen share controls (on the top of the shared window, where your mute button winds up). The "Participants" and "Chat" buttons open floating windows, just as they do in full-screen Zoom without screen sharing. Thanks to @EkasNaomi for setting me straight.

I find it helpful to use a **second monitor**, but for sharing slides I need to fiddle with the window placement. I prevent the slideshow from displaying full-screen, which disables the presenter view. Then I keep my slides on the second screen and move the Zoom gallery window to my laptop monitor, so I'm facing the webcam when I look at my students. This way I can advance my slides without losing sight of my students.

The second monitor is also handy when students share their screens (e.g. during student presentations). By default, when other participants share their screens, the shared content appears on the second monitor. So for student presentations I can keep my usual gallery view of students on my laptop monitor and look away toward the shared content on a separate screen.

> **Note:** Students might find it helpful to use a secondary monitor if you're sharing your screen in order to show lecture slides *if* that's a feasible option for them. I never had a second monitor as a student, but most televisions these days can serve as external monitors, so it might be feasible for more students than you'd expect (especially students attending class from home).

Recording lectures

Again, you'll want to situate yourself in a space with few auditory distractions, good lighting (natural sunlight if you can swing it) and an acceptable backdrop. Silence your computer and phone notifications so they don't interrupt you.

Mic placement

There is an art to microphone placement that I do not possess. The **best placement for a mic** on a stand depends on various factors, e.g. the pickup pattern of the mic (cardioid vs. shotgun vs. omnidirectional, &c.) and its sensitivity. But since you'll probably be recording in a fairly consistent environment, my advice is to run some tests before recording your lecture footage for the first time, varying the placement of the mic.

> **Note:** If you're recording on your phone, then your phone speakers might not be the best indication of the sound quality. Try testing the mic in a few different positions and play the video back on headphones or computer speakers. Also be mindful of the unwanted noise (e.g. road noise, family members) that might interrupt your recording, even if it's not present during your tests.

If you use a **lavalier mic**, you may have to mindful of noise produced by your movements and clothing. Try to place the mic high on your chest, where it won't be jostled by your gesturing. Sometimes a lavalier records handling noise when the top portion of the wire is jostled. Again, the best way to learn the quirks of your microphone is through experience.

> **Note:** My BOYA BY-M1 lavalier has a small pickup attached by wire to a cylindrical unit with electronics and a clip, which in turn has a long wire that can be plugged into a phone or computer. I found the clip to be useless, and placed the cylindrical

unit in a pocket. It couldn't let it hang because it would record distracting handling noise if the wire between the microphone and the cylinder is jostled too much.

There is also some art to hiding microphones, but for homemade lecture videos I don't see the point.

Camera placement

You'll want to place the camera **near eye-height** if possible, and frame yourself well, excluding anything from the background that you don't want in view. A landscape-orientation is usually best for the final video (but if you plan to make your presentation materials the focus of your video, and place yourself in an inset in a corner, a portrait-orientation might be fine).

If you're using an integrated webcam, there is typically no zoom option so the main way to alter the field of view is through distance (or editing; see "Position and scale," p. 16). This is where having a tripod can be helpful (since it's easy to move). If you're indifferent about your background, you can move yourself instead of the camera.

> **Note:** If you're using a cell phone or other camera, note that there is a difference between "optical" and "digital zoom." An **optical zoom** adjusts the camera lens (changing the focal length), allowing the camera sensor to record a narrower scene with greater detail. Most phone cameras have very limited optical zoom (newer high-end phones have maybe two or three zoom settings). A **digital zoom**, by contrast, records a narrower scene by cropping the edge of the frame, so the resulting video has a lower resolution. So if you're pinching your camera app screen to change the edges of your frame, you're losing resolution. You might be fine with that (maybe it's easier than cropping the video

in post), but be aware. If you want smaller field of view in your frame without sacrificing image quality, and you don't have an optical zoom, you need to move the phone closer to yourself.

Importing footage

Recording and working with video can be complicated, so it's worth thinking through your whole process before you start. Many universities now subscribe to Panopto for their faculty to record videos. The name is creepy but it's a useful service—Panopto makes it (relatively) easy to package all your footage together, automatically synchronizing video of yourself, of your presentation materials, and your audio. It is an ideal tool for most faculty. However, at this time you cannot use Panopto to record with a phone camera (the mobile app is for viewing only, not recording).

So if you want to use a **camera** other than your computer webcam to make your videos, you have two options. (1) If you want to use the Panopto video editor and other tools, you can record a video with your phone or other camera while using Panopto to capture your presentation materials, then import your video to Panopto later using the web interface. (2) If you want to use a different video editor, you can save Panopto recordings of your presentation materials locally (i.e. on your computer), and then import those files into your video editor of choice along with video from your phone. When you're done editing, you can still use Panopto (or YouTube or whatever) as a hosting service by uploading the finished video (this is what I did).

Presentation materials

If you want to get slides or other presentation materials into your videos, you probably should not point a camera at a screen; the resulting video will usually be difficult to see and read.

Video capture (i.e. recording a screen) can be expensive and complex, but you can use Panopto to do it easily. Panopto includes a "Record PowerPoint" option that you can use to capture your slides while you record yourself. That option, however, generally gives a poor framerate. If you have animations and transitions in your slides, they might wind up looking choppy.

If you want to record your presentation materials more smoothly (or if you use software other than PowerPoint), there may be a better option. You can display your presentation materials on an **external monitor** (a television with HDMI or DisplayPort input works, too) and set Panopto to record that monitor as a video source.

Note that to get a smooth framerate, you may have to alter Panopto's quality settings (see note below). On Windows the quality settings appear in the main window; on a Mac, click the "Panopto" menu in the menu bar and select "Preferences."

Note: I displayed PowerPoint slides using an old television (max resolution: 720p) as an external monitor. I captured video using Panopto, with quality set to "Ultra (motion)," which has a resolution of 1280 x 720 (i.e. 720p) and a framerate of 30 fps. You may not be able to capture slides at 1080p/30 fps.

If you're capturing video and audio of yourself using a separate device (e.g. a phone camera), go ahead and record audio from your computer, too. You can use that audio track to **synchronize** the two videos later. Try clapping when both Panopto and your phone are recording. When you're using your editing software later, look at the audio waveforms for the two videos and align the peaks. Now your videos are synchronized, and you can delete the lower-quality audio. If you're managing all your streams in Panopto, the synchronization should be automatic.

Quality settings

Video quality is generally reckoned in three figures: **resolution** (how many pixels are in each frame), **framerate** (measured in frames per second or "fps"), and **bitrate** (how much data per second is encoded in the video, usually measured in bits per second). If you're concerned about students with slow internet, you want to keep the bitrate from being too high. The bitrate is affected by the resolution and the framerate but also by factors that come into play at the end of the video-making process (e.g. file compression; see "Exporting," p. 18). For recording, let's focus on resolution and framerate.

The ideal quality settings for recording depend on (1) what quality you want for the final video, and (2) how you'll manipulate the recordings.

For (1): I aimed for videos with a **resolution of 720p** (each frame is 1280 pixels wide and 720 pixels high) and a **framerate of 30 fps** (30 frames per second).

> **Note:** At a resolution of less than 720p, text on slides can be difficult to read. You might want a lower resolution (e.g. 800 x 600) if your videos don't include much text and your students have poor internet access. You could aim for higher resolution—1080p (1920 x 1080 pixels per frame) is the standard for high-quality YouTube videos, and if your videos are hosted on YouTube they'll automatically stream at lower resolutions for viewers with slower internet—but any higher than 1080p (e.g. 4K) is almost certainly a poor use of data storage space.

> **Note:** For framerate, 30 fps is a common standard for video that won't appear choppy to most viewers. Films usually have 24 frames per second, but streaming video services play nicer with increments of 30 or 60 fps. A framerate of 60 fps gets you that hyper-real HD daytime television look, but in my view it's not worth the higher bitrate.

For (2): You generally want to record at the **same quality as your target or higher**. If you'll be applying a digital zoom (in camera or in post), you want a higher resolution than your final quality target since you'll be discarding pixels at the edge of the frame. If you'll be shrinking the video so that it doesn't take up the full frame (e.g. footage of yourself that will be inset into a corner of the final video), then you can record at lower quality settings.

A final consideration is the **file format** of your recordings. Using a standard file format (like **.mp4**) gives you more flexibility in editing, but can produce bigger files. An alternative on some phone cameras is a **high efficiency video** format (HEVC) which will produce highly compressed videos. This results in a loss of information but that might not be a big deal if you don't move very quickly.

> **Note:** I aimed for a target resolution of 720p and a target framerate of 30fps for my finished videos. I recorded my slides at 720p/30fps using Panopto; higher quality settings were unnecessary since I wouldn't be zooming or manipulating the timing. I recorded video of myself on my phone camera at 1080p/30fps, in case I wanted to apply zoom effects while editing. I saved my footage in .mp4 format.

Lighting

If you're using **natural light** in your videos, the same rules apply here as for video calls (p. 3). Try to face the light, so that your face is well-illuminated. If you've got **artificial lighting** (p. 6), try to do likewise. But keep bright artificial lights out of the camera frame; having a bright light in the frame tends to make everything else look dark (like a backlit photo). And I recommend taking some brief test footage before you begin recording in earnest for the first time, just like with sound (p. 9).

Ring lights are designed to be placed around a camera lens (e.g. you might mount your phone in the center), but you can still use your computer with a ring light. It might not be possible to place your computer webcam inside the light while keeping the light out of frame, or just place them side-by-side for a more naturalistic effect, with the ring light raised around or above your eye height. If you know your good side, favor it with the light.

Lighting with **softboxes** is more complex. If you've got one softbox, use it like a ring light to illuminate your good side. If you have two, you can use the second one to fill in some shadows and create a less high-contrast look. Place it on your other side, but dimmer than the first light (or farther away from you). The third light (the "hair light") is typically mounted on a boom to illuminate the top of your head, which helps you to stand out from the background. Be sure to counterbalance the boom! For more advice on placing softbox lights, look up tutorials on "three-point lighting."

> **Note:** Since I recorded in the evenings, I used a set of three softbox lights. I balanced the boom with a canvas bag full of books. But for most others who can't shoot during the day, I'd recommend a ring light instead of softboxes.

Shooting footage

Acquiring equipment and learning to use it requires up-front investments of time and money (and a longer-term use of space) that is manageable for some faculty. But very few faculty can afford large, ongoing investments of *time*. And editing video can be very time-consuming. To reduce the amount of time you spend on editing, I recommend taking care during recording to minimize the need for edits. E.g. don't do multiple takes of each section of your lecture. Minimize pauses and interruptions. And keep in mind that students will likely speed through your videos.

> **Note:** I generally took multiple takes for opening lines and closing lines, but for everything in between I tried to simply press on without fuss. An ideal recording session would involve a few takes for opening and closing remarks, flanking an uninterrupted flow of lecturing with no pauses, breaks, or verbal disfluencies. I was never close to achieving this to my own satisfaction, but I recommend you set your standards lower than I did.

If you foolishly plan to edit your footage significantly, you might think about developing a simple system for **slating**. You know how on movie sets a take will start with someone holding a black and white slate or clapperboard? That can be useful in editing for a lot of reasons, but for lecture videos it helps when you're trying to determine quickly where a take begins or ends without having to repeatedly watch your own footage. Especially for a lecture video where the footage all looks quite similar. The system can be simple, like holding up fingers (first take, second take), or a thumbs-up (this is the end of a good take). Anything that's visual and easy to spot in a video editor.

Alternatively, if you edit by focusing on the soundtrack waveform instead of focusing on visuals, you might use sound to slate your takes. Silence punctuated by a clap makes a pretty distinctive-looking waveform, so you can clap (once for a bad take, twice for a good one?) to make notes for yourself later.

> **Note:** I used raised fingers and silence to mark the beginnings of takes, when absolutely necessary. And just after starting my recording, I would clap a few times so that I could easily synchronize my presentation materials with my footage of myself.

Editing and publishing video

So now you've recorded some video. In order to get it to your students, you need to upload the finished video to some hosting service (e.g. Panopto, YouTube) and distribute the link. And before you do that, you may want to do some editing. Again, I would caution restraint here—editing video can be a very time-consuming process, and editing too much was my own greatest error. But if you're determined to do it anyway, or if you're a faculty person making a short video rather than a lecture and you'd like to incorporate some significant editing, then maybe you'll find some of the following starter tips helpful.

Using Panopto

If you have access to Panopto, it includes a simple web-based video editor that's **adequate for most uses**. The editor is easy and intuitive and allows you to work simultaneously in two streams (e.g. one for slides and one for lecture footage). Basically, you can highlight portions of the video to exclude them from playing. This is particularly helpful for cutting out the beginning and end of your footage (so the final video can start with the beginning of your lecture rather than with footage of you clicking the "Record" button). You can also cut out other bits of the video, if you are interrupted during recording or flub a sentence. And you can cut out a secondary stream while the primary stream continues to play (more on streams below).
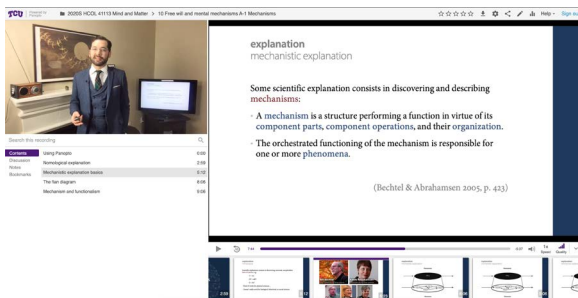

Figure 1: Two streams in the Panopto web viewer.

But the editor also has many **limitations**. You can't rearrange clips (you can't take a later bit of the recording and insert it earlier in the video). You can't alter the built-in transitions (they all appear like jump cuts in the editor but are rendered as quick cross-fades in the processed video). And if you make a lot of edits, the editor becomes slow and difficult to use. This can be a problem if you're adding chapter breaks or captions later.

> **Note:** I tried the Panopto editor but I made a lot of cuts. As a result, every caption I edited caused the interface to crash for a few seconds. But if you don't make a lot of cuts in the editor (and I recommend you don't), this shouldn't be a problem for you.

Publishing on Panopto

Even if you don't use the Panopto editor, you can publish your videos on Panopto, which has a lot of virtues as a publishing platform. You can limit the visibility of your videos to people at your institution. You can avoid YouTube's overly aggressive copyright-monitoring (so you can use music and video clips in your lectures that might get a YouTube video taken down). And there are a number of other features.

You can add **chapter** markers to make your videos easier to navigate for your students (they also have the advantage of revealing the organizational structure of your lectures in a way that students find easy to understand). You can also embed online quizzes, links, and other activities into your lectures using the chapter breaks.

And you can add **captions**, which appear as scrolling text (not subtitles) alongside the video when it's viewed on the Panopto website. I try to include captions in all my video materials to make them more accessible. The caption functionality

isn't great—but since you can import machine-created captions it's relatively easy and effective. The machine captions were mostly good, but weren't great at identifying my sentence breaks properly (and you'll probably have to spell-check it, especially for jargon). But I saved a lot of time by relying on machine captions as a first draft. You may have less luck depending on your accent.
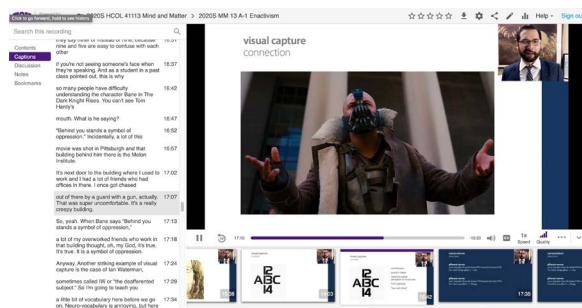

Figure 2: Captions in Panopto.

Another nice feature of the Panopto platform is that it allows viewers to change the **playback speed**, like YouTube does So your students can watch videos at various speeds from 0.5x–2x. I encouraged my students to watch on faster speeds if they found it helpful (2x is generally too fast for most people, but speeds between 1x and 2x are usually fine since most folks can understand speech faster than lecturers produce it).

You can track **viewership figures**, too, as long as you distribute the video link through your LMS, so that you know which students have watched and how much they've watched (maybe that's what earns Panopto its creepy name?).

And Panopto videos can incorporate multiple **video streams**—e.g. one for your slides and one for footage of yourself. One stream is designated as the primary stream, and you can't make cuts to it in the video editor without also cutting the secondary streams. The streams allow your students extra flexibility in viewing your videos. If

your video is embedded on a website (e.g. in your LMS) then one stream will take up most of the frame, while another stream will occupy an inset in a corner. But viewed on the Panopto website, students can view the streams separately (so e.g. text on a slide isn't obstructed by your face), and switch their positions (choosing which stream is the big one, or going back and forth).

Managing streams on Panopto

As an advanced technique, you can edit your video content in an editor of your choice and upload video files to Panopto as streams. You can designate separate start times for each stream (this helps to ensure that your streams are synchronized the way you like). Importing a video stream does not affect Panopto's ability to make machine captions.

> **Note:** This option involves some extra technical complexity, though. If you edit your streams separately, you need to ensure that they are fully synchronized *before* uploading them, since you can't alter the timing in the Panopto video editor (except to alter the start times). The best way to do this is probably to work with two video channels in an editor like Adobe Premiere Pro, and then export two videos from the same project file.

Editing with Adobe Premiere Pro

If you don't have access to Panopto or you're not satisfied with the editing options, you can use other software like iMovie or Adobe Premiere Pro. I have access to Premiere through my university, so that's what I used and my remaining advice focuses on it.

The main **advantage** of working with a program like Premiere is that it's extremely powerful—it can do just about anything you'd need, except some advanced graphics work (but if your graphics are taken care of by your existing presentation materials (PowerPoint slides, &c.) then that's a

non-issue). As a **disadvantage**, the learning curve is extremely steep. There are a lot of free tutorials online if you're willing to learn, but it can be very frustrating if you don't have an independent interest in video production. And Premiere is expensive if you don't have access through your institution.

I include some tips below. They don't substitute for a proper tutorial, but they include some basics and can give you an idea of what you can do with a program like Premiere, and what terms to search for if you want to learn more.

Starting a new project

Create a new project, then before you do anything else create a **new sequence** (in the project panel in the lower-left, click the "new" icon and select "Sequence…"). Note that selecting different tabs at the top of the window (e.g. Editing, Color, Effects, Audio) gives you different arrangements of panels or "workspaces." The sequence will contain information about the output quality for your video, and about the edits you make. You may find a preset sequence type that suits you but it might be easiest to create a custom sequence.
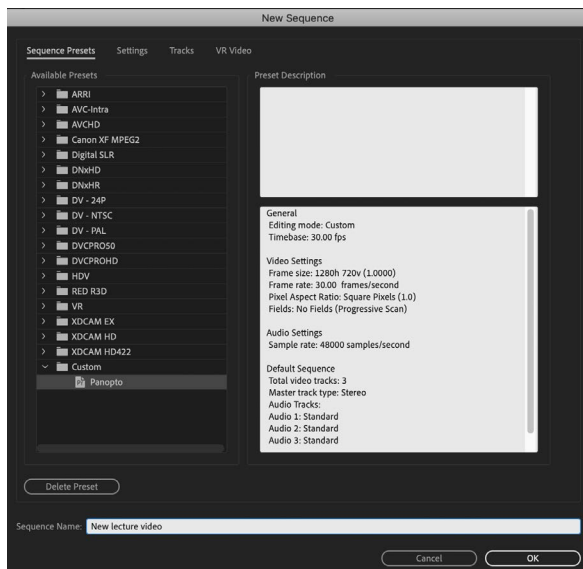

Figure 3: Example sequence presets in Adobe Premiere Pro.

Note: I created a custom sequence preset that I could use in all my lecture videos. My presets are pictured in Figure 3. And a pro-tip: whatever you name your sequence will be the default filename when you export your video.

You can also add media files to the project panel: video files of your lecture and presentation materials, other clips to insert into your lecture, music files, images, &c. Then you'll drag these media files from the project panel to the timeline (just right of the project panel in most views) to arrange them in your sequence. You can arrange clips sequentially or concurrently (you'll have multiple video channels, where higher channels occlude lower ones, and multiple audio channels).

Cuts

Again, I must stress that for normal lecture videos you should strive to make as few cuts as possible, in order to save your time for other endeavors. But the basics are thus. You can use the *select* tool (shortcut: v) to trim a clip—alter the starting point or ending point—by dragging the handles at either end. If you want to use part of a clip in one place and another part in another place, you can cut it using the *cut* tool (shortcut: c; imagine you're working with physical film?). The clip is divided into two at the point where you click with your cursor. You can then move the resulting clips independently. And unlike with physical film, you can extend them past the point of the cut—so like a worm in the urban myth, you can cut a clip into two parts, and grow each of them back into the original clip (although it's easier to copy and paste).

If you're frequently cutting out pauses and gaps, you should familiarize yourself with the **ripple edit** tool (shortcut: b). This tool allows you to trim a clip, just like the *select* tool, but preserves the distance between adjacent clips. So if you cut a clip where you'd like to remove a pause, then trim

the resulting edges using the ripple edit tool, there will be no gap leftover around the cut.

You can apply video and audio effects to clips (see below: "Position and scale," "Improving your sound in post," "Improving your video in post"), but it's not easy to simultaneously apply effects to multiple clips. If you're cutting a clip, but want the same effects applied to all the resulting parts, it's easiest to apply the effects *first* and cut later. Failing that, though, you can copy a clip (the usual shortcut: Ctrl+c on Windows or ⌘+c on MacOS), then right-click or Ctrl+click on another clip and select "Paste attributes…" This allows you to copy and paste effects (you get a window where you can select which ones) onto clips one at a time.

Position and scale

You can alter your clips with effects, and I'll cover just some basics here. First, you can alter the size and position of clips (especially important if your source media files do not have the same resolution as your sequence). Find the "Effect controls" window (usually in a tab in the top-left panel). Under *Motion* effects, you can alter the **position** of the clip in the sequence frame (i.e. move it left, right, up, or down) and its **scale** (i.e. make it bigger or smaller/zoom in and out). So if, like me, you sometimes record at a higher resolution than you want in your final video, you can make adjustments here so that you achieve your desired framing.

These are also the tools you can use to create an inset (as in Figure 4). Place your slides and your lecture footage (or whatever) concurrently in the timeline, so that the clip you want inset is on a higher channel (e.g. V2 is higher than V1). Then adjust the scale and position of the higher clip until you achieve the desired effect.

grammar

Rules for combining sounds, words, and phrases in a language or lect.

Ex. Declarative main clauses in English typically have a subject-verb-object word order.

verb   subject   object

Maraíonn an portán a naimhde.

slaughters   the crab   his enemies.

Figure 4: Screenshot of a lecture video with slides and inset.

Note: As a more advanced variant of this technique, you can alter the frame of the inset by using a clipping mask. I did this to reduce the horizontal dimensions of my inset so that it would obstruct my slides less. Below the Motion effect controls are controls for *Opacity* effects. Select your inset clip and then click on a shape for the mask (ellipse, quadrilateral, or draw your own using the pen tool). You can adjust the edges of the mask by clicking and dragging the vertices in the program monitor (upper-right panel), but beware they're fiddly. These vertices will move and scale along with the clip.

If you won't be fiddling with the inset configuration (e.g. by reversing which clip is inset) but you will be making a lot of cuts, you can save some time by **nesting** your clips. Select all the clips you want nested (i.e. your background and your inset clips), then right-click them in the timeline and select "Nest…" This replaces the clips in your timeline with a new clip (actually a subsequence, which you can edit by clicking on it in the project panel in the lower-left) that takes up only one video and one audio channel in the main sequence. You can edit the nest clip in the timeline (by trimming, cutting, applying effects, &c.) all at once instead of editing each clip separately.

Improving your sound in post

You can use audio effects on your clips to improve the clarity of your speech and reduce unwanted noise (e.g. background noise). The easiest way to do this is to select the audio of your clip and

apply a preset to it. Click the "Audio" tab at the top of the window, then in the "Essential Sound" panel (far right) click "Dialogue." You can apply further presets at the top of the panel (I applied the "Balanced Male Voice" preset. There's also a "Balanced Female Voice" preset but unfortunately no preset for voices with intermediate pitches). Like other effects, it's easiest to apply this effect *before* making any cuts.

Depending on your tolerance for fuss, you can apply other audio effects. The DeNoise effect can improve the clarity of your voice and is easy to use.

> **Note:** I generally applied three audio effects in my videos: DeNoise, the Parametric Equalizer, and Dynamics.[4] But if you make cuts, you might find (like I did) that your voice sounds muffled at the start of each clip. I fixed this problem by creating a "Submix" channel for my vocals. Right-click or Ctrl+click one of the audio channels in the timeline (near the microphone-shaped icon), and select "Add Audio Submix Track." Then, in the Audio workspace, find the Audio Track Mixer. At the top of each channel column there is a dropdown menu for the track output (where audio from the channel is sent). I kept all my vocal audio in the A1 channel, so I sent the audio from that channel into the submix I created (then the submix sends to the master, so the modified audio appears in the final video). Then you can click the arrows at the left of the panel to reveal a column of slots for each track, and each slot can hold an audio effect. I applied all my effects to the submix instead of to the clips, and my muffling problem was resolved. Note that the Dialogue presets must be applied to each clip individually, and cannot be applied to the audio channels (either to e.g. A1 or to a submix).

Improving your video in post

I didn't fiddle much with video effects, but I did apply **color correction** to my lecture footage. If you're familiar with the "Edit" mode on Instagram (which allows more fine-grained control than filters), this is similar. You can find plenty of tutorials online[5] (but note that *color correction* and *color grading* are different, and you're probably after the former).

Music

I decided to include music in my lecture videos, since I heard somewhere that background music makes lecture content easier to process. Maybe it's something you don't want to spend time on. It takes time up-front to find suitable music, and (depending on how fussy you want to be) it takes some extra time to add music in each video.

I downloaded music that was free to use, typically through a CC-BY license. There are a variety of **Creative Commons** (CC) licenses that allow the free use of CC-licensed media under various conditions. A CC-BY license requires that you credit the original creator, but other CC licenses may not be appropriate for lecture videos. A CC-SA license requires that you "share-alike," and if your lecture videos are not publicly available you may violate the terms of the license. According to some, you cannot use CC-NC (non-commercial) licensed media if you're paid to make your videos. I'm no copyright expert, so I stuck to CC-BY licensed music and credited songs and artists at the end of each video (including a link to the creator's website or a public archive).

I trawled a number of databases, especially the Free Music Archive (freemusicarchive.org) and

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[4]   Instructions for using these effects can be found here: Russell, Mike. (2019, Mar. 4). "How to Make Dialogue Sound Better in Premiere Pro. Mike Russell (YouTube). https://www.youtube.com/watch?v=cSceBAQkwSo.

[5]   E.g. Erickson, Elijah. (2018, Dec. 29). "How to Color Correct in Premiere Pro CC 2019 (Lumetri Color)." Tech Infusion (YouTube). https://www.youtube.com/watch?v=tq--m515d8M.

Kevin MacLeod's music (incompetech.com). I was attracted to music by Blue Dot Sessions, Chad Crouch, Kevin MacLeod, and Podington Bear (who are featured frequently in podcasts), but your mileage may vary. There is also free music available for download at the YouTube Audio Library (youtube.com/audiolibrary/music) and by Bensound (bensound.com), which tends to be poppier/more corporate.

> **Note:** When inserting background music into Premiere, I applied more audio presets. I selected the clip in the timeline and, in the Audio workspace, in the "Essential Sound" panel, I tagged the clip as Music and applied the "Balanced Background Music" preset. This does a number of things, including reducing the gain (volume) of the clip. And if you tag music as Music and vocals as Dialogue, a number of other options become available (e.g. Premiere can automatically duck the music against the vocals, reducing the gain of the music when there is concurrent speaking and raising the gain of the music if there's no speaking).

I would typically reduce the audio gain (volume) of music. Right-click or Ctrl+click the clip and select "Audio Gain…" or, for quicker tweaks, you can grab the horizontal line in the center of the clip in the timeline and drag it up or down. You can also use this line to "animate" sound clips, e.g. for different gains at different times or for fading in or out. Add a key frame at the playhead by clicking the squat, hexagon-shaped icon (under the S) at the left end of the audio channel (you may need to expand the channel by clicking on the bottom and dragging down to make the icons visible). You can then raise or lower the gain of different key frames independently.

> **Note:** If you're particularly enterprising, you can create title music. I recommend grabbing a short music clip, *no longer than about five seconds*. You

can trim the clip using a variety of audio-editing programs. If the end isn't clean, you can make it sound a little more polished by adding a reverb effect.[6]

Exporting

When you've finished editing your video, you can export it. This process uses the sequence you've been building in your project file and draws on the media clips you've used (so don't move your source files until this is done!) to create a new media file, e.g. an .mp4 video. The process takes a while, so be prepared to wait.

So when you're ready, click the File menu in the menu bar and select Export > Media…, or type Ctrl+M or ⌘+M. You'll find a variety of options to select, but if you set up your sequence correctly at the beginning ("Starting a new project," p. 15) then most of these will be correct for you already.

The main trick for exporting a video file for upload to a streaming service (like Panopto) is to **use a highly compressed coding format**. This minimizes the bitrate of your video (see p. 11), which will make it easier for your students to view it. Furthermore, services like Panopto and YouTube will probably compress it further, and in my experience less damage is done to the file if it's already highly compressed when you upload it. So in the export window, find the Format dropdown menu and select H.264 or HEVC (H.265).

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[6]   E.g. Russell, Mike. (2013, Jul. 26). "How To Stop A Music Track With Reverb In Adobe Audition CC." Mike Russell (YouTube). https://www.youtube.com/watch?v=qh5OYS1hPW0.