LIGHTS, CAMERA, ACTION! RECORDING CLASSROOM LECTURES – A SIMPLE AND AFFORDABLE APPROACH

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Abstract
While the demand for online courses has increased, many students also still want to be educated in a traditional face-to-face environment. Lecture capture offers a way for faculty to teach a class both face-to-face and online simultaneously, making the course accessible to both types of students. By using a camera to record the instructor and the whiteboard along with a screen capture and video editing program such as Camtasia 2000 or OBS Studio, instructors can record their in-person lectures and create high-quality videos that can be posted online. These videos can be used by students who are taking the course in an online format or who were unable to attend class as well as by students who attended the in-person lecture and would like to use the lecture video as a study aid. This paper describes a comparatively low-cost method for recording, editing, and producing online content using lecture capture. The features of two video recording software packages, Camtasia and OBS Studio, are compared, and step-by-step instructions are provided for using both software packages to record classroom lectures.

Keywords: lecture capture, low enrollment courses, student progression

JEL Classification: A20, A22, A23

Introduction

As colleges and universities attempted to return to "normal" operations after the COVID pandemic, it quickly became clear that the educational landscape had changed drastically. Enrollments in higher education institutions did not recover from the pandemic the way many educators had hoped they would. Between fall 2019 and fall 2022, college enrollments decreased by about 1.11 million (National Student Clearinghouse Research Center, 2023). Although enrollments appeared to have stabilized in fall 2022 as the pandemic's impact diminished, the problems for higher education are only expected to get worse in the next few years. In 2026 we are scheduled to reach what is referred to as the enrollment or demographic cliff that is expected to reduce the number of college-age students by at least 15%. This decline is the result of the decline in birth rates since the 2008 recession (Grawe, 2017).

In addition to declining enrollments, another issue facing higher education is a change in student preferences regarding how they want to be educated. As students returned to college following the pandemic, some were enthusiastic about resuming face-to-face courses, but other students found that they preferred the flexibility of online learning. As a result, colleges and universities are seeing an increase in demand for online and hybrid course options. Prior to the pandemic, the number of students enrolled in online classes had already been growing. By fall

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2016, more than 30% of students were taking at least one class online (Seaman et al., 2018). The pandemic appears to have accelerated the demand for online classes. A recent report from Educause (Robert, 2022) compares student modality preferences in early 2020 (before the pandemic) with those in 2022. This research found that in the 2020 survey, 65% of students said that they preferred to take their classes either completely or mostly face-to-face. By 2022 this percentage had declined to only 41%. On the other hand, the percentage of students who preferred their classes to be either mostly or completely online rose from 9% in early 2020 to 29% in 2022. The percentage of students who preferred their classes to be relatively evenly split between face-to-face and online remained fairly constant (20% in 2020 compared to 18% in 2022). These survey results suggest that in order to attract students in the future, universities are going to need to have a robust mix of online and face-to-face options for students to choose from.

Prior to the pandemic, introductory classes in a subject area, especially those taught for the core curriculum, often had multiple online sections taught every semester. These courses have relatively high demand which made them a priority in the development of more flexible options for students, including fully online. However, upper-division classes that may only be taught once per year (or possibly every other year), which may involve considerable online development costs, or have few occasions to re-use the materials, were much less likely to be offered online prior to the pandemic. In the face of declining enrollments and increased demand for online courses, it is becoming necessary to offer these small upper-level courses in both a face-to-face and an online format in order to meet the needs of students and support their progression towards graduation. However, offering multiple modalities for these small upper-level classes can be a challenge.

It is within the context of these relatively difficult, low-frequency courses that we propose a comparatively low-cost method for recording, editing, and producing online content. The aim is to provide a relatively painless lecture capture option for faculty who may have little experience with video production or who have little immediate support available to quickly develop an online section. We assume the reader possesses only a basic understanding of video/sound equipment setup. We also assume the reader is trying to accomplish this with a minimum out-of-pocket cost or budget and will present both low-cost and free options when they are available. The aim is to provide both a shopping list/checklist of items to obtain and guidance on how to effectively use scarce faculty, classroom, and/or personal resources to produce relatively high-quality, engaging content that can be used to supplement or replace face-to-face classes. Additionally, the same methods could be used to build class lectures in an entirely online environment from the outset.

Benefits of Lecture Capture

Recording classroom lectures is not a new technique for higher education. Universities first began recording lectures in the 1950s to create televised classes. Over time, the development of the internet along with better recording technologies increased the use of lecture capture at universities (Cilesiz, 2015). During the pandemic, the use of lecture capture grew rapidly, and the technique remains popular even as face-to-face classes have resumed as a way to make education more accessible (Koenig, 2021).

There are multiple benefits related to recording live lectures rather than simply relying on narrated PowerPoint slides for online lectures. First, it allows students to revisit lectures in which they may have actively participated. This allows the student to revisit conversations about a

classroom topic to reinforce or clarify their knowledge of that subject. It also is useful in preparing for exams or assignments. Often faculty members stress areas of importance during classroom lectures, while narrated slides may not. A classroom lecture may also provide useful feedback to both the student and the professor regarding topics that may need to be reinforced. A recorded lecture provides both the students and faculty members an opportunity to be more prepared for exams. Additionally, recorded lectures add flexibility to the curriculum, allowing students to learn at their own pace and on their own schedule.

A recent review of the literature on the use of lecture capture in business education found that student attitudes toward lecture capture are generally positive, with students valuing, among other things, the convenience of recorded lectures as well as finding them helpful in understanding the course content and preparing for exams. This review also found that the research indicates that students performed as well or better in courses where lecture capture was used relative to traditional in-person classes (Ling & Knight, 2023). Another recent review of the literature on lecture capture that included all academic areas found that the top three benefits of lecture capture in the 71 studies they reviewed were that it aids in student learning and/or revision, it enhances students' performance in the course, and it improves students' work-life balance (Banerjee, 2021).

Most of the research on lecture capture has focused on its use as a supplement to face-to-face classes. However, one recent study (Artz et al., 2022) used an experimental design to compare the performance of students in an introductory microeconomics course who were randomly assigned to attend face-to-face lectures to students who were randomly assigned to watch recorded lectures, and then both groups were given a quiz over the material. The two groups were then flipped, and the experiment was repeated. The results of this experiment suggest that the impact of being assigned to watch recorded videos varies by the difficulty of the material. On comparatively easier material, students in the recorded video group experienced a small but significant decline in quiz scores. However, on a more difficult topic, being assigned to watch a recorded lecture resulted in a small but significant increase in quiz scores. The improvement in performance on the more difficult material was larger for men, students with lower GPAs, and students who expressed a preference for online lectures. The authors hypothesize that the increase in performance on the more difficult material came from the ability of students to use the videos to help them study. Although the results of this research were mixed, they do suggest that lecture capture can have a positive impact on student performance.

As the demand for online courses increases, lecture capture offers a way to teach a class both online and face-to-face simultaneously. The forced move to online learning during the pandemic increased students' familiarity with the online environment, and it seems likely that the demand for online courses will remain high in the future. Online learning offers students flexibility in obtaining their education, and recent research suggests that online courses can help colleges meet their student progression goals by potentially shortening the time to graduation and improving four-year graduation rates (Fischer et al., 2022). As described earlier, demand for online courses has been growing while overall enrollment in colleges and universities has been declining, and further declines are expected beginning in 2026 when we reach the enrollment cliff. With fewer total students, it can be difficult to fill both face-to-face and online sections of small enrollment courses. Using lecture capture to teach a course face-to-face and online simultaneously allows universities to efficiently meet the needs of both in-person and online learners with the same class and can aid students in progressing towards graduation.

The lecture capture process outlined in this paper is accomplished using commodity video and audio equipment, along with free or easily accessible and reasonably priced video editing software (OBS Studio and Camtasia, respectively). It is assumed that all setup and lecture recording is carried out by the faculty member alone, and no additional assistance is required.

Hardware Options

There are a variety of hardware options and configurations available for recording lectures; however, we focus on those that are both portable and easily assembled and disassembled. To speed up the production process post-recording, we installed Camtasia 2020 (the video recording software we used) on our classroom instructor's computer. This step saves the time required to import recordings into editing software and allows us to capture both the lecture's computer screen directly (i.e., the slides in full resolution) and the video/audio from the lecture as separate tracks into a single project file from the outset. Camtasia also automatically provides an array of production features that add value to the recording, the ability to edit video and sound, and access to templates used for introductions, credits, transitions, callouts, scrolling texts, and more. Furthermore, the time required to learn Camtasia's basic features, those required to accomplish outcomes achieved in this work, is very short.

A typical lecture in a college classroom consists of a professor, a slide presentation, and a whiteboard. Often the focus of the presentation periodically shifts between the slides, the whiteboard, and the professor. For this reason, it is important for each to be recorded clearly and with minimal intrusion of the recording process into the classroom setting in order to allow the student to follow along with the natural flow of the class as if he/she were there. There are different methods that can be used but to varying degrees of effectiveness.

Recording with a Stationary Camera from the Back of the Room:

This method has the advantage of capturing the board, slides, and professor in a single video, reducing the complexity of the process. If the camera is of sufficient quality, the image of the slides and written material on the board may be clearly visible, but camera picture resolution is key. Higher quality, such as 1080p or better, is likely a necessary option and will allow for digital enlargement of portions of the recording that can be used in video production to shift the viewer's focus from board to slides or from slides to professor. Sound quality will depend on the quality of the input device. A wireless lapel mic is preferred to any stationary USB mic or an internal computer mic, as the quality of a lapel mic does not depend on the relative location of the instructor in the classroom, as long as the signal is sufficient. However, the signal of a wireless lapel mic may be subject to interference and/or battery failure, where wired mics are not.

A major disadvantage to recording from the back of the room is that it may inadvertently and potentially without permission capture images of students in the process. A second disadvantage relates to the distance from the subject. As the distance to the board, slides, or presenter increases, the quality of the video declines. The same is true for voice recording if sound is captured through the camera or a classroom microphone. Furthermore, whiteboards are often subject to glare, and some marker colors make for very difficult note-taking. Regardless of method, thought must be given to marker color and the camera's focal location to minimize these issues. There is an inherent tradeoff between the quality of equipment required and distance to the subject. To record from a greater distance with sufficient video quality, one likely must incur the cost of a higher-priced camera.

Recording with a Stationary Camera from the Front of the Room:

This method has the advantage of being close to the action, and thus the closest view of the board, slides, and the professor, which also produces the highest quality video recording possible for any given equipment combination. Even with commodity video equipment, such as a standard external webcam or with one built into a laptop, one can capture adequate quality video. Sound recording from a device placed at the front of the room is also more likely to produce good results as long as the instructor's movement is kept to a minimum. Furthermore, it is less likely that a student would be inadvertently recorded as part of the video; however, the potential for voice recordings of student interactions would remain. Depending on school policy, steps may be required to inform students or obtain consent from students who are inadvertently recorded in the process.

The disadvantage of recording video and audio from the front of the room is that it diminishes the available work area for the instructor. A camera placed near the board will have a diminished field of view and may not be able to capture the full board, the projector screen, and the instructor at the same time; however, the parts that are captured would be higher quality. Nevertheless, if the instructor's equipment budget is severely limited, this may be the best or only sufficient option available. A useful suggestion involves 1) setting up the camera to cover a specific portion of the board that the instructor plans to use most and 2) marking the floor with masking tape to indicate the range of the camera's coverage.

The hardware combination we used is based on hardware we had on hand; however, readers could use similar equipment that may be available to them.

Our equipment combination consists of:

1) a Logitech C930 HD 1080p USB webcam with a USB extension cable (6-foot+),
2) a SAMSON Stage PXD1 lapel microphone (with USB receiver), and
3) a classroom presentation computer with Camtasia 2020 installed on it.
4) A nice option to include is a 4-port USB hub, allowing for quick plugging and unplugging of all devices at once.

With this combination, an instructor (without added assistance) can set up, record, and pack up, without adding more than an extra couple of minutes at the beginning and end of the class. Furthermore, the equipment can easily be transported/stored in a single tote bag.

In terms of equipment, the choice of camera is the most crucial. Camera resolution is a critical feature because of its impact on video quality. Our camera had a 1080p resolution at 30 frames per second, and we felt the video quality was very good. The actual cameras on the market will change over time, but based on a review of the best cameras for videoing lectures, some other features that can be useful in a camera include autofocus and image stability. If there are concerns about the lighting in the room, a built-in ring light or a camera with light correction may be useful (Science and Literacy). If your budget allows, you might also want to consider a camera with an auto-tracking feature that would follow the speaker as they move around the classroom. Appendix D outlines the cost of the recommended hardware in summer 2023.

Video Editing Software Options:

There are many advantages of using a screen capture and video editing software like Camtasia 2000 or OBS Studio. One advantage is that the software allows you to record both the classroom and the computer screen at the same time. Since the computer screen is recorded, there is no need to film the classroom screen with the PowerPoint slides, so the camera can be set up in the front of the classroom focused on the smaller area with the lecturer and the whiteboard. This approach provides a very clear recording of the whiteboard. Having recordings of both the computer screen and the classroom gives you the ability to enlarge the recording of the computer screen when the focus of the lecture is on PowerPoints or you are showing a video and then to enlarge the classroom recording when the lecture needs to focus on solving a math problem or drawing a graph on the whiteboard. This approach allows you to record lectures with high-quality video of both the PowerPoint slides and the whiteboard.

Both Camtasia and OBS have their respective strengths and weaknesses in creating classroom recordings; however, Camtasia provides a more comprehensive video/audio package for those users who create, edit, and produce standard instructional videos. A significant benefit of Camtasia is that it records in tracks, allowing the user to separate the different components of the video for easy editing. As demonstrated in the section Changing Students' Focus, the user can resize the different visual components to move the focus from the presenter to the PowerPoint presentation before rendering the video for final distribution. The main strength of Camtasia is that most (if not all) of your creation and editing needs can be met in one package if the aim is to produce videos using one camera, one microphone, and a PowerPoint presentation. Camtasia is moderately-priced, and with some practice, one can quickly become proficient at producing quality videos.

OBS provides some editing capabilities, but this isn't its forte. OBS is geared toward those users with more technical experience, who need the ability to create more complex scenes, who need to transition between different scene layouts, who are extremely budget-minded, and who have access to and are willing to work with a separate editing software package. Although Camtasia and OBS can perform many of the same tasks, in the editing phase of video production, Camtasia has a significant advantage.

As indicated, an advantage of OBS is that it allows for multiple simultaneous video and audio inputs. For example, it is possible to have (many) more than one camera, more than one microphone, and/or more than one window in a scene, all being recorded simultaneously. Although recording from multiple inputs may tax computer resources and become confusing to

the presenter, it allows for much more scene customization. It also allows the user the ability to create multiple scenes and transition between them in real time. These features are most important for streaming but may be useful in recording as well. For example, a science instructor may want to record video of both the instructor and an ongoing experiment using two separate webcams and microphones. This simply isn't possible with Camtasia. However, the addition of inputs in OBS is straightforward.

OBS is also capable of transitioning between different pre-created scenes. When presenting information from a PowerPoint, the instructor may want to shift focus from herself to the presentation and back again by resizing and repositioning the webcam video (smaller) and the PowerPoint (larger). In Camtasia, this may be accomplished after the recording completes but before the video is rendered for distribution. In OBS, the user would need to create two separate scenes and assign each one "hot keys" to trigger the transition. A keystroke can then be used to smoothly shift focus to the PowerPoint and then back again with another keystroke. This may eliminate some post-recording video editing.

As mentioned, OBS has built-in streaming capabilities. Though Camtasia has available streaming capabilities, this feature currently requires an added service (TechSmith Relay), which may significantly add to the purchase price of the software.

OBS is also fully capable of accessing video and audio from IP cameras, which isn't implemented in Camtasia. This allows OBS to use classroom cameras that are computer-independent, given the correct user privileges. Many recently updated classrooms have been equipped with IP cameras to facilitate Zoom, Teams, Google Meet, and other remote technologies. Thus, OBS may more fully take advantage of this type of classroom technology.

Table 1 summarizes the features of Camtasia and OBS, comparing the strengths and weaknesses of each software package. A guide to using the Camtasia and OBS Studio software to record and edit videos can be found in appendices A and B, respectively. Appendix C compares the cost and features of Camtasia and OBS with two software as a service (SAAS) options, Panopto and Loom, that could also potentially be used to record classroom content. The choice of software can be a complex one, but the ability to start producing videos with a freely available video production package makes classroom video capture well within the reach of anyone with a laptop and webcam.

Table 1 - Comparison of Camtasia and OBS.		
Features	OBS	Camtasia
Recording	Capable of recording video and audio from multiple sources, including multiple application windows, desktops, webcams, and microphones simultaneously.	Can record video and audio from a screen, a webcam, and a microphone, simultaneously, with the ability to pause and resume recordings; however, it's not capable of recording from multiple inputs of the same type.
Live Streaming	Can stream live video and audio content to popular platforms, such as YouTube and Twitch natively.	The standard install of Camtasia does not support live streaming without adding paid services from TechSmith.
Video Editing	Offers very basic editing tools, such as video cropping, resizing, and adding text. To cut out sections, external editing software	Comes with advanced video editing tools, such as adding animations, text effects, transitions, special effects, and captions.

	is required.	
Audio Editing	Offers basic audio editing tools, such as noise reduction and EQ adjustments. Also allows for multiple sound inputs with individual volume control for mixing.	Offers advanced audio editing tools, such as adding effects, filters, and the ability to adjust the volume of tracks. Also allows sound inputs from both the internal operating system and one additional input device (mic).
Transitions	Supports a limited number of transitions between scenes, such as fade and cut.	Offers a wide range of transitions, such as fade, slide, and page curl.
Effects	Offers a variety of basic video effects, such as color correction and brightness adjustments.	Offers a wide range of video effects, such as adding motion graphics, color adjustments, color effects (e.g., green-screening), display effects, spotlighting, and more.
Plugins	OBS supports third-party plugins that can extend functionality, such as adding support for additional streaming platforms, support for PTZ (Pan-Tilt-Zoom) cameras along with face tracking for PTZ cameras.	Third-party plugins are not available in Camtasia.
Exporting	Supports exporting video in a variety of formats, including MP4, FLV, MOV, TS (DVD), and M2U8 (for streaming). No extra time is required for rendering the final output.	Supports exporting video to MP4, WMV, AVI, GIF animation, and can render to several online video platforms automatically. Rendering can take considerable extra time once the editing is completed.
Price	Free and open-source software.	Camtasia's base install is $299 ($212.99 for the educational edition), with different additional pricing options for added features/capabilities.
Platform support	Available on Windows, Mac, and Linux.	Available on Windows and Mac only.

Best Practices for Making Classroom Videos

For faculty members considering using this method to record lectures, there are some best practices that were learned after recording a face-to-face class for a semester.

1. If possible, use a lapel microphone for the best sound quality. This is especially important if you will be walking around or writing on the board. For shirts without a collar, the microphone can be clipped to a lanyard.
2. Do not stop recording if there is an issue or problem during the class. You can edit things out of the video later. Once the issue is resolved, return to the approximate place in the room where you were before the problem started and resume your lecture. This same

technique can be used to eliminate dead time such as the time spent erasing the whiteboard.

3. If students in the face-to-face class ask a question, be sure to repeat the question so that the question is clear to students watching by video.
4. If possible, set up the camera so that there are no students visible in the classroom. This will minimize distractions in the video and respect the privacy of the face-to-face students. If there are students that are in the video view, make sure to notify them that they are being recorded.
5. Post the videos at a consistent time each week. For example, if you record a face-to-face class on Tuesday morning, you may want to tell students the recorded video will be available by Tuesday afternoon. This allows the online students to plan their schedules the same way they would in a face-to-face course.
6. There are various video-sharing platforms available, but there are advantages to using YouTube to share your videos with students. All college students are familiar with the YouTube platform, and YouTube also has the ability to automatically caption your videos. Although the captioning created by YouTube may need to be edited, using YouTube is an easy way to make the videos accessible to all students.
7. Do not strive for perfection. In the editing process, focus on making a video that will provide the students with a good educational experience that enables them to learn the material. Do not get bogged down with editing. For example, spending an extra 10 minutes to make a transition absolutely perfect will have little or no impact on student learning and will not be a good use of the instructor's time.

Conclusion

The pandemic has changed the education environment. It has sped up the adoption of traditional online methods among many faculty members who before the pandemic had little or no experience with them. It has also emphasized the importance of being both nimble and flexible with mode of delivery. Although most schools have resumed offering face-to-face sections, the demand for fully online sections has increased. Furthermore, there is an increased demand for (and supply of) online content delivery, even in designated face-to-face sections. At least some of this increase in online content delivery is likely to represent a permanent shift. As higher education approaches the enrollment cliff of 2026, they will need to strive to make their classes more accessible in a variety of dimensions if they want to attract students. Video lecture capture offers an efficient way to meet the needs of both face-to-face and online students simultaneously in this new educational environment, and this paper fills a niche by describing an efficient and relatively inexpensive process faculty members can use to begin videoing their face-to-face lectures and making them available to students online.

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Appendix A
Using Camtasia's Recording Software

Camtasia 2020 can be used to record audio and video directly from the computer screen and from a webcam simultaneously, allowing the presenter to choose where to focus the students' attention, whether on the instructor or the slides. This section provides a brief introduction to Camtasia 2020 and the steps required to create, edit, and produce a YouTube video from a recorded class.

First, make sure all hardware is plugged in and any software required to support hardware is installed. Upon starting Camtasia, select **New Project**, then press the red Record button on the top left side of the window.
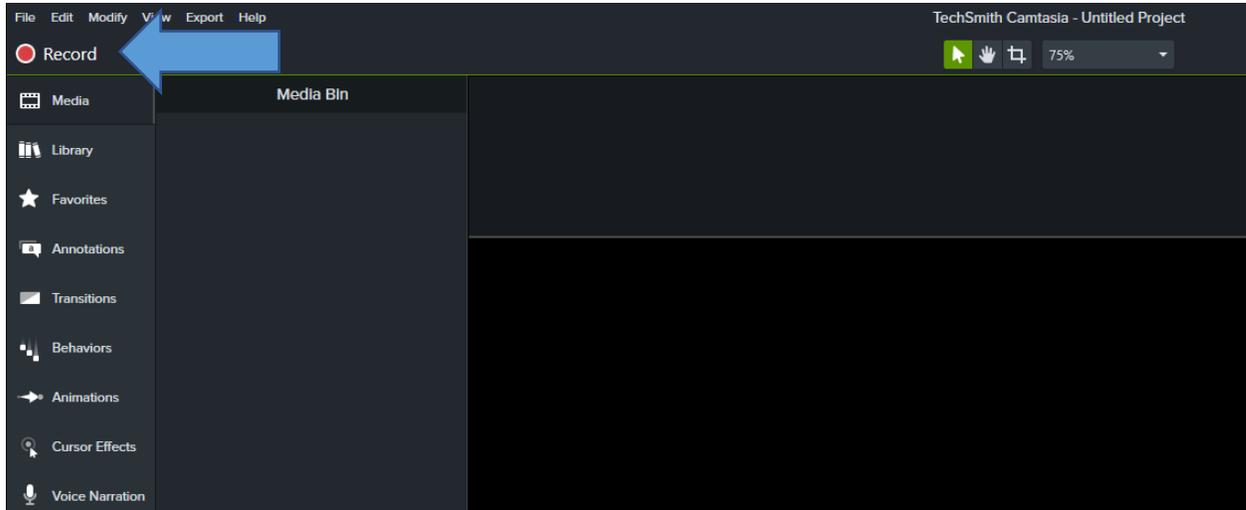
This will open the Camtasia Recorder, which has two panels. The first panel sets the area of the computer screen to record. The second panel selects the video and audio inputs for the recording of the class and toggles between recording the audio from the computer and from a microphone.

Selecting the Recording Area
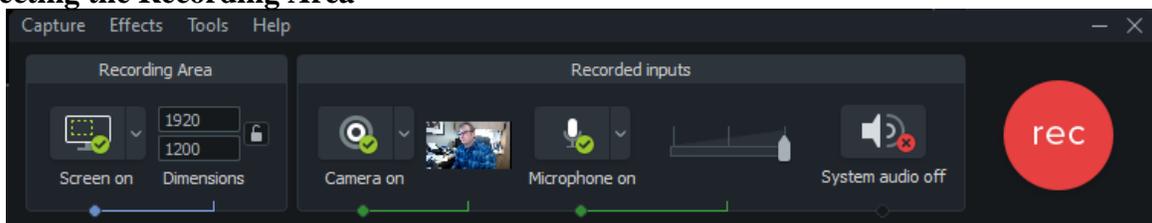
1) Left-click on the screen to enable screen recording. You will see the green checked circle and **Screen on** indicating that you are ready to record the computer screen as a video. When selecting the area to record, you can start by recording your entire screen by selecting **Full Screen** from the down arrow. This setting highlights the entire screen to be recorded with a green dashed box. If you have multiple screens connected to your computer, you can move the dashed box to the desired window by hovering your pointer over the line and dragging. You can experiment later with this setting for capturing different parts of the screen or a program window.

2) Left-click on the Camera down arrow in the Recorded inputs to select the camera you wish to use. There may be more than one camera in this list if your computer has access to multiple camera input devices; however, you can only use one at a time. If the camera is available,

selecting it should also turn it on and make it available. A thumbnail picture should be visible along with a green checked circle over the camera icon.

3) Similarly, select the microphone you wish to use. If you have access to a USB lapel microphone, install it prior to starting Camtasia.

4) If you plan to play audio or video for the class using the computer during your presentation, you will want the system audio to be toggled to **ON**; otherwise, leave it off, as this setting records chimes, mouse clicks, and other sounds the computer makes during the presentation.

5) Press **Record** to start recording video from the camera and from the selected screen or area of the screen. There will be a 3-second countdown to the beginning of the recording. Press **F10** or the stop button on the recording panel to stop the recording process.

Once the red **rec** button is pressed, the recording panel will minimize, and the 3-second countdown begins. After 3 seconds, you can begin your presentation. At the end of your class, close PowerPoint (or other presentation software), and click on the orange Camtasia icon in your Windows taskbar (bottom of screen) to bring the recording panel back to the foreground to end the recording, or press **F10**.

Camtasia will automatically load your class recording into the Media Bin and make both the webcam video and screen recording available for editing in Camtasia 2020. You can review (play) the video by pressing the play button below the screen displayed in the window. The video of the screen capture will be accompanied by a smaller video window from the webcam. You can use your pointer to select and change their sizes and/or the relative locations of the two recordings on the screen. Also, notice that both videos (from the screen and from the webcam) are synchronized by default. As long as the two video "tracks" are not shifted in the timeline relative to one another, the video from the webcam and the video from the computer screen or slides will remain synchronized.

Changing Students' Focus

Throughout the class, the focus may shift from slides to the instructor at the board and back again. Camtasia allows the user to make that transition in the production process after recording rather than having to coordinate those during the recording process. Once the recording is complete and Camtasia returns to the project window, you will see the following window:
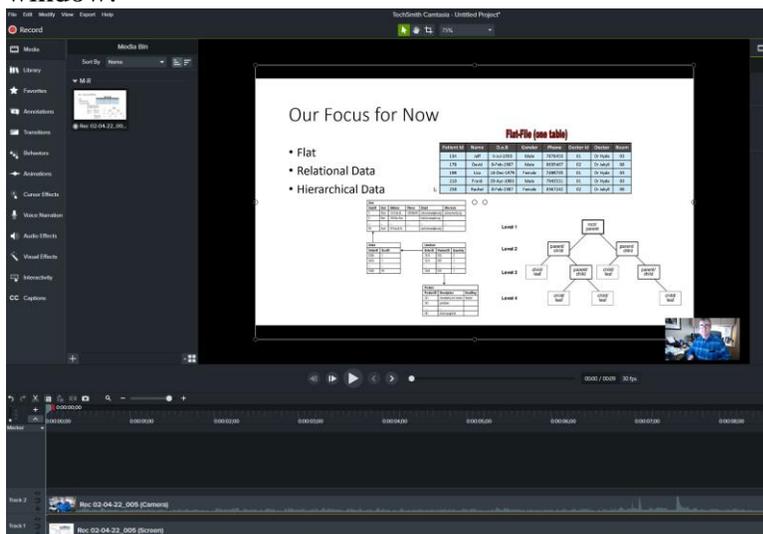
Pressing the play button will start the video playback and then you can follow along in the timeline across the bottom of the window. At any point in the playback timeline, you can pause and edit the location and size of the two videos on the screen.
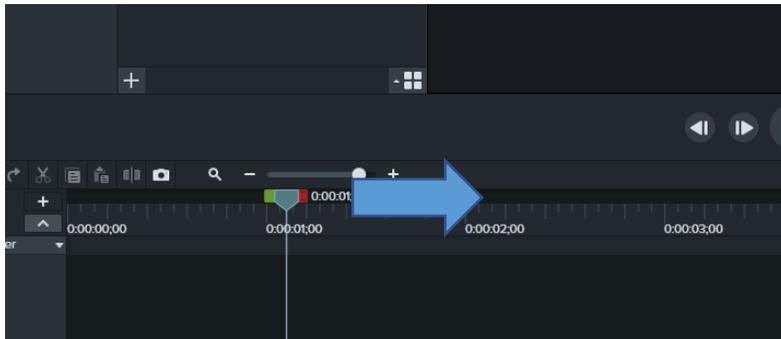

The **playhead** is the vertical line that moves along the timeline (bottom of Camtasia window) as the video plays. To change a video's size and location, follow these steps:

1) Right-click on the blue part of the playhead and select **Split All.** This will divide the video into two parts, allowing you to change the size and location of the video components as you move from before to after the split.
2) Move the playhead to the part of the timeline you wish to edit.
3) Left-click on the video you want to relocate or resize.
4) Use the mouse to drag and reposition the video, and/or
5) Left-click on the small circles on the edge of the video and resize by dragging with the mouse. By default, the aspect ratio of the video will stay locked.
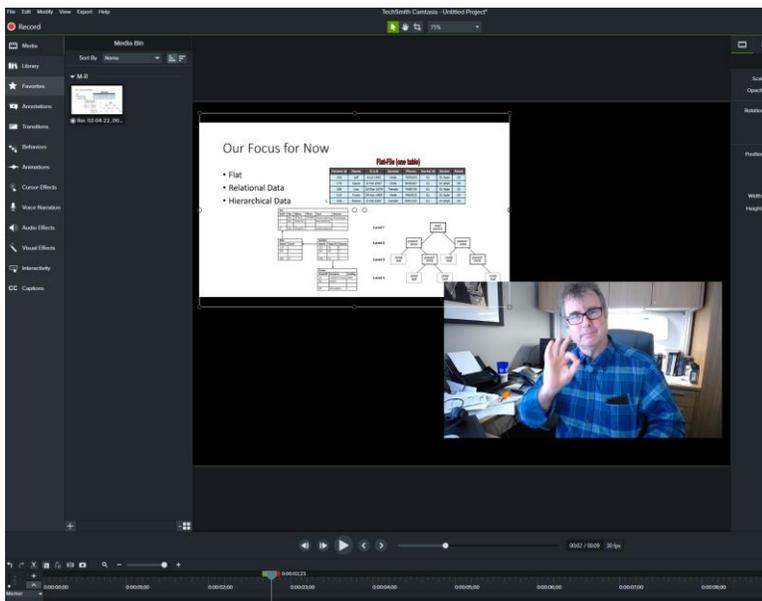
Above, both videos were repositioned and resized. If played from the beginning, the two videos will both resize after reaching the same point in the timeline. Transition effects can be added to soften the transition. The same technique can be used when the instructor moves to the board and away from the slide presentation and reversed when doing the opposite.

To add transition effects, select **Transitions** from the list on the top left of the Camtasia window. This will provide the user with more than a dozen video transition options. Select one and drag it on top of the split for each track. In this example **Glow** was used for Track 1 and Track 2. The picture below depicts the transition for both videos. Repeat as needed.
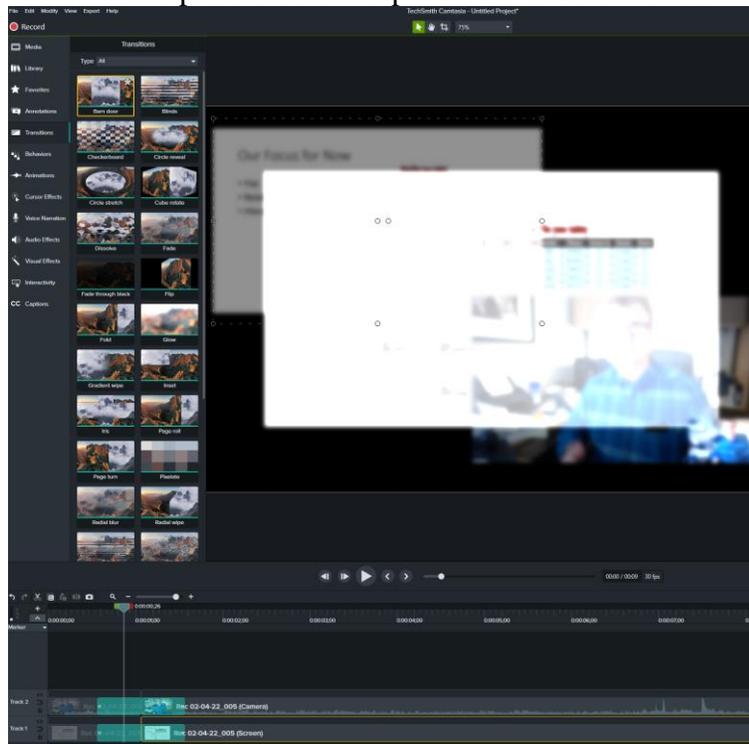
Cutting and Editing

The ability to perform simple video/audio edits is a nice feature of Camtasia. Mistakes, slips, long pauses, or interruptions are all things we wish we could eliminate from our classes. A nice aspect of lecture capture in Camtasia is that we can actually cut out and even (to some degree) correct mistakes that are made in the classroom. Even though we can rewind and start over, we aren't forced to relive our mistakes every time we replay our video. Cutting segments out of a video is as simple as highlighting and removing, but there are some techniques that can make the process quicker and easier.

To remove a segment of video/audio from the timeline do the following:
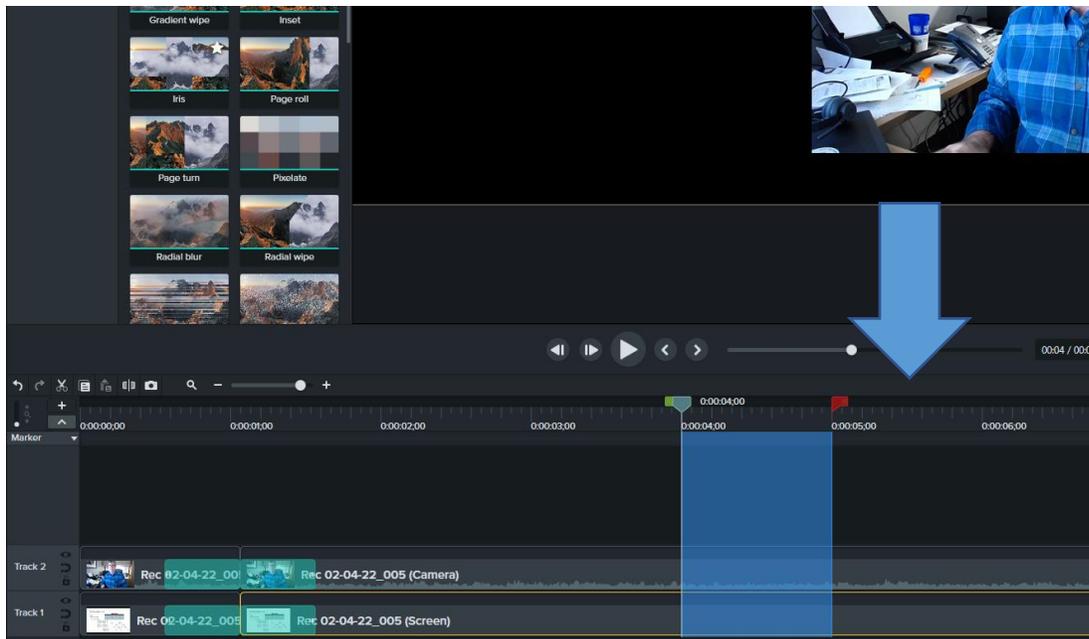
1) locate the beginning of the spot to be removed with the playhead.
2) Left-click on the red flag on the right side of the playhead and drag it to the end of the timeline to be cut out.
3) Right-click on the blue shaded area and select **Cut.**

This will remove the same timeline segment on both tracks, keeping both videos synchronized even after the cut. A vertical dotted line in the timeline will appear where the cut occurred. If the cut creates a significant interruption, you can use a **Split All** and a transition effect to soften the transition. A helpful hint to help pinpoint mistakes that you recognize while lecturing includes a short pause in your presentation. The audio track will have a blank space that will provide a visual cue of where a mistake is located in the timeline.

Adding Intros/Outros

Adding titles, introductions, credits, and callouts add to the production value of classroom capture videos. Furthermore, it enables instructors the ability to brand their class and potentially increase a student's ability to recall information contained in the video.

To add an intro do the following:

1. In the top left-hand side of the screen right click on **Library**, from the pull-down at the top of the library pane; make sure you are in the Camtasia 2020 library.
2. Then right-click on the **Intro** folder, which will reveal more than a dozen intros that you can choose from.
3. Once you choose the intro you would like to use, drag and drop it at the beginning of your video track.
4. Captioning can be added to the intros to personalize your video as in the picture below (where the spinning computer intro was used), by clicking on the image as the intro plays and entering text into the textbox.
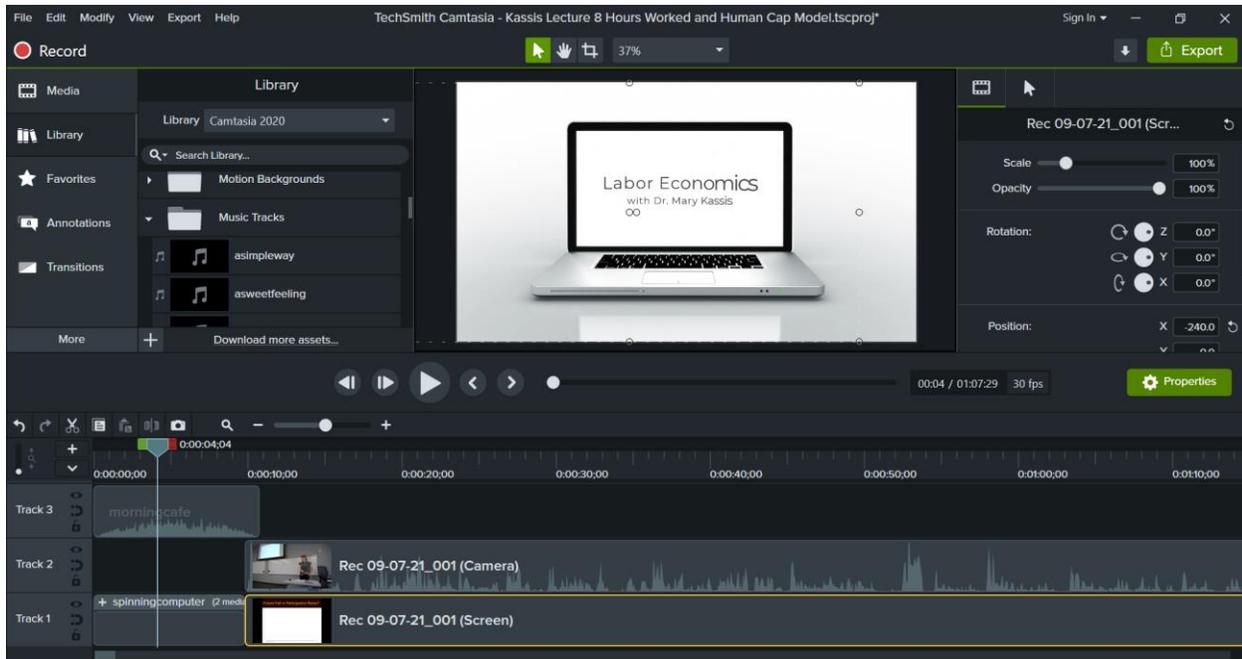
5. You can also add music to your intro by scrolling down the library folders to find the folder Music Tracks. This folder has more than a dozen music tracks to choose from. You can right-click on each track to hear a preview.
6. Once you have chosen your music track, drag and drop the track at the beginning of your video. This will create a third track (Track 3 in the picture above). You can then shorten your music track to line up with the length of your intro.

Exporting Video from Camtasia

Once you have completed your video project in Camtasia, you can export the video to a local file on your computer or to various video viewing platforms such as YouTube or Vimeo.
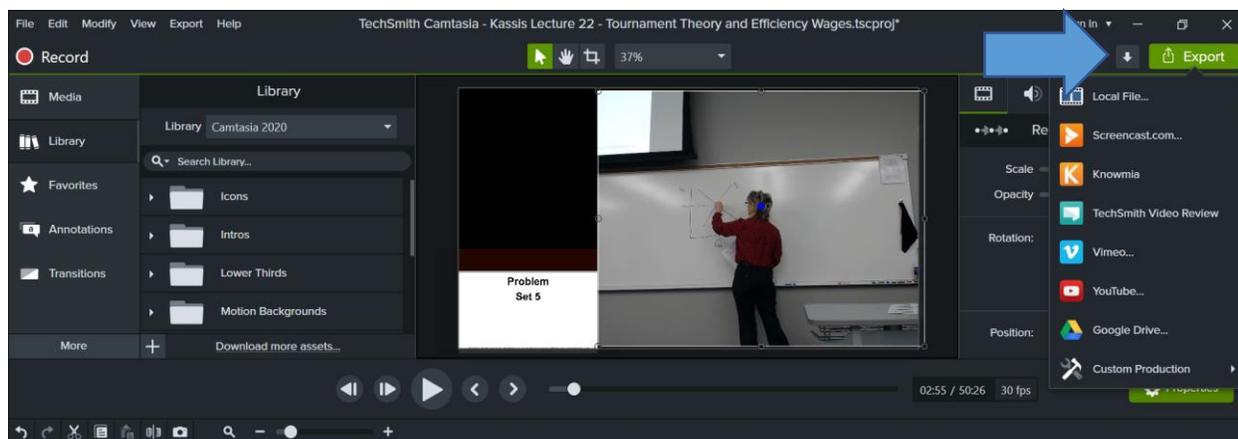
To export your video, do the following:
1. Right-click on the green export button on the top right-hand corner of the Camtasia screen. This will bring down a menu of export options.
2. Right-click on the export option of your choice to begin the export process.

Appendix B
Using OBS Recording Software
      Although Camtasia is used extensively in higher education and commercially for online content creation, there are free/open source workable alternatives. One such alternative is Open Broadcaster Software or OBS Studio (https://obsproject.com). OBS Studio can be used to record audio and video directly from the computer screen and from a webcam simultaneously, providing many of the same advantages of Camtasia; however, the learning curve and initial setup for OBS is a bit more than for Camtasia's products. This appendix provides a brief introduction to the OBS install and setup process, and then we will provide steps to record and produce/upload video to YouTube based on a video recording and a MS PowerPoint presentation.
      Before making your first recording, you must obtain and install OBS Studio. The current version of OBS Studio is 28.x.x. It is available for Windows, MacOS, and Linux in a variety of downloadable forms. The installer's download size is about 120 mb and is completely free to use with no restrictions. You will need to download the installer for the platform of your computer (Windows, Mac, or Linux) and begin the install process. During this process, you can select different locations for the software to install, but the defaults should work for most.

Once the setup is complete, you should see the following popup. You can continue by launching the program to further set up your specific hardware (webcam, microphone, etc.).
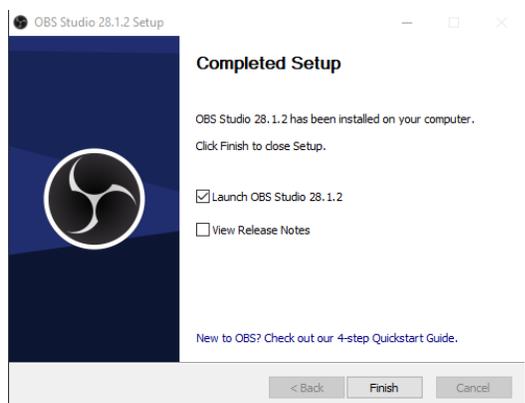
Make sure all hardware (webcam and external microphone if desired) are plugged in and any software required to support hardware is installed. Once the program installation has finished, open OBS and create a new scene.

At this point you will have to configure OBS to access your video and audio hardware.

1. Open OBS. By default, a new empty scene is available for you to add sources. The scene name(s) are displayed in the "Scenes" window in OBS. A scene can contain multiple sources, such as program windows, a desktop, a webcam video, and more. A simple instructional video may consist of a scene that includes a PowerPoint presentation (or a screen capture), a webcam video of the instructor interacting with the class, and an audio recording. This simple setup will require a minimum of three sources.
2. To configure your screen capture in OBS, you need to add a source to your scene by clicking the "+" icon in the "Sources" panel and choosing "Display Capture" or "Window Capture", depending on whether you want to capture your entire screen or just a specific application or window (e.g., PowerPoint). Choose "Window Capture" initially and select "Create new." Name it something you can remember, for example, "PowerPoint."
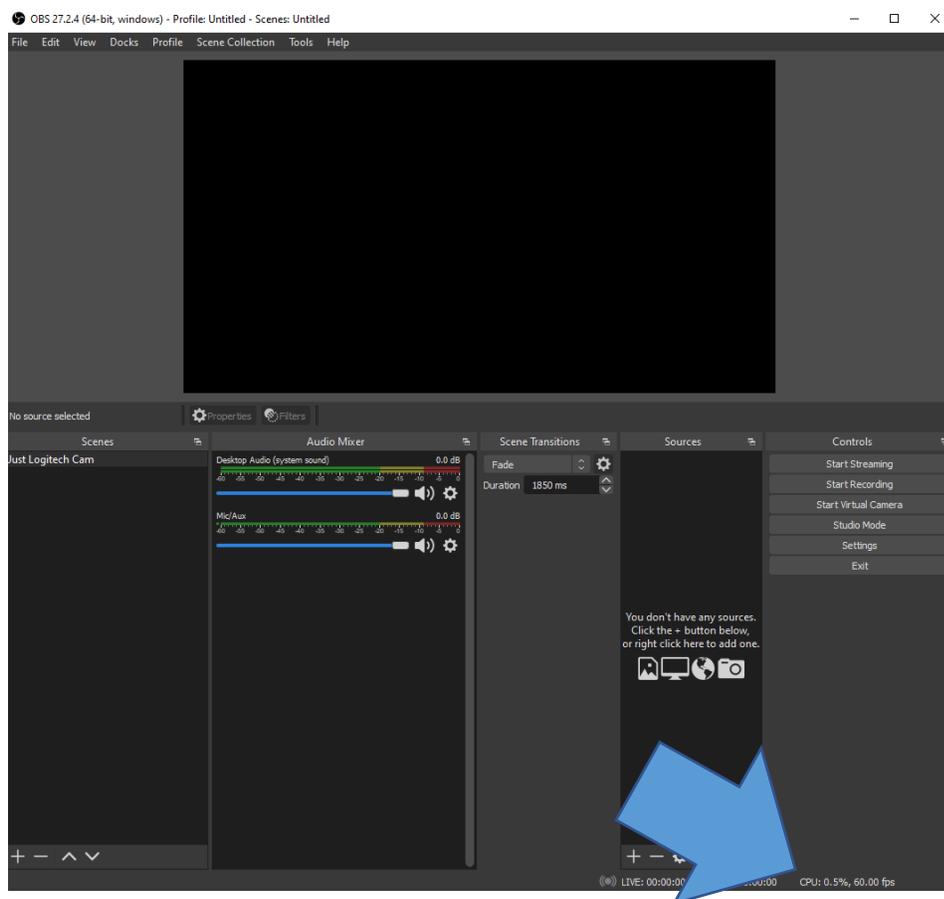
3. Select the window from the pull-down menu that contains your PowerPoint presentation. [Leave other default values unchanged initially.]
4. To add input from a webcam, repeat step 2, and select "Video Capture Device." Name it something you can remember, for example, "Logitech930e." Then choose the device from the pull-down menu, without changing the selected defaults.
5. To add input from a sound-capture device, repeat step 2 and select "Audio Input Capture." Again, name it something you can remember, for example, "Blue Snowball" in this example. [Note that many webcams, including the Logitech c930e, have built-in microphones that may be added separately. To do so, repeat 2, naming the device in OBS something memorable, and in this case, selecting Microphone (Logitech Webcam C930e) from the device pull-down.]
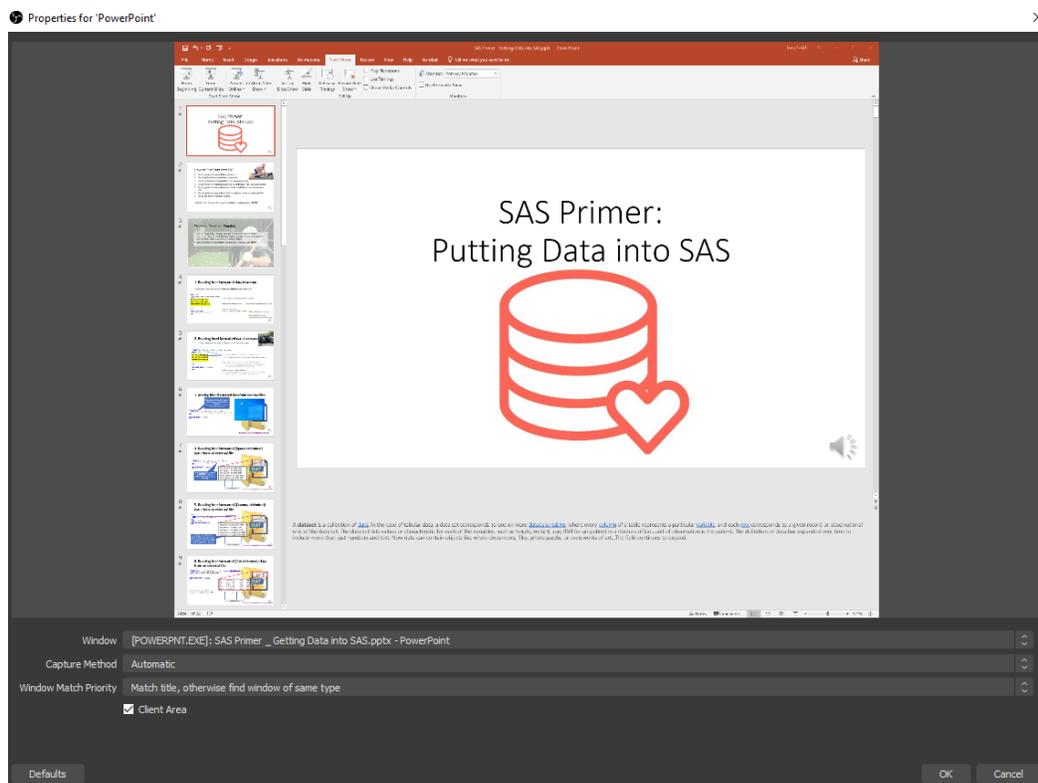
6. If successful, you now have added the ability to record a window from your computer (i.e., PowerPoint), along with video from a webcam, and audio from either your microphone-equipped webcam or from a separately installed microphone. Now, you will need to adjust the size and position of your capture source within OBS to fit your needs. You may move and resize both your PowerPoint window and your webcam. This may take some experimentation to achieve the desired effect/locations.
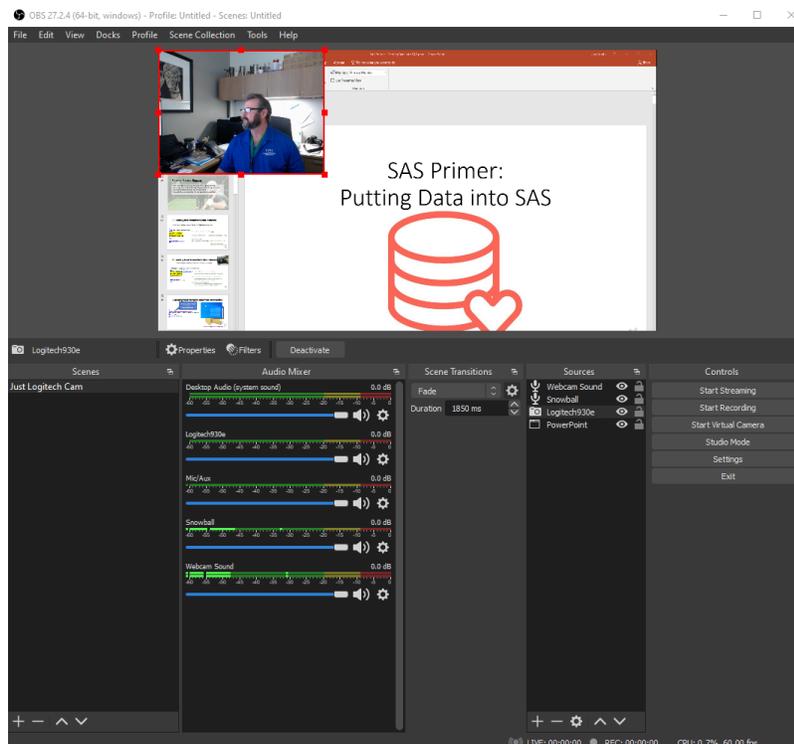
7. Observe the dB bar for the microphone to make sure the audio input is picking up your voice properly.
8. Start a test recording by clicking the "Start Recording" button in the "Controls" panel. Choose where you want to save your recording and give it a name.
9. Carefully watch your test recording to ensure the sound and video are synchronized, i.e., that the sound and the video match. If the voice and sound are not synchronized, the advanced audio properties for your microphone (found by clicking on the gear icon next to the sound device in the Audio Mixer) will allow you to adjust the timing of the sound relative to the video recording. Use "Sync Offset: to add milliseconds to the sound recording. Typically, sound is delayed, as video requires more processing time. Record a video of yourself clapping three times with about a second between claps. If the video of the claps does not synchronize with the sound, add offset time until they synchronize. Start at 100ms and increase or decrease in intervals of 20ms until you are satisfied with the results.
10. Once you are confident the software is set up correctly with your components, start your class and use the scene monitor (in the OBS software) to make sure that OBS is capturing your screen, webcam, and your voice.
11. When you're finished, close your PowerPoint presentation and stop the recording by clicking the "Stop Recording" button in the "Controls" panel.
12. Although the video is saved by default in .MP4 format, editing may be desirable to remove unwanted parts, add intros/outros, add captions/titles/transitions, or adjust audio levels. After you've stopped the recording and saved the .MP4 file, you can further edit the video using another editing software if needed. To find the location where OBS saves the video files, click "File," then select "Show Recordings."

Appendix C

Software Comparison
Although there are several options available to record classroom content, the two considered in this work are Camtasia and OBS. A primary consideration is the ability to budget for the cost. Panopto and Loom provide some of the same functionality (sometimes more). However, as both are distributed as a service, the final cost of each depends on the user. Currently, Panopto provides its video recorder as a free service at https://www.panopto.com/record/, which allows the user to create videos utilizing multiple cameras and microphones and upload (to YouTube.com) or download the resulting video in .webm format (viewable in VLC video player). Trimming, cutting, clip merging, and limited post-production may be accomplished in VLC using tools and filters.

SOFTWARE	Camtasia	OBS	Panopto	Loom
Product Description	Individual License	Individual License	Software as a Service (SAAS)	Software as a Service (SAAS)
Cost	$299 ($212 Education)	Free	$14.99 per month (recorder is currently free, with no restrictions on video length if downloaded)	$15.00 per month
FEATURES				
Capture	Single-Camera	Multi-Camera	Multi-Camera	Single-Camera
Hosting	Youtube, Vimeo, Screencast, Knomia, Google Drive, Proprietary Hosting Platform (Techsmith)	Not Automated, but output uploadable to multiple sites	Youtube, Proprietary Hosting Platform (Panopto), Send to Classroom	Proprietary Hosting Platform (Loom), downloadable videos in MP4 format may be manually uploaded on multiple sites
Streaming Support	Yes (Proprietary + $)	Yes	Yes (Proprietary + $)	No

Project Files for Post-Production Editing	Yes	No	No	No
Effects	Yes	No	No	Yes (basic)
Captions	Yes	Yes	Yes	Yes
Video Trimming	Yes	Yes (hides unwanted content)	Yes (hides unwanted content)	Yes (basic)
Combine Videos	Yes	Yes	Yes	Yes
Video Downloadable	Yes	Yes	Yes	Yes

Appendix D

Recommended Hardware Combination

All images below are captured from Amazon.com. Prices are accurate as of June 2023; however, prices, features, and availability are subject to change. The Logitech C920 web camera ($59.99), BlueSnowball iCE USB microphone ($39.99), Innogear webcam stand ($21.99), and a USB 3.0 hub ($7.99) provide a flexible and portable combination for classroom recording where there is an available web-connected computer. The addition of the USB hub allows the instructor to leave all USB devices plugged in, thus requiring only one USB port from the computer and reducing setup time. The total price for this package is about $130. As a convenient option, the Samson XPD2 lavalier microphone and receiver can be substituted for the BlueSnowball microphone for a total cost of about $174.

Roll over image to zoom in

Logitech C920 Hd Pro Webcam (Black) Black
Visit the Logitech Store
4.6 ★★★★½ ˅   3,461 ratings | 103 answered questions
Amazon's Choice in Webcams by Logitech
🌿 Climate Pledge Friendly

-5% $59⁹⁹
Typical price: $63.20 ⓘ

Get $60 off instantly: Pay $0.00 upon approval for the Amazon Store Card.

Available at a lower price from other sellers that may not offer free Prime shipping.

Purchase options and add-ons

Payment plans	˅
$10.89/mo (6 mo) at example APR of 30% (rates from 10-30% APR)	

Brand	Logitech
Connectivity Technology	USB
Flash Memory Type	Micro SD
Color	Black
Special Feature	Low Light
Screen Size	2.2 Inches

˅ See more

Roll over image to zoom in

Logitech for Creators BlueSnowball iCE USB Microphone for PC, Mac, Gaming, Recording, Streaming, Podcasting, with Cardioid Condenser Mic Capsule, Adjustable Desktop Stand&USB cable, Plug&Play – Black
Visit the Logitech for Creators Store
4.6 ★★★★½ ˅   35,550 ratings | 1000+ answered questions
Amazon's Choice for "computer microphone"
🌿 Climate Pledge Friendly

-20% $39⁹⁹
List Price: $49.99 ⓘ

FREE Returns ˅
Available at a lower price from other sellers that may not offer free Prime shipping.

Extra Savings 90 days FREE. Terms apply. 1 Applicable Promotion

Eligible for Return, Refund or Replacement within 30 days of receipt ˅ | Free Amazon product support included ˅

Color: **Black**

Style: **Microphone**

Mic + Monitor Light	Microphone

Recommended Uses For Product	Streaming
Brand	Logitech for Creators
Model Name	1929
Connectivity Technology	USB
Connector Type	USB
Special Feature	Stand

˅ See more

InnoGear Webcam Stand, Upgraded Flexible Desktop Stand Gooseneck Stands Holder for Logitech Webcam C922 C930e C920S C920 C615 C960 and BRIO and Other Devices with 1/4" Thread

Visit the InnoGear Store

4.5 ★★★★☆ 2,532 ratings | 29 answered questions

🌿 Climate Pledge Friendly

$21⁹⁹

FREE Returns ▾
Join Prime to buy this item at $19.79

Get $60 off instantly: Pay $0.00 upon approval for Amazon Visa.

Available at a lower price from other sellers that may not offer free Prime shipping.

Extra Savings Save 5% on InnoGear …   3 Applicable Promotion(s) ▾

- Compact but Sturdy: InnoGear webcam stand features a compact but weighted all-metal base to provide optimal placement, portability, and stability. Rather than unscrewing or re-clamping a stand with each change of scenery, this InnoGear model can be easily repositioned around the home. The weighted round base offers stronger protection to your webcams than those tripod stands, as it won't be tripped easily.
- Anti-scratch & Skid-proof: Four non-slip cottons attached to the bottom of the webcam stand keep your webcam securely in place while protecting surfaces from scratches and reducing noise from movement.
- Adjustable Angle & Height: Detachable gooseneck and effortless

Roll over image to zoom in

USB 3.0 Hub, ORICO 4-Port USB Hub, Ultra Slim USB Splitter for Laptop for MacBook, Mac Pro, iMac, Surface Pro,XPS, PS5, PC, Flash Drive, Mobile HDD(Black/0.5ft)

Visit the ORICO Store

4.6 ★★★★☆ ▾ 44 ratings | 5 answered questions

$7⁹⁹

FREE Returns ▾
Save up to 10% with business pricing. Sign up for free Amazon Business account

Extra Savings Save 5% on 4 Port USB C to USB Multiport Adapter with 1*U…   1 Applicable Promotion ▾

Size: 0.5FT

| 0.5FT | 3.3FT | 6FT |

Color: Black/USB-A

Brand	ORICO
Color	Black/USB-A
Hardware Interface	USB 3.0
Compatible Devices	USB Flash Drives, Mouse, Keyboards, Card Readers, Laptops, Desktops
Data Transfer Rate	5 Gigabits Per Second

About this item

- 4-port at Same Time-The small and speedy USB Multiport Adapter can easily expand one of your computer's USB ports into four USB 3.0 Ports to iMac, Macbook, Mac Pro / mini, Surface Pro, XPS, Notebook PC, Mobile HDD, and More. Just Plug and play, you don't need a driver and it's easy to use. That's fine for keyboards, mice, and memory sticks.(Does not support charging for phone or other device!).
- 5Gbps Data Transfer-With high efficient USB3.0,This ORICO 4-port USB splitter provides 5 Gbps stable data transfer(10 times faster than usb 2.0) and can transfer a HD movie in seconds.Easy to read hard

Roll over image to zoom in

Samson XPD2 Lavalier USB Digital Wireless System with Lavalier Microphone and USB Stick Receiver, Works with Computers and Samson Expedition Portable PA Systems

Visit the Samson Store

4.1 ★★★★☆ ˅   419 ratings | 38 answered questions

$86.04

FREE Returns ˅

Available at a lower price from other sellers that may not offer free Prime shipping.

Extra Savings 90 days FREE. Terms apply.   1 Applicable Promotion ˅

Eligible for Return, Refund or Replacement within 30 days of receipt ˅ | Free Amazon product support included ˅

style: Lavalier

Handheld	Handheld+ Lightweight Speaker Stands
$99.99	$169.98
Headset	Lavalier
$52.99	$86.04
Lavalier+ Lightweight Speaker Stand	
$109.13	

Set: XPD2

Brand	Samson
Item Dimensions LxWxH	6.26 x 1.69 x 4.88 inches
Connectivity Technology	Wireless, Wired (USB)
Color	Black
Compatible Devices	Personal Computer, Camera, Headphone, Smartphone, Speaker

About this item

- 2. 4GHz USB digital wireless system ideal for live sound reinforcement, broadcasting, podcasting and live streaming