How to set up any room for lecture capture

A complete guide to implementing lecture capture anywhere on campus, from content considerations to equipment configuration and more.

Panopto on a Page

At Panopto, we believe that video has the power to fundamentally transform the way students learn and the way people share knowledge. So we build software for schools, universities, and other organizations that makes it easy for anyone to record, live stream, and share video.

Academic institutions around the world use Panopto to enhance the learning process and improve student achievement. Using Panopto's flexible video platform, universities and schools can record lectures, flip classrooms, capture student assignments, and engage faculty, students, communities, alumni, and others. With Panopto, every video in an institution's library is automatically searchable, shareable, secure, and accessible anytime and anywhere, on any device – all you need to do is click "record".

Panopto was founded in 2007 by technology entrepreneurs and software design veterans at Carnegie Mellon University's School of Computer Science. Today we're the fastest-growing lecture capture solution at leading universities around the world.

Panopto has been recognized by Gartner as a "Leader" in its *Video Content Management Magic Quadrant* report. Click here to visit our website and learn more.

Want to try Panopto for yourself? Visit www.panopto.com today for a free 30-day trial or to schedule a demonstration of our software.

Overview

Three Generations of Lecture Capture

The First Generation of Lecture Capture

As long as there have been lectures, there's been lecture capture.

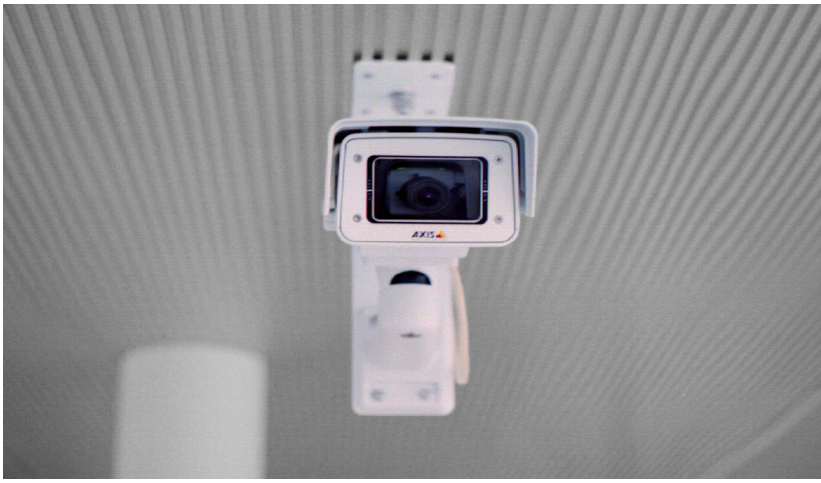
For most of history, we've lived with what can now be considered the "first generation" of lecture capture: students feverishly scribbling notes to make their own recordings of the key points of a given class. Toward the end of the 20th century, technology was brought in to assist. Whether by institutions or the students themselves, tape players, camcorders, digital voice recorders, laptops and more have all been put to the task of recording lectures for individual use.

This first generation left much to be desired. Taking notes forced students to focus on the micro-level of the details being spoken instead of the macro-level of the concepts being taught. And when institutions stepped in, they quickly found that creating and storing recorded lecture files was far too expensive and time consuming to make available to all students.

The Second Generation of Lecture Capture

Then, seemingly overnight, the culmination of decades of small improvements in all the relevant technologies changed everything.

Digital file storage became less expensive than physical. Digital camcorders achieved parity with analog, and soon became inexpensive enough that universities could forego a formal AV team and simply install a camera in the back of high-priority classrooms. And the internet (especially YouTube) demonstrated that video could be shared online.



Second generation solutions standardized lecture capture around fixed hardware.

In higher education, a number of dedicated vendors brought these technologies together — formally establishing the second generation of lecture capture.

In this "modernized" approach to lecture capture, institutions generally invested in internally-developed or vendor-supplied video solutions that, due to their cost and complexity, could only be implemented in the largest lecture halls or dedicated recording studios.

Second-generation lecture capture solutions were typically built around proprietary hardware installed on-premises, with a single camera used for recording. Over the next ten years, software-based products would be introduced to supplement the hardware-based primary tools.

In terms of output, most second generation solutions captured a single stream of video and paired it (either alongside or as picture-in-picture) with the static slides presented during the lecture. Other solutions would capture only the slides and the presenter's audio.

The Third Generation of Lecture Capture

In a growing number of institutions, lecture capture is transitioning from optional to a standard component of every class, driven largely by student demand. And as video technology itself moves toward commoditization (with cameras that are ever more capable and affordable and storage costs that only fall with time), and a wave of new classroom pedagogies tap video to enable new learning experiences, the second generation of lecture capture solutions is quickly being replaced with a more flexible third generation.

Predominantly software-based and cloud hosted, today's lecture capture solutions can be deployed campus-wide overnight and come ready to integrate with existing LMS tools. Third generation solutions record from virtually any video or audio device that can be plugged into a laptop, and can capture and play multiple simultaneous video feeds, slides, images, screen recordings, and more.

Third generation lecture capture prioritizes flexibility, enabling faculty and students to use video in more ways.

Today, schools are using these new solutions to outfit every classroom in every department with lecture capture. To optimize the return on this investment, university leaders are opting for video platforms that are flexible enough to accommodate the unique logistical requirements of each learning space and support "infinite customization."

Lecture capture has even become a factor in infrastructure decisions. As just one example, at University of Central Florida, rapid growth in enrollment over the last few years led to students fighting for seats in overcrowded lecture halls. To address the issue, UCF now relies on the flexibility of its lecture capture system to live stream many of its

most popular courses and ensure that students who can't physically sit in the classroom still get an equivalent, first-rate educational experience.

Looking to the Future

When you visit a classroom today, you see faculty using technology in general, and video specifically, to reclaim class time, facilitate active learning activities, and develop a new style of teaching that adjusts to the needs of individual students. Students can consume course material at their own pace, in any location, and in bite-sized chunks as they hop between devices.

In today's classrooms, video and other technologies have enabled instructors to test new active learning pedagogies.

And that makes now an excellent time to consider how your institution currently supports video-enabled instruction, as well as how you might make video even more accessible, flexible, and useful for faculty and students alike.

In this guide, we'll discuss considerations for provisioning any room on campus for lecture capture, and illustrate 8 examples of possible lecture capture setups for various learning spaces. We'll also share our favorite audio and visual gear for lecture capture.

If your goal is to make lecture capture possible anywhere on your campus, this is your definitive guide.

Initial Considerations For Provisioning A Room For Lecture Capture

With today's lecture capture systems, virtually any room can be provisioned for video with a simple flick of a switch. From large auditoriums to smaller classrooms, or from dedicated labs and practice spaces to faculty offices, creating a baseline video capture setup can be as easy as downloading the appropriate software to a computer and plugging a camera into a USB port.

That, however, doesn't mean that lecture capture can or should be deployed the same way in every instance. To get the best results, you'll want to plan for the practical realities of recording in each room you provision. Start by asking the following questions:

Where Will You Be Recording?

Room size, seating, lighting, and existing presenter tools will all impact the setup of audio and video feeds for lecture capture in a new space. In some cases, rooms will have existing AV equipment like microphones and projectors that can be used with your lecture capture solution, so you may not need to add extra peripherals or computers to every room.

There are also many possible use cases for lecture capture within non-standard classroom settings such labs, student simulation spaces, the field and more. We'll discuss some examples of non-standard learning spaces as well.

When provisioning a new space for lecture capture consider the following:

While classrooms come in all shapes and sizes, there are a handful of archetypal models.

You can find recommendations for setting up lecture capture in seven core classroom types in Part II of this guide.

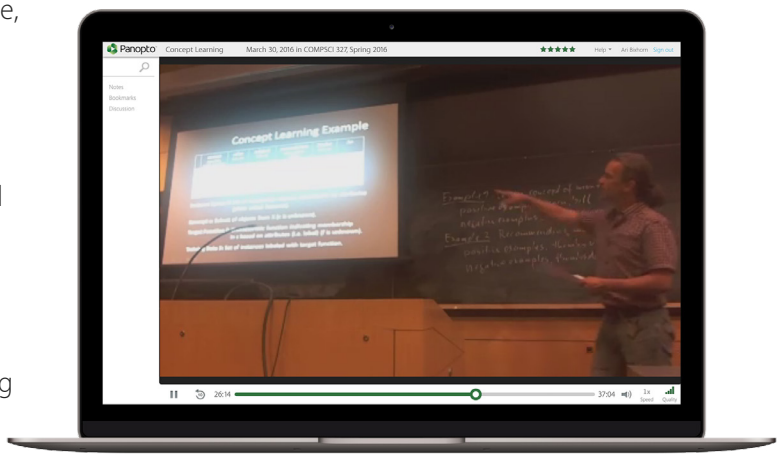
Room Size

The size of the room will impact the type and placement of your audio and video recording equipment. Large lecture halls or auditoriums will require equipment and installations different from those needed in smaller classrooms and offices. For example, a webcam may be suitable for faculty office space, but not for a large lecture hall or auditorium.

Prior to provisioning a classroom, you'll want to confirm its dimensions. Doing so may help you identify spatially similar rooms, which will serve as useful guides to what will work well when you set up lecture capture in the new location.

Breaking Up Larger Rooms For Better Recording

Lecture halls are typically big, sometimes dark, and usually full of people. As a result, single, fixed-camera lecture recording solutions can produce an on-demand video that is noisy, out-of-focus, or obstructed. And if the classroom features a projector or another large screen, it's possible that the recording may be both too dark and too bright at the same time.



Above, single cameras can struggle to capture the instructor, slides, and boards clearly.

Below, breaking up the lecture to record instructor and slides separately makes details easy to read.

Fortunately, there's an easy solution: record the presenter separately from the presentation. This is usually easy to achieve with a video mixer, or may be supported without the need for extra hardware, using the "distributed recording" functionality of your lecture capture tools to synchronize multiple recording devices simultaneously into a single session. By framing up the instructor in their own video feed, the camera can be set to the specific lighting conditions of the lecture stage, freed from the glow of the projector, students' tablet and laptop screens, and people getting up in the middle of the lecture.

Seating Arrangements

The standard seating arrangement within a classroom or lecture hall will impact the type and placement of your recording equipment. In most cases, you will only want to capture the lecturer's voice and image, minimizing any sound or views of the audience.

In some spaces commonly used for seminars, workshops, labs, and discussions, however, you may need to plan to capture audio and video that will include the students seated in the classroom. Courses in science, engineering, art, and other fields regularly include discussions and demonstrations as part of the classroom experience. These are often well-served by having an extra recording device dedicated to capturing those activities.

Lighting

Typically, classrooms already have sufficient lighting to achieve acceptable quality in your lecture recordings. There are, however, some scenarios that might make your subjects hard to see in a recording. Being aware of potential high and low lighting issues can help improve the quality of your videos.

Adding a light source near your recording equipment helps moderate the natural light in a room and improves the visual quality of your recordings.

Natural Light from Windows

Windows are useful for providing lighting in your classroom, but should not be behind the instructor. Recording instructors in front of a window nearly always results in backlighting that leaves the presenter in a shadow. Avoid provisioning a fixed lecture capture setup that captures a presenter in front of windows, and also instruct teachers to avoid recording themselves in front of windows in a non-fixed setting.

More direct natural light in the morning or evening, depending on which direction the window faces, can also create glare that makes whiteboards and other display surfaces hard to see on camera. Window shades or solar screens can help block natural light when needed in these spaces.

Dim Lighting While Presenting

When presenting slides in class, it's not uncommon for instructors to dim the lights. While doing so makes the slides easier to read in class (and should have no impact on the recording, as slides will typically be captured separately), if there is not enough light, the presenter may barely be visible in the resulting video recording.

Test the lighting in each classroom and ensure that there's adequate lighting on the instructor. In classrooms that use room control systems like those offered by

Crestron, provide a recommended lighting setting that faculty can easily select. Adding a small tabletop light near the podium, or putting a higher-end camera closer to and directly on the presenter, may also help in rooms where there is not enough light.

Non-Standard Rooms and Spaces

In recent years, instructors have begun to incorporate new blended and active learning pedagogies into their courses using video as the enabling technology.

The following are a few examples of how lecture capture software can be applied outside of the traditional classroom:

- Laboratory Demonstrations (Click to watch video)
- Medical Demonstrations (Click to watch video)
- Nurse-Patient Simulations (Click to watch video)
- Law Student Mock Trials (Click to watch video)
- MBA Student Presentations (Click to read case study)
- Geology Field Work (Click to watch video)
- Commencement Ceremony Webcasts (Click to watch video)

Existing Audio-Visual (AV) Devices

When it comes to video and audio capture devices, the market is flooded with new options every year. Whether you're buying new AV hardware or will be reusing existing gear, we've included a review of the types of equipment commonly used for lecture capture, along with a list of our own equipment recommendations, further below in this guide.

Existing classroom tools like projectors and audio systems can be used to quickly and affordably provision a room for lecture capture. And in classrooms with existing AV equipment already connected to a computer, it may be possible to provision lecture capture in a matter of minutes simply by downloading the appropriate recording software. In other cases, you may only need to add a peripheral device, such as a desktop microphone, video camera, and possibly an external capture card, in order to provision your in-class system.

Rooms equipped with more extensive AV control systems, such as Crestron, Extron, and AMX, can also incorporate lecture capture capabilities with some support. We recommend you work with your AV control provider to integrate your lecture capture solution with these systems.

Room control systems are increasingly easy to integrate with your lecture capture solutions.

What Will Be Presented?

In the most common classroom scenario, your lecture capture solution will be required to capture audio and video of a presenter along with some combination of supporting materials in the form of slides, a computer screen, and additional feeds from secondary or specialized video cameras.

However, while that may be the norm, there are countless other scenarios and content types your faculty may want capture for their courses. As you set up new spaces for lecture capture, consider the presenter(s) and the range of content they may want to capture.

Presenter Considerations

Number of Presenters

While most classrooms will only need to capture audio and video for a single instructor, you'll want to have a plan in place (especially for larger rooms) to accommodate multiple presenters or classes with guest lecturers. Capturing audio from multiple presenters may require adding more lapel mics and an audio mixer. And you may need one or more video cameras to capture multiple people in a given area of the room.

Audio-Only Option

While most faculty will want to pair their lecture slides (and other recorded materials) with both the audio and video of their classroom presentation, some instructors may prefer to stay off camera and include only their audio.

To help faculty become more comfortable recording their lectures (and in doing so, bolster lecture capture adoption across campus), faculty should be given the option of recording both video and audio, or audio-only.

Presenter Mobility

Some lecturers prefer to move around when they present, while others do not. This can create a challenge in provisioning classrooms for lecture capture, as the same room may host a mix of both styles over the course of a day.

When provisioning a room, test a few styles of presenting (e.g. behind-the-podium, moving throughout the classroom, etc.) to see what your cameras and microphones can easily capture. Then, use available furniture and seating to create the best possible "stage" for your instructors. You may also want to mark the floor with tape to help teachers recognize when they'll be walking out of the camera's view.

Masking tape is a simple, non-permanent way to help instructors see where cameras are focused.

Likewise, be sure to provide audio options so teachers can select a microphone that suits their style. A lavalier or clip mic will be best for presenters who like to move, particularly in a larger room. Podium or desktop microphones can be provisioned in smaller rooms where the presenter typically remains in one place.

Comfort Level with Technology

As with any technology, the pitch of the expected learning curve makes all the difference when it comes to adoption. Emphasizing ease of use in the selection criteria for your campus lecture capture solution is essential.

As institutions begin moving away from multiple departmental instances of lecture capture toward standard campus-wide solutions, one of the benefits often seen is that the technology becomes more consistent and familiar for faculty and students. The transition to third-generation lecture capture solutions has bolstered that effect. Instead of proprietary hardware, instructors can now capture classes with the laptops and mobile devices they're already comfortable using.

Making it easier for instructors to record using the devices they are already familiar with can help boost lecture capture adoption.

Even still, some instructors will recoil at the prospect of using a new classroom technology. Learning technology teams can often mitigate these reactions through early and ongoing training. And increasingly, lecture capture solutions have introduced new features intended to lessen the day-to-day burden on faculty. It's now often possible for lecture capture administrators to schedule and automate a semester's worth of lecture recordings in advance. This enables instructors to simply walk into a room and teach like they always have, while the system takes care of all the recording and video processing details automatically.

Content Considerations

In the majority of classrooms, instructors will include visual materials to support students' learning experiences. These materials may be written on a board, or projected in the form of slides, additional videos, computer screens, document cameras, or any number of other formats.

The limitations of first- and second-generation lecture capture hardware generally meant institutions could only record these materials by projecting them to a standard screen that was then captured with a video camera. Worse, lecturers often spent much of class standing in front of the screen, blocking the materials as they presented.

The harsh contrast between the brightness of the presentation and the darkness of the lecture hall makes it difficult for a camera to record both subject and slide presentation in a single frame, limited by the camera's dynamic range. Because the camera is unable to record both bright and dark with the same settings, it must attempt to choose one or the other, or flicker back and forth between the two creating a visually distracting recording.

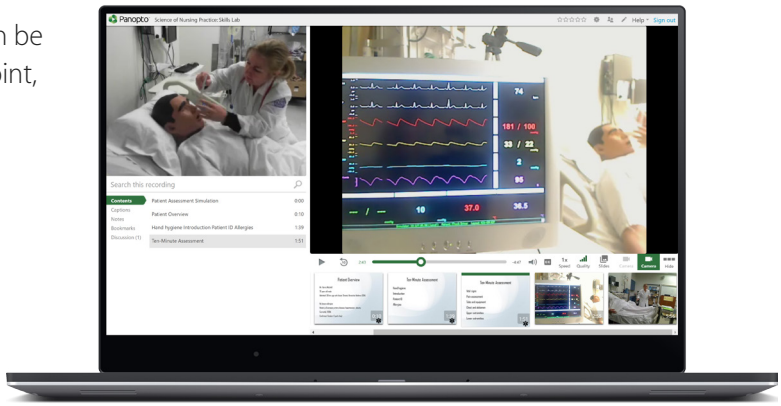
Third-generation lecture capture software now provides the ability to flawlessly capture these supporting materials in a way that is easier and produces a higher quality, more legible image. And since playback can now include multiple video feeds, instructors don't have to think about how a given slide or demonstration will "read" to the camera at the back of the room — whenever unique content needs arise, they can simply plug in an extra camera and capture the new material as an additional feed.

Slides

Most lecturers will want to capture presentation slides that can be made with any number of presentation tools such as PowerPoint, Google Slides, Keynote, Prezi, and Canva. With most lecture capture software, you won't need an external video camera to capture a presenter's supporting slides. Instead, they'll be captured directly from the presenter's computer.

Computer Screens

Some presenters will want to project their computer screen as part of their lecture when they need to show or demonstrate something live. Ideally, you will want to give your lecturers control over when the recording switches between slides and screen — either as an easy switch in real-time during class, or as a toggle option in post-production editing.



The easiest way to capture classroom details is to enable faculty to plug in an extra camera when needed.

Click to view a sample classroom recording featuring two separate video feeds and slides.

Curated Videos

If a presenter wants to show additional curated videos from YouTube or other sources, many lecture capture tools will be able to record the video via screen share. Just be sure be sure to check that your lecture capture solution can capture the computer's audio, too, or otherwise you'll only see the image playing without sound. Other solutions make it easy to incorporate external videos by embedding the video in post-production. This eliminates the need to capture computer audio and results in higher quality, smoother video playback.

Whiteboard, Blackboard or SMART Board

Legibility is everything when it comes to capturing these materials, so take time to create a few test recordings to ensure the camera is close enough to make the writing readable. You'll also want to test at different times, to ensure any morning or afternoon glare from the sun is accounted for in your settings.

For the most consistent results, you may want to install a dedicated camera for capturing the board (watch an example video). And if your writing surface is moveable, like a whiteboard on wheels, you will likely want to mark the floor to indicate where the board should be placed in order to align with your camera.

Document Camera

Specialty document cameras are the modern-day equivalent of overhead transparency projectors. They not only display printouts, but can present and magnify just about any real-world object from letters and leaves to textbook pages and tablet screens.

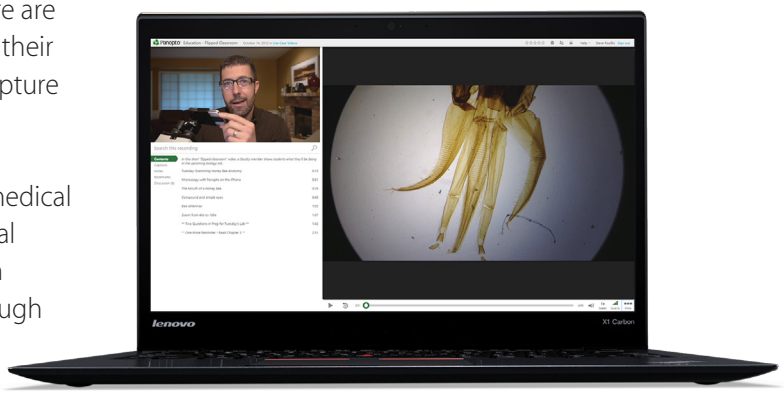
When provisioning a room with a document camera, be sure to connect the document camera to your lecture capture software so it can pull in the feed, and as always, test to ensure everything records clearly and as expected.

Specialized Recording Equipment

There are many unique applications for lecture capture as there are classrooms. Increasingly, many fields of study have developed their own highly-specialized equipment, and ideally your lecture capture solution should have the ability to record those feeds as well.

Whether your camera is connected to a microscope in a lab, medical equipment in a surgical theatre, exploratory tools for geological study, or even just mobile tablets and smartphones for used in fieldwork, your lecture capture solution should be flexible enough to make that video available on-demand for students.

We'll cover examples of how you can provision for these types of needs in Part II of this guide.



Click to view a sample recording created with a specialized microscope camera.

Making Lecture Capture Work for Instructors: Fixed vs. Flexible Setups

There's often some trade-off in ease of use between fixed and flexible setups. You will want to consider your selection and placement of AV devices, as well as the usability of your setups in various classroom settings.

Fixed Lecture Capture Setups:

The goal of a fixed setup is to allow a lecturer to walk in and record their lecture with very little effort. With a fixed setup, you'll have audio and video recording devices provisioned in a room, with cameras and microphones positioned in advance.

Flexible Lecture Capture Setups:

Flexible lecture capture setups allow instructors to make their own choices when it comes to which video and audio tools they'll use for recording, thereby enabling faculty to experiment with new blended and/or interactive learning techniques, as well as to make use of the specialty equipment that may be unique to their field. By definition, flexible setups vary greatly, and can be anything from simply allowing the lecturer to use their own webcam or mobile device for recording, to complex, one-of-a-kind scenarios based on classroom needs.

Flexibility is a key consideration in lecture capture. More flexible solutions will enable instructors to utilize video in more ways.

Flexible solutions can be a highly valuable way to support student learning experiences, but may also require more assistance from an AV specialist on campus in order to ensure classroom activities are captured as intended.

What Equipment Will You Need?

When it comes to lecture capture equipment, the basics are simple. You'll need a computer configured for lecture capture, as well as audio and video recording devices that will feed into the computer.

While lecture capture software enables instructors to record basic video content with just a laptop or mobile device, most colleges provision their classrooms on campus with a fixed lecture capture system. These systems provide teachers with a ready-made recording environment, in which faculty simply walk in, plug in, and hit record. The lecture capture system ensures consistent quality in the classroom videos, and minimizes the need for presenters to learn and tweak potentially complex in-room AV setups.

In this section we'll compare options for the backbone of your lecture capture setup — building a lecture capture computer versus buying a rack-mount lecture capture appliance. We'll then dive into specific features you should consider when selecting peripherals such as video cameras, microphones, capture cards and other accessories for your setup.

Check out our equipment guide in Part III for a rundown of our favorite lecture capture appliances, devices, and accessories.

Lecture Capture Computers

At the core of an in-room lecture capture system is a lecture capture computer that runs video capture software and grabs AV feeds from connected classroom devices. A lecture capture computer can either be a customized desktop, or it can be purchased as a plug-and-play rack-mount appliance. We'll discuss the benefits of each approach, but first let's look at the components that typically go into a lecture capture computer.

What Goes Into a Lecture Capture Computer?

A lecture capture computer is typically a midrange to high-end computer with video capture software installed and the proper ports for capturing and syncing AV feeds.

Typically, a lecture capture computer will have the following components:

- A midrange to high-end microprocessor
- Large internal storage capacity to support the storage of video files
- Ethernet connectivity
- USB 2.0, 3.0, or 3.1 (Type-C) ports
- Video-in ports (some combination of HDMI, DVI, SDI, VGA, and analog)
- Video-out ports (typically HDMI, DVI, DisplayPort, or VGA)
- Audio-in and out ports for mics and line audio

Your choice to either use customized desktop computers, or to purchase rack-mount appliances, will depend greatly on the following:

- Your existing infrastructure
- Your budget
- Your desire to upgrade as technology changes

Option 1: Customizing Desktop Computers

Customizing an off-the-shelf desktop computer is typically the most flexible solution and generally comes at a lower cost. The tradeoff is usually your team's time, as you'll need to set up each computer individually.

A few key considerations:

Existing equipment:
Many classrooms are already equipped with a computer that can be provisioned for lecture capture with a few relatively simple upgrades. In most cases, adding video capture software and potentially upgrading the video capture card will generally be more budget-friendly than making a switch to rack-mounted appliances.

Budgeting:
You can usually build or upgrade existing desktop computers for under $1000 each.

Upgrade Flexibility:
Given the rate at which video technology can change, a customized desktop often gives you more flexibility to upgrade the operating system, drivers, desktop applications, memory, hard drive, video cards, and other internal components.

With lecture theatres in two countries of the world, three cities in UK and another that requires a ferry to get to, installing new technology at the University of Southampton can be a challenge.

Choosing to implement software-based lecture capture on their own computers allowed the team to "switch on" lecture capture in all 160 centrally bookable lecture spaces, as well as make recording available on every staff member's PC, all overnight and without staff visits and complicated configurations.

Graham Robinson, University of Southampton eLearning Specialist, shares the of how they did it and how it worked – click to read more in his post.

Option 2: Buy Rack-Mount Appliances for Lecture Capture

Purpose-built, rack-mount lecture capture appliances come ready out of the box, so setup is usually quick and easy. While it is typically a more expensive option than a customized desktop, some rack-mount appliances can be just as flexible and may fit better with your existing AV setup.

A few considerations for provisioning classrooms with purpose-built appliances:

Existing Infrastructure:
If your classrooms are already provisioned with rack-mounted equipment, purpose-built lecture capture appliances will often be preferred. In cases where the rack is in an adjoining room, be sure to plan for cable logistics and signal boosters, since video, audio, and data cables can suffer from signal degradation at longer lengths.

Budgeting:
Purpose-built video capture appliances typically cost anywhere from $3,000 to $20,000 each. The specific features included in an appliance will vary by vendor, so be sure to have your solution provider detail the specifications of the processor, hard drive, video and audio capture capabilities, video and audio output options, and automation and remote control capabilities.

Upgrade Flexibility:
Most modern lecture capture appliances are based on the Wintel architecture, making it straightforward to upgrade the operating system, memory, hard drive, and other internal components. Other appliances are built using embedded systems that cannot be easily modified. This typically limits the lifespan of the device, or at a minimum, requires you to ship outdated appliances to the lecture capture provider in order to receive an upgrade. In addition to the time required to ship the appliance and the resulting downtime of your lecture capture system, these trade-in upgrades also often come with an increased annual maintenance cost.

The Panopto-Certified Video Capture Appliance by Seneca

Option 3: Utilizing Faculty Laptops for Lecture Capture

In the absence of a dedicated video capture computer in the classroom, a lecturer can install lecture capture software onto a personal laptop and then connect AV equipment, such as a camera, microphone, and an external capture card.

This is a quick and flexible setup option that can be scaled to many classrooms, but the presenter will need to be able to connect peripherals and have functioning knowledge of how to use your lecture capture software.

A Letter of Recommendation: Remote Recording and Scheduling

One software-based lecture capture feature can make recording remarkably simple for both presenters and the AV team — remote recording. If your lecture capture software provider offers this feature, your technical team will be able to schedule and manage your lecture recordings from anywhere with a web browser or smartphone.

For faculty and non-technical presenters: A mobile app with a remote control interface turns any smartphone into a secure touch panel for controlling in-room AV gear. This interface standardizes the controls for different devices in different classrooms on campus. It's the perfect solution for anyone who has avoided recording lectures because they weren't sure how it all worked.

For your AV team: Remote recording has the potential to reduce workloads, giving them the ability to schedule recordings in specific classrooms in advance. With just a few clicks, you can securely schedule a single event or a recurring weekly lecture for the entire semester. You can even control how the recording is captured by selecting video sources, setting the recording quality, and even choosing to live stream the recording or not.

Additionally, AV teams can use the remote recording feature to securely monitor recording status, preview live recordings, and check audio levels. From one remote location, you can check the status of recordings all across campus to make sure scheduled recordings are going as planned.

Video Recording Tools

In an ideal world, a single camera model would meet the requirements of every learning space.

This perfect, all-in-one camera would support pan, tilt and zoom (PTZ) to accommodate the size and setup of any classroom. It would deliver smooth, broadcast-quality video in different lighting conditions. It would have a small form factor to fit on a podium or discreetly mount to the wall. Its cost wouldn't prohibit you from buying one (or more) for every classroom across campus. And of course, it would plug directly into a standard USB port to eliminate the need for video capture cards. You could buy this all-in-one camera in bulk to receive significant discounts, and you could save time by provisioning the same camera model in every learning space.

Of course, this camera doesn't yet exist, although we can see glimpses of this future through recent advances in 4K, 60 frame-per-second (fps) USB webcams and smartphone cameras.

Until the all-in-one camera arrives, you've got choices. Fortunately, where budgets are concerned, the cost of the highest-quality cameras has dropped significantly in recent years, and the capabilities of even the most inexpensive devices have risen considerably.

You'll find that the "best" camera(s) will vary by classroom, based on the room size, available lighting, existing infrastructure, course-specific demands, and presenter logistics. For example, a high-end PTZ camera may be your best choice for a large lecture hall frequently used for guest presentations and live events, while a consumer-grade camcorder or even webcam may suffice in some smaller classrooms.

As you consider your options for each learning space, keep in mind that the goal of any lecture capture camera is to reproduce the classroom environment with high enough fidelity to improve the student viewing experience. When thoughtfully provisioned, video cameras help students feel as though they're in the room even if they're watching from miles away.

Let's look at the major categories of video cameras on the market, compare their relative strengths, and discuss why you might select one over another for any given space.

Camera Type	Lecture Hall	Classroom	Office	Active Learning Spaces	In The Field
Webcam		✓	✓	✓	
Camcorder	✓	✓			
DSLR	✓	✓			
PTZ	✓	✓		✓	
Motion Tracking Camera	✓				
Mobile Device (Smartphone/Tablet)			✓	✓	✓

Webcams

Webcams are compact video cameras that are either built into a laptop or connected externally via a USB connection. Webcams have become remarkably powerful in recent years, with models like Logitech C922 supporting 60fps and Logitech Brio supporting up to 4K resolution. Many webcams will also record audio, although the quality of audio captured currently varies greatly from model to model.

Logitech c922 Webcam

What They're Good For

Webcams can produce smooth, clear video in smaller, well-lit spaces. These affordable cameras are ideal for a lecturer recording herself in a small room or office setting with ample lighting.

What They're Not Good For

The small sensor in a webcam will not handle diverse lighting scenarios well. Low lighting will introduce noise and choppy video, and backlighting will generally underexpose the presenter. You also won't get the same depth

of field (DOF) as you would with higher-end cameras if you're looking for a more professional-looking recording. Webcams are not recommended for large lecture halls, although they can work as a baseline solution in smaller, well-lit classrooms.

Price Range
A quality USB webcam for lecture capture will typically cost between $30 and $100. This budget-friendliness also makes USB webcams the perfect video tool for flipped classrooms, and an ideal supplemental video source for capturing close-ups of whiteboards or in-class demonstrations.

Camcorders

Portable video camcorders, like the Sony Handycam or Canon VIXIA series cameras, will have more features and higher-end capabilities than a webcam. Camcorder lenses typically provide zoom capabilities anywhere from 8x to 60x. These cameras also have larger sensors and wider dynamic ranges than webcams, performing better in low-light situations. And camcorders typically provide greater control over white balance and exposure to help ensure the consistency of your recordings.

What They're Good For
Mounted on a tripod, wall, or ceiling, or even using a camera operator, camcorders are good for recording lectures in most standard classrooms and lecture halls. These cameras will give you high-quality video with the flexibility to zoom in on a presenter from a distance.

What They're Not Good For
Camcorders offer a lot of range and versatility, but they're overkill for traditional flipped classroom recordings. For example, faculty recording themselves in an office setting won't need this type of camera (and will likely prefer to use something less complex). In addition, camcorders don't provide the ability for AV teams to remotely control the panning, tilting and zooming. This may make camcorders less attractive as a wall- or ceiling-mount option for large lecture halls.

Sony HDR-PJ540 Camcorder

Price Range
A quality, consumer-grade camcorder for lecture capture will typically cost between $300 and $1000. For many institutions, this will be the right mix of recording quality and price, and will be the go-to option when provisioning new rooms. For even greater quality, higher-end, professional camcorders, like the Sony HXR-NX100 or the Canon XF200 HD typically list between $1000 and $3000.

Along with the camcorder itself, it's likely you'll also need to invest in a capture card in order to connect the camcorder to your lecture capture computer. Check out our section on Connecting Video Recording Devices to Lecture Capture Systems for more details on capture cards.

DSLR Cameras

Digital single-lens reflex (DSLR) cameras made their name in still photography, but in recent years, they've also become a contender for high-quality video capture. These interchangeable-lens cameras sport significantly larger sensors than camcorders, making it easier to capture high-quality video in difficult lighting conditions, and to achieve more cinematic depth of field.

Panasonic Lumix GH4 DSLR

What They're Good For

DSLRs can produce incredibly high-quality, professional-looking video. They can be set on a tripod or mounted to the wall or ceiling in fixed setups to record lectures and guest presentations. They also make for excellent recording studio cameras.

What They're Not Good For

DSLRs are unique beasts. Their zoom range generally ranges from 4x to 10x, less than that of many camcorders. So they're not ideal for the largest of lecture halls. In addition, most DSLR lenses don't zoom smoothly, and like camcorders, their pan and zoom capabilities can't be controlled remotely. As a result, they often aren't the best choice for camera operators. And due to their price, DSLRs are overkill for most small classrooms.

Price Range

A quality 1080p or 4k DSLR camera with a full-frame sensor and interchangeable lens can cost between $1,200 to $3,000 (additional lenses typically cost extra).

PTZ Cameras

The defining characteristic of pan-tilt-zoom (PTZ) cameras is their ability to have their direction and zoom controlled remotely. Cameras such as the Sony SRG-120DH and SRG-300H are meant to be wall- or ceiling-mounted, and then controlled by a wireless remote, room AV control system (like Crestron), or joystick controller. These cameras have large zoom ranges, and most newer PTZ models capture excellent-quality video in 1080p at 60fps.

Sony SRG-120DH PTZ Camera

What They're Good For

PTZ cameras can be used in almost any classroom or lecture hall. Their remote control makes them ideal for important events and guest presentations in large auditoriums where a camera operator is required. They also offer a lot of flexibility for recording in multi-purpose rooms, labs, and simulation spaces.

What They're Not Good For

These cameras can be overkill for small classrooms, both in terms of their cost and capabilities. And with their fixed setup, PTZ cameras aren't meant to be used outside traditional learning spaces like classrooms, auditoriums, and labs.

Price Range
A quality PTZ camera will range from about $1,200 to $3,300. You may need to purchase a remote controller in addition to the camera in some cases, so be sure to factor that into the total cost for these cameras.

Motion Tracking Cameras

Motion tracking cameras, such as the iSmart Lecture Tracking camera (LTC-A2001N), are innovative PTZ cameras that can automatically follow a presenter as he or she moves, without the need for an operator to manually pan the camera during a recording. The iSmart camera uses facial recognition and motion detection technology to follow the presenter moving about the front of the lecture hall.

iSmart Lecture Tracking Camera

What They're Good For
Motion tracking cameras are built for larger lecture halls where the presenter has room to walk around. By following the presenter, these cameras typically capture a tighter field of view. This creates a more engaging shot of the lecture compared to a wider field of view that captures the full presenting area or stage.

What They're Not Good For
This technology comes with a high price point, so it won't be ideal for many standard classrooms and lecture spaces. Likewise, if your room limits the amount of space presenters have to move about, or if your instructors just tend to stay put behind a podium as they present, there will be little value to be found in spending more on this technology.

Price Range
The iSmart Lecture Tracking camera starts at $6,000.

IP Cameras

An IP, or internet protocol, camera can send and receive video over a local network or the internet. This type of camera is most commonly used for security and surveillance, and was a common choice in some early lecture capture installations. IP cameras installed as part of your security infrastructure can sometimes be repurposed or reconfigured to also support lecture capture.

What They're Good For
When available, repurposing or updating IP cameras can save you from purchasing new cameras when provisioning a space that already has these devices installed. You will first need to check that your existing IP cameras are compatible with the lecture capture software you're using. Then, there will typically be a bit of extra setup to install drivers that enable your lecture capture software to recognize these cameras.

What They're Not Good For

IP cameras are not recommended for new lecture capture installations. There are generally higher quality camera options at lower price points that are easier to set up for lecture capture.

Price Range

IP cameras can range from a couple hundred dollars to a couple thousand dollars, depending on their features. Models that have higher resolution, flexible pan, tilt and zoom capabilities, and other high-end features will typically cost over $1000 each.

Smartphones and Tablet Cameras

Most people today already have a device in their pockets that can record course content — their smartphones. High-end smartphones and some tablets have the ability to record high-quality video at up to 1080p and 60fps with image stabilization. These devices have made new use cases for lecture capture possible, from in-the-field recording to multi-camera captures of demonstrations, and more.

Mobile devices are familiar, flexible, and increasingly capable of capturing high-quality video.

What They're Good For

Smartphones and tablets can take lecture capture outside the traditional classroom into the field, the lab, or into student breakout spaces. These devices are perfect for ad hoc recordings and capturing multiple (sometimes tricky) viewpoints in a demonstration. Widely available with students as well, they can also be perfect for tool for recording student presentations, projects, role-plays, and other video-based assignments.

What They're Not Good For

Typically, smartphones and tablets are not used as the primary video capture source in fixed classroom setups. For example, you wouldn't provision a classroom for lecture capture with an iPad mounted at the back of the room, as mobile devices have limited battery life and often lack sufficient onboard storage for large video files. You would, however, use a mobile device to capture video from another viewpoint during a demonstration or presentation in class.

Price Range

Mobile devices vary widely in price depending on the brand, model, and features. If buying from a standard retailer, you can expect to pay anywhere from about $200-$800 for a mobile device with good video capabilities. Your institution may have the power to buy a large quantity of devices at a discount or you may already have many of these devices available for use on campus. And of course, in many cases, most of your faculty will already have their own tablets and smartphones that can record and publish video to your lecture capture software via a mobile app.

Specialty Cameras

Specialty cameras expand the type of content that faculty can include in their recorded lectures. These cameras typically capture feeds that are secondary the presenter video and their on-screen content. So check that your lecture capture software is capable of capturing video from multiple sources. Below are some of the most common examples of specialty cameras:

Document cameras:
A document camera can be used to display print materials or real-world objects. You can also use document cameras to capture the screen on a smartphone, which can be useful for demonstrations.

Microscopes:
Video microscopy can be captured in several ways. Newer digital microscopes provide direct video out via USB or HDMI. And traditional compound microscopes can be fitted with a smartphone adapter to capture video via mobile lecture capture apps.

Interactive whiteboards:
Rather than simply pointing a camera at a whiteboard to record, a variety of technology-enabled interactive whiteboards can now be connected to a lecture capture system and recorded much like a secondary computer screen. Interactive whiteboards capture the content instructors write on them using a number of different methods — infrared scanning, resistive touch, and electromagnetic or ultrasonic markers are all common. Check with your lecture capture system provider for specific setup recommendations.

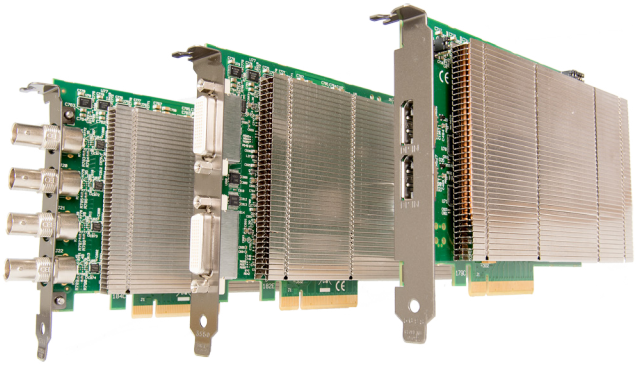
Specialty scientific instruments:
There is a broad range of medical and scientific equipment that faculty may want to present in lecture video. Mobile and multi-camera recording features will allow for many non-conventional video capture scenarios, but check with your lecture capture system provider for specific setup recommendations.

WolfVision VZ-8plus Document Camera

Connecting Video Recording Devices to Lecture Capture Systems

Different cameras provide different ways to stream video from the device to the lecture capture computer. Webcams, some PTZ cameras, and an increasing range of specialty recording devices make it simple by using USB 2.0 or 3.0 connections. Whether you're using a laptop, a desktop, or a rack-mount appliance, these devices typically just plug-in and work.

By contrast, camcorders, DSLRs, most PTZ cameras, and many specialty cameras send video to the lecture capture computer over HDMI, SDI, DVI, VGA, component, or composite connections. These require either an internal or external video capture card to convert the feed into a format that can be recognized by the computer as a video source.



Datapath VisionSC Capture Cards

For rack-mount appliances and most desktop computer setups, an internal video capture card makes the most sense. These cards typically provide single, dual, or quad inputs for video, with options for all of the typical video interfaces.

For laptops, internal video capture cards aren't an option. Instead, external capture cards (sometimes called capture dongles) can accept incoming video from the camera and convert it to USB. These converters are available for HDMI, SDI, DVI, VGA, and analog video sources.

HDMI to USB

SDI to USB

DVI to USB

VGA to USB

Analog to USB

In just the last few years, USB 3 video capture cards have begun to change the face of high-quality video recording and live streaming. An AV setup that once cost thousands of dollars and required complex, specialized appliances can now be achieved with an existing midrange laptop and a $300 dongle.

Want to know more? Click to read our overview of USB 3 video grabbers.

A Letter of Recommendation: Distributed Recording

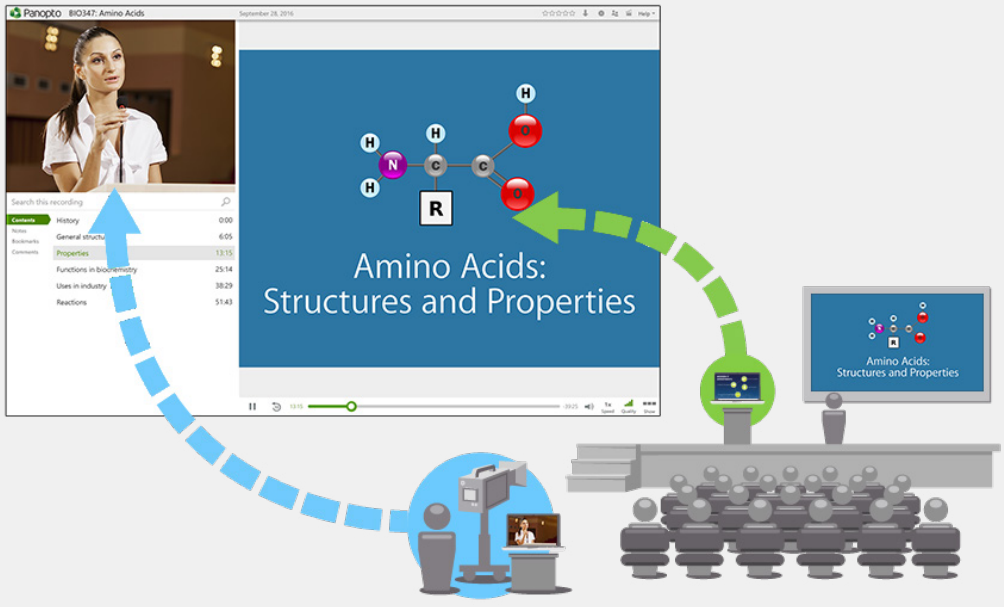
Some lecture capture systems provide a capability called distributed recording (also known as multi-machine recording).

With distributed recording, you can use separate web-connected lecture capture computers and/or mobile devices to capture multiple video and audio feeds. These feeds are automatically synchronized on the lecture capture server or in the cloud with no hard-wiring or other physical connections necessary.

Benefits of Distributed Recording

- Larger rooms with complex setups no longer need hundreds of feet of cable to connect every device and computer together
- Record from multiple video sources without a centralized mixer
- Reduce the need for video signal converters
- Can be used for live and on-demand webcasting
- Record and sync streams from different locations and networks
- Record and sync from multiple mobile devices

For more, check out our detailed video review of distributed recording.



Distributed recording simplifies in-room recording setup by using separate computers to capture different aspects of the lecture.

In this example, slides are recorded using a laptop at the front of the room, while the presenter is recorded using a camcorder and laptop in back.

Audio Recording Tools

There's a simple secret to getting the most out of your lecture capture tools, and it's this: your audio matters twice as much as your video. When students can hear crisp, clear audio of their instructors in a recording, poor video quality may still be a distraction, but one that can often be overlooked. By contrast, broadcast-quality video is for naught if the audio is garbled or otherwise unintelligible. Without a quality talk track, students will rarely find a recording useable.

Fortunately, the same trends that have made video recording devices more accessible and affordable in recent years have also been at work with audio devices. Today, institutions will find a plethora of easy and inexpensive devices. Let's take a look at what's available, what each does well, and why institutions might select one over another for any given space.

Microphone Type	Lecture Hall	Classroom	Office	Active Learning Spaces	In The Field
Desktop mic		✓	✓	✓	✓
Boundary mic		✓		✓	
Lavalier mic	✓	✓		✓	✓
Handheld mic	✓			✓	
Podium mic	✓	✓			
Built-in / Native mic			✓		✓

Desktop mics

Desktop microphones are designed to sit on top of a table or podium, near the presenter.

Blue Microphones Yeti USB Mic

What They're Good For

Desktop microphones will produce excellent sound when they are positioned directly in front of a stationary lecturer. Desktop mics are recommended for quiet office spaces or at a podium where a lecturer will be standing.

What They're Not Good For

These microphones are not very good at reducing background noise. You'll need to ensure that desktop mics will be positioned close to the person speaking, and that they'll generally be used in quiet spaces. A noise-cancelling microphone shield can help reduce background noise if you already have desktop microphones you want to use. For presenters who like to move around, these are not ideal.

Price Range

A quality desktop microphone will cost between $50-$150.

Boundary mics

A boundary microphone is a small, omnidirectional mic that sits flat on a surface, such as a table or mounted on a wall. The boundary mic is designed to pick up sound that reflects off the surface on which it is mounted or positioned.

HuddlePod Air
Wireless USB Boundary Mic

What They're Good For

Boundary mics are good for recording seminar-style courses in small rooms or smaller discussion classes. These small, unobtrusive mics can also be used as a fail-safe for fixed lecture capture setups. The quality won't be as good as other microphones, but in case a lecturer forgets to use or turn on another primary microphone source, a boundary mic will capture acceptable audio most of the time. Note that, in this scenario, you'll need to add an audio mixer to pull the extra audio feeds into your lecture capture system.

What They're Not Good For

If you are aiming for optimal sound quality in your recordings, you should not use a boundary mic as your primary audio recording device.

Price Range

A good boundary mic will range from about $50 to $100.

Lavalier mics

A lavalier microphone (also commonly referred to as a lapel mic, clip mic, body mic, or lav) is a small, hands-free microphone that can be worn by the presenter, and which will capture high-quality audio even as he or she moves around. The microphone plugs into a wireless transmitter that the presenter wears on a belt or waistband, and the transmitter sends the audio feed to a receiver that will need to be connected to your lecture capture system.

What They're Good For
Because they are worn by the lecturer, lavalier mics are good for capturing crisp, clear audio of a single presenter in most scenarios. There are even lavalier mics that plug directly into a smartphone or tablet, so they can be used for recordings both in the classroom and in the field.

What They're Not Good For
These wireless systems typically require slightly more setup than other hard-wired microphones, as the transmitters and receivers will need to be set up on matching frequencies. Lavalier mics also have a tendency to eat through batteries. Rechargeable options are available, but you'll need to ensure they are placed on the charger when not in use. It is a good idea to set up a room with at least two lavalier mics in case the primary lav mic isn't functioning.

Price Range
Wireless lavalier microphone systems will start around $100 and can run upwards of $1000 for rechargeable systems.

Sony ECM-AW4 Wireless Lavalier Mic

Handheld mics

Handheld microphones are traditional microphones that a lecturer holds and speaks into directly. These can be wireless or wired into your lecture capture or AV system in a classroom or lecture hall. They are available with a range of capabilities and audio capture patterns (otherwise known as polar or pickup patterns, detailed below), and depending on the quality the cost can also vary quite a bit.

What They're Good For
Handheld microphones can be a smart a backup for lavalier microphones that may not be charged or may otherwise not be working. They are also ideal for recording quality audio of audience questions. If you want to capture a Q&A session after a presentation, you will definitely want to have one or two handheld mics connected to your lecture capture system.

What They're Not Good For
As a primary microphone source, handheld microphones tend to get in the way when a presenter is lecturing or giving a demonstration — particularly if the presenter is also clicking through supporting slides. A presenter may also get tired of holding a microphone for the entirety of their lecture. Wireless handheld microphones can also cause similar headaches to lavalier mics when they eat through batteries.

Price Range
Handheld microphones range from around $40 to around $300 each. Note that with wireless handhelds, the mic is just the transmitter. You'll also need to purchase a separate wireless receiver that then plugs into your lecture capture computer. And depending on the microphone, audio XLR cables may not be included, which could further increase your cost per unit.

Sennheiser e935 Handheld Mic

Podium mics

Podium microphones, or gooseneck microphones, are intended to sit atop a podium or lectern where a stationary presenter will be speaking. You'll have many pickup pattern options with podium microphones, similar to other styles of microphones. You can also purchase bases for these microphones with features including "active" LED indicators and mute switches.

Shure CVG18-B/C Gooseneck Mic

What They're Good For

Podium microphones are excellent audio sources for stationary presenters who do not intend to move around during a lecture or presentation. Or they can serve as a backup audio source in rooms where a primary lavalier mic isn't charged. You can attach these directly to a podium or use a base to make them functional on any desktop or table, making these mics a good choice for a panel of presenters sitting at a table, too (although you will need one microphone for each presenter).

What They're Not Good For

Podium microphones are not recommended for any scenarios where the presenter will be moving around. Likewise, they are not ideal for recording scenarios in which more than one person will be presenting at a time, or for recording in-class discussions.

Price Range

Podium microphones can range from around $100 to $300, depending on features included.

Built-in mics

Many video recording devices already have built-in microphones for recording audio. However, these mics tend to produce fairly low quality audio compared to external, dedicated microphone sources. If you plan to use a native audio source, it's a good idea to perform a test recording to check the audio quality ahead of time. Depending on the performance of the microphone, you may find you want to add a separate audio source.

Logitech BRIO Webcam

What They're Good For

Built-in microphones, such as those installed in most modern laptops and smart phones, or the native microphone in select camcorders and webcams, can sometimes be used effectively in quiet office spaces. They vary wildly in their quality, so be sure to test them before using recording. For the best quality audio in this category, look for a webcam such as the Logitech C922, C930e, or Brio that captures stereo audio with noise cancellation technology.

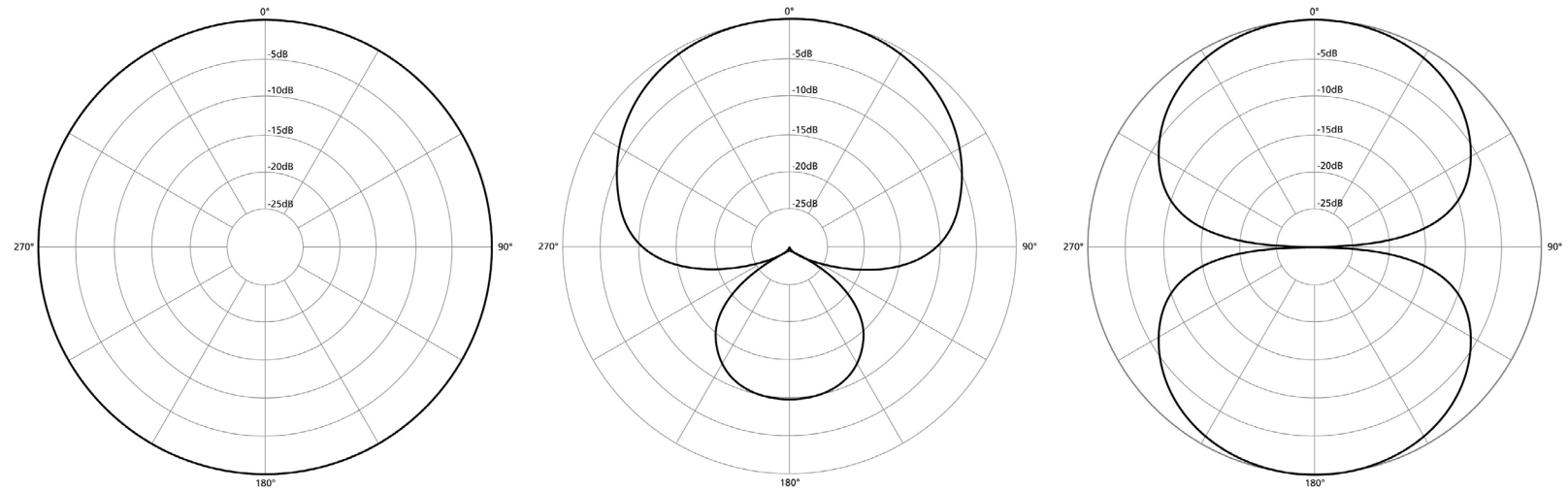
What They're Not Good For

Few if any built-in microphones will work well in any classroom where the recording device is set up more than arm's length or two from the presenter. Likewise, they are not ideal for capturing group discussions, as anyone who is farther away from the microphone will be hard to hear.

A Letter of Recommendation:
Pay Attention to Pickup Patterns

The pickup or polar pattern of a microphone refers to the microphone's sensitivity to sound relative to its direction or angle from the microphone. You will want to select a microphone whose pickup pattern will most effectively capture sound from the lecturer and minimize other sounds you don't want recorded — for example, from the students in the audience.

Some microphones will give you the option to select more than one pickup pattern, while others will record only one type of pattern. As you provision audio recording devices for your classrooms, it's important to understand the following pickup patterns:



Omnidirectional *Unidirectional (Cardioid)* *Bi-directional (Figure 8)*

A mic with an **omnidirectional** pattern will be equally sensitive to sounds produced anywhere within range. This will be ideal for capturing full-room sound, but less so for capturing specific audio, such as the words being spoken by the instructors.

A mic with a **unidirectional** pattern will be most sensitive to sounds produced immediately in front of the microphone, while the sides will be less sensitive and the rear mostly ignored. This pickup will be ideal for capturing specific audio like the voice of a presenter, but less helpful for recording more open discussions.

And a mic with a **bi-directional** pattern will prioritize sounds from both the front and back, while the sides are ignored. This is typically valuable only in more specialized use cases, such as when two presenters might be seated beside each other, or for recording music when the goal is to produce truly stereo sound.

Connecting Audio Recording Devices to Lecture Capture Systems

As with your video recording devices, your audio recorders will most often connect directly to your lecture capture computer. If your microphone cable does not align with any existing ports in your lecture capture computer, adapters should allow you to plug almost any type of microphone cable into your system. For example, higher-end microphones frequently output via XLR connections, requiring XLR-to-USB converters, such as those offered by Behringer, Shure, Blue, and Focusrite. Similarly, multiple audio sources will need to run through an audio mixer into your lecture capture computer.

XLR-to-USB Converter

Additional Lecture Capture Accessories

Along with the standard recording equipment, there are a variety of audio and visual accessories that you may need for your lecture capture implementations. While this particular space is rapidly changing, here is a quick overview of some of the most common accessories we see used for lecture capture today.

Video Switchers and Mixers

A switcher allows you to toggle between multiple video sources and send the source to one or multiple displays. This is useful for large auditorium setups that often need to capture multiple video feeds and have more complex display configurations.

Splitters

A splitter allows you to send one display source to multiple peripherals or displays. For lecture capture purposes, you would use a splitter to send video from a lecturer's display to both your lecture capture computer and to an audience-facing display.

Audio Mixers

An audio mixer or mixing console will let you capture and control multiple audio sources and levels. This is particularly useful if you are provisioning a room with multiple microphones to give lecturers more flexibility when presenting, or in rooms where you'll have multiple presenters. To use your mixer, you'll first feed your audio into the mixer and then plug the mixer into a USB or audio port in your lecture capture appliance.

Behringer XENYX 802 Audio Mixer

Visual Recording Indicators

Visual recording indicators are small lights (typically LEDs) that turn on when a lecture capture system is recording. These are incredibly useful in rooms where you may have lectures scheduled to record automatically, giving faculty a quick visual confirmation that the recording is working as expected. Likewise, a visual indicator light can help a presenter realize more quickly when a lecture isn't recording properly. Some models can even pause the recording with a tap.

Lecture Capture Setup Examples

Standard Classroom — Lecture-Based Course

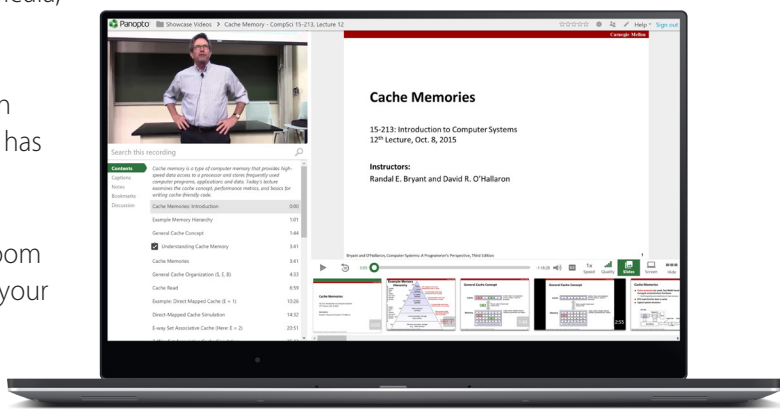
The vast majority of lecture capture implementations will take place in what can be considered a traditional or standard classroom. While few of these are ever perfectly alike (even within a single building), most are generally 400-600 square feet (37-55 square meters) in size and are optimized for 15-35 students depending on seating arrangement.

Our first two examples of how to implement lecture capture will address this prototypical classroom — first, for primarily lecture-based curricula, and second, for primarily discussion-based curricula.

In this first example, we'll assume the instructor will most often be presenting at the front of the class, and that the classroom has already been equipped with a projector.

In this example, you'll want to start by provisioning the classroom with a computer (if one does not already exist), and installing your lecture capture software on that machine.

The small size of the room should limit the mobility of your instructors. As such, you'll be able to set up a camcorder to record relatively close up video in a specific spot (typically at



Click to view a sample recording of a lecture in a standard classroom.

the podium, although any open area near the front but not too close to the screen where slides will be shown is fine). Additional webcams or camcorders can be positioned as desired to capture the board or any in-classroom demonstrations or activities. You can set up a desktop or podium mic in that space as well to ensure high audio quality.

If your instructors would prefer greater mobility, simply position your camera further back in the room to capture a wider field of view, and offer lapel mics to ensure audio is captured. Boundary microphones at the front of the room can be useful as a fail-safe for audio in case there are technical issues with the lavalier mic, but you will also require an audio mixer. Remind instructors not to present in front of or near the projector screen.

Next, you'll then want to check to see if the machine already has ports for the audio and video tools of your choice, and to add capture cards or other converters if necessary. Once you are able, connect all of your video and audio recording devices directly to the classroom computer.

Finally, connect both your classroom lecture capture computer and your projector to an HDMI video splitter, and provide an additional cable so that instructors will be able to connect their own laptops to the splitter as well upon entering the room. This will enable your instructors to use their own laptops to both present and record their lectures simultaneously.

Basic Connections, Diagrammed

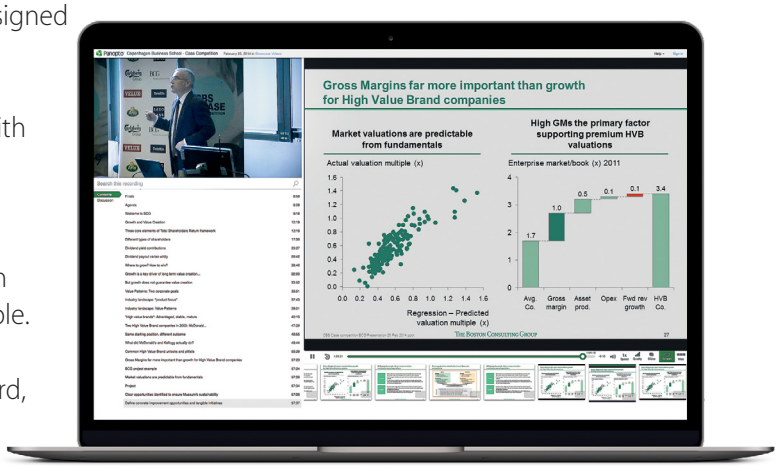
Standard Classroom — Seminar or Discussion Course

In this second example, we'll assume that instead of class time being oriented around a traditional lecture, the room will most often be used for open discussion and active learning.

Here, we'll also assume the same standard size classroom from example one, with seating for up to about 30 students, and a projector already installed. This is a seminar space with a circular seating arrangement designed to support instructor-led discussions in class.

As before, you'll want to start by provisioning the classroom with a computer (if one does not already exist), and installing your lecture capture software on that machine.

To capture a classroom-wide discussion, you'll want to position your primary camera to capture as much of the room as possible. Talk with your instructors to understand if there is anything specific they may want to capture as well, such as slides, a board, or a dedicated space in the room for in-class activities like demonstrations, presentations, experiments, role-play sessions, or anything else. You'll connect both your primary camera and any secondary recording devices directly to your lecture capture computer.



Click to view a sample recording of a seminar in a standard classroom.

Because audio can and will come from any corner of the room, you'll want to set up boundary microphones and an audio mixer to ensure sound will be clearly and consistently recorded everywhere in the room. Connect your microphones to your mixer, and connect the mixer to the lecture capture system.

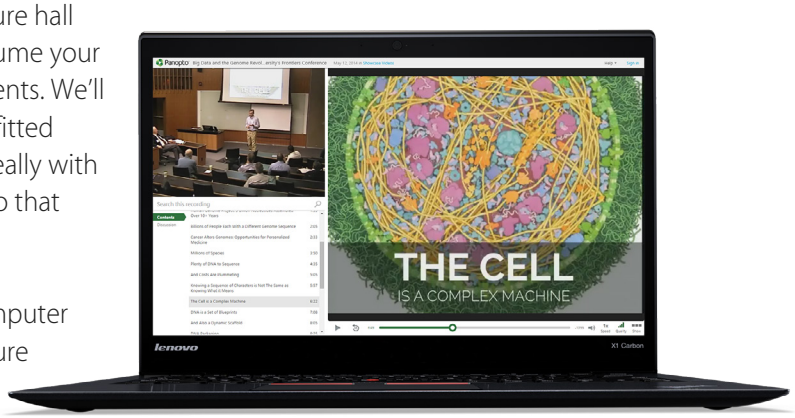
Finally, as before, connect your lecture capture computer and your projector to a video splitter, and provide an additional cable so that instructors can connect their own laptop to the system. This setup will capture clear audio and video of both the presenter and students during in-class discussions.

Basic Connections, Diagrammed

Large Lecture Hall / Auditorium

While fewer in number than standard classrooms on most campuses, large lecture halls designed to seat up to 200 or more students are often the first environment that springs to mind when teams begin thinking about implementing a lecture capture solution. And that's for good reason — these larger spaces will require a bit more planning in order to ensure they are well provisioned.

In this first example, we'll walk through provisioning your lecture hall with a single lecture capture computer or appliance. We'll assume your lecture hall is large, with auditorium style seating for 250 students. We'll also assume that such a large classroom has already been outfitted with projector, along with handheld or lapel microphones (ideally with a podium mic as a fallback) that all feed into an audio mixer, so that instructors needn't shout to be heard.



Click to view a sample recording of a lecture in a large auditorium.

You'll want to begin by provisioning the classroom with a computer (if one does not already exist), and installing your lecture capture software on that machine. In this larger room, it will be best to house this computer in the lectern or otherwise near the front of the class. Alternatively, if you'll be using an appliance, you'll want that installed similarly near the front. Either way, you'll need to confirm the solution is able to connect with the feeds from your audio mixer and the camera(s) you intend to use, or that you've added a capture card in order to record those sources.

Whether it's a formal stage or simply an open area up front, large halls typically have more space for instructors to move around as they present. As such, your primary camera should be able to record a wider view to ensure nothing is missed. If you have teaching assistants available or a dedicated AV team, a PTZ

camera is usually easy to operate, and will allow for panning and zooming to record your instructors up close.

Along with your primary camera, you'll want to ensure any other recording tools like document cameras or other secondary cameras are all plugged into your lecture capture computer or are connected via capture card. As always, test to ensure everything records as expected.

Finally, as before, connect your lecture capture computer and your projector to a video splitter, and provide an additional cable so that instructors can connect their own laptop to the system.

If your presenters will manually begin recording once they've connected their laptop, the only step required will be to click "record" on your lecture capture system. If instead the classroom is remotely scheduled to record the lecture, all the instructor will need to do is connect his or her laptop and begin presenting. As a failsafe, some schedulable lecture capture solutions even offer an "on-air" light you can connect that will provide a visual cue to let the instructor know that the room is recording properly.

Altogether, this setup will capture clear audio and video of the presenter, who is free to walk the front of the room, while minimizing background noise.

Basic Connections, Diagrammed

Large Lecture Hall / Auditorium — Distributed Recording

Often, the greatest challenge to provisioning a large lecture hall for video capture is simply connecting everything together. Whereas camera, microphone, computer, and presenter may be all located in a relatively small area in a traditional classroom, larger rooms have quite a bit more space to plan for.

Traditionally, these spaces have required significantly more investment in order to produce useable lecture recordings. Multiple cameras may be set up to capture the stage from different angles along with secondary devices to capture the board or demonstrations. Audio may require handheld or lapel mics, backup table mics, and typically, boundary mics for backup when the scheduled content calls for all-room recording.

Tying all these tools together would be video and audio mixers, signal converters, and a staggering length of cable. These connections drive up the cost and increase the complexity of recording in large rooms.

Click to view a sample recording of a guest lecture in a large auditorium.

The concept of distributed recording is designed to mitigate some of the complexity and cost of those physical connections, using the computing power of your lecture capture tools and the cloud instead. With distributed recording, video and audio feeds can be captured on separate machines and then synced in the cloud. This has two important benefits. First, it dramatically reduces the amount of cable required to provision your room. Second, because modern lecture capture systems perform signal detection and conversion, it eliminates the need for hardware-based signal converters.

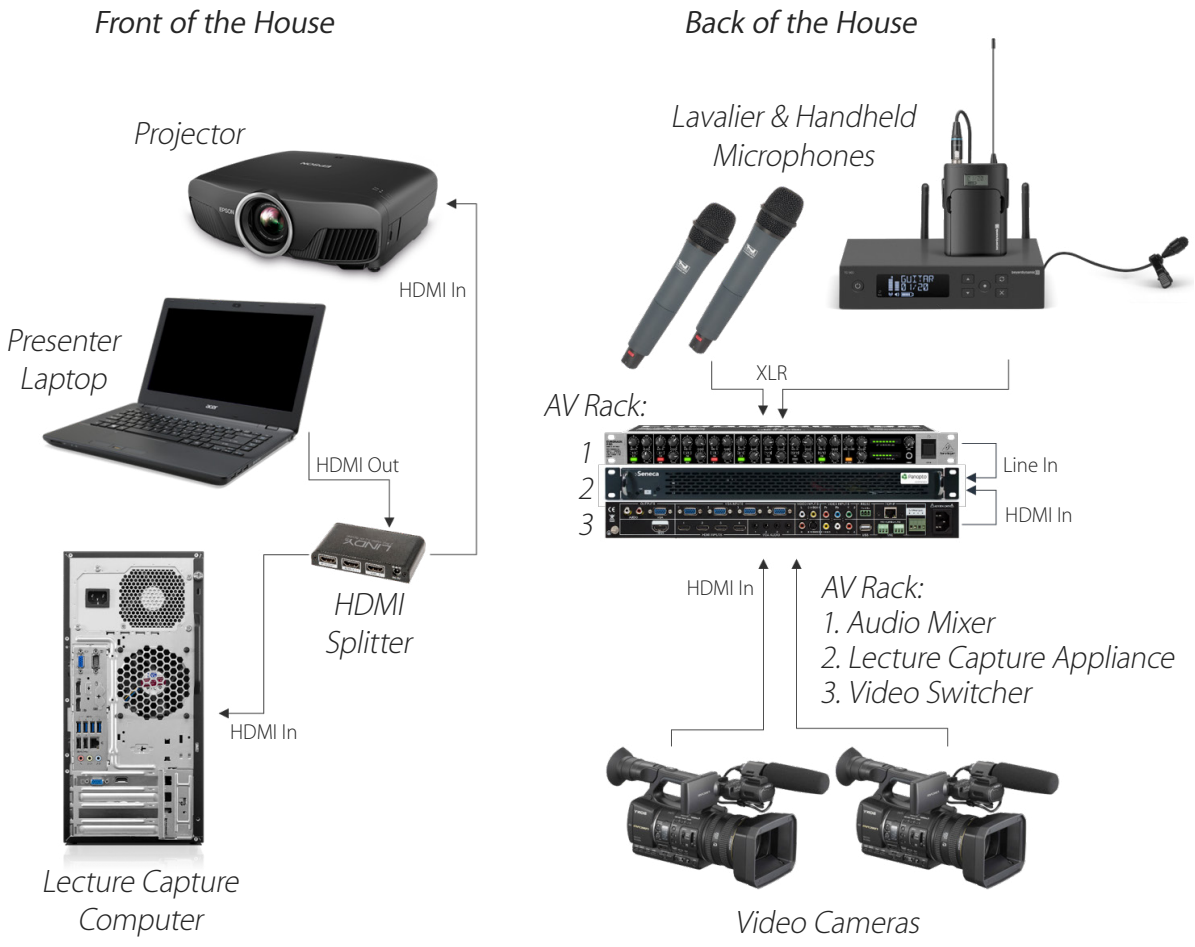
To provision a room for distributed recording, begin by mentally dividing the room into two or more segments. In this example, we'll use the traditional "Front of House" and "Back of House" designations, covering the tools we'll use on the stage and further back in the classroom, respectively.

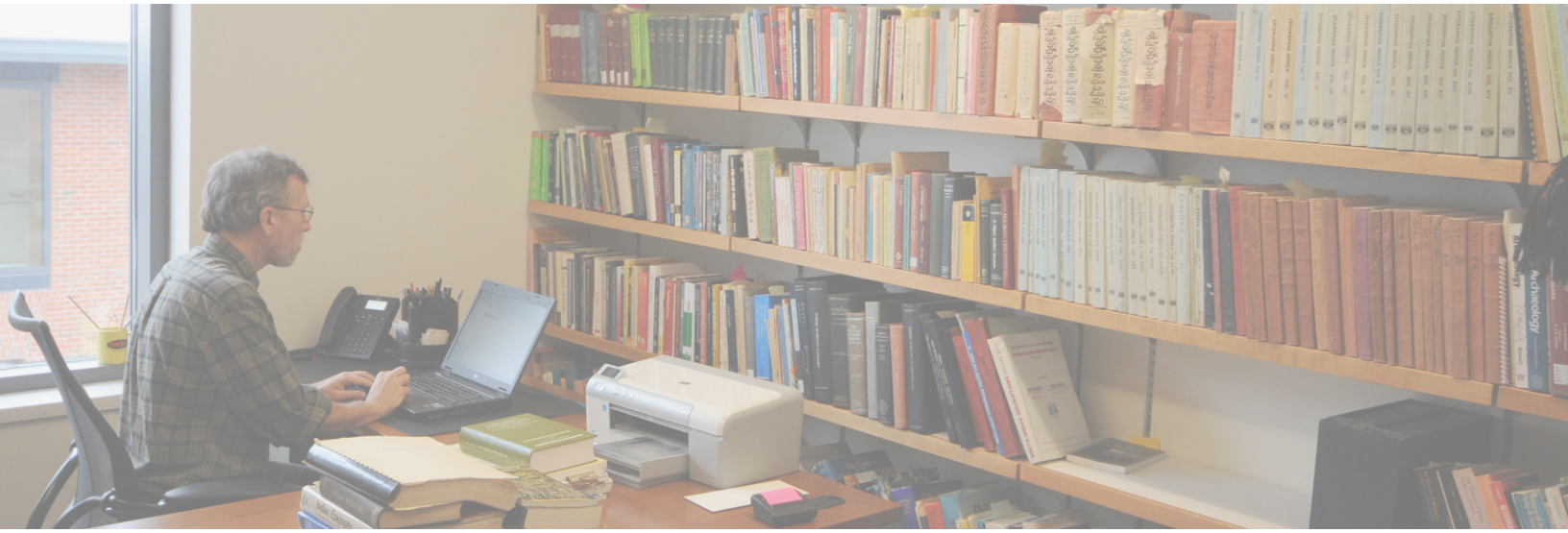
In the back of the house is a rack-mount lecture capture appliance that resides in your auditorium's AV room. Here, it can capture feeds from the sound mixing board already set up in the auditorium. You'll also connect the camera(s) set up in the back of the auditorium to this lecture capture appliance.

In the front of the house, you'll want to set up a separate lecture capture computer, connected by video splitter to your projector and ready with a cable for your instructors to connect their own laptops to the system.

To bring everything together, you'll set both lecture capture computers to record into the same video session - this capability is built into lecture capture systems that support distributed recording. Your lecture capture solution will then do the heavy lifting of synchronizing your feeds. Note that this setup works equally well for live and on-demand video.

Basic Connections, Diagrammed



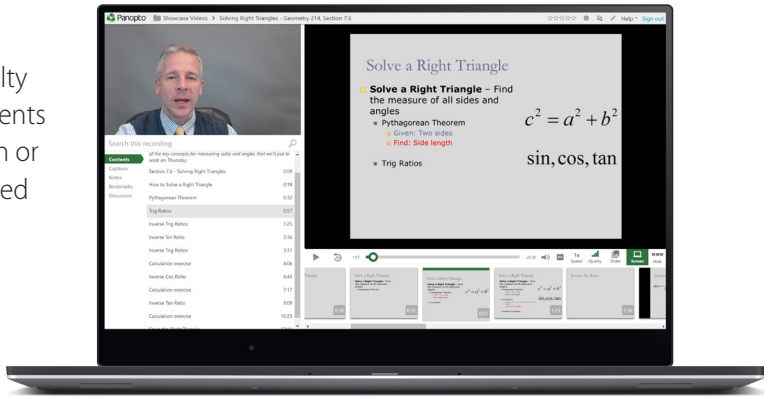


Faculty Office Space

In our first four examples, we've reviewed how lecture capture can be implemented in some of the most common learning spaces. However, as today's instructors continue to find more valuable applications for video in the learning experience, restricting lecture capture solely to classrooms simply isn't wise.

As the flipped classroom pedagogy sweeps through higher education, many instructors have begun to seek out efficient tools for capturing and sharing pre-class instructional materials. Your lecture capture software can be a perfect tool for this use.

The following is an example of a lecture capture setup in a faculty office space, where the teacher will be recording video for students to review. These recordings may be used for distance education or flipped classrooms, or could be simple communications intended to guide study and prepare for exams.



Click to view a sample recording of a flipped classroom in a faculty office.

In this example, lecture capture software simply needs to be installed on the teacher's laptop. Often, the laptop will already have built-in video and audio recording tools, but to get the best recording quality possible, an external HD webcam and a desktop microphone can be added.

To record, the instructor needs only to bring up his or her slides (or other content to capture and share on-screen), check the lighting in the room, and press record.

Basic Connections, Diagrammed

In The Lab

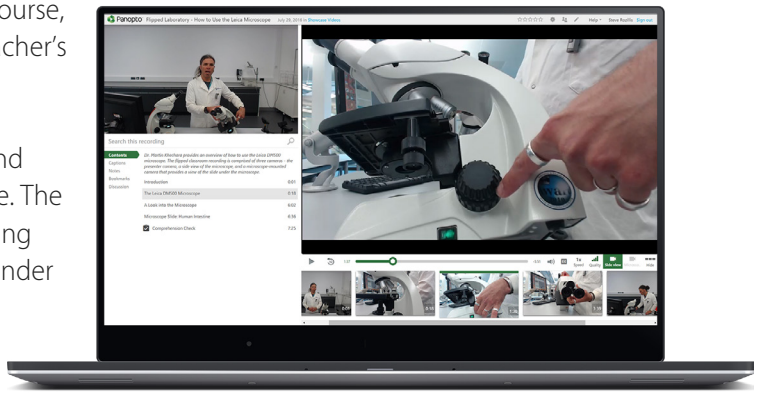
While faculty offices will likely be the most common non-classroom locations you'll need to be ready to provision for lecture capture, over time, nearly every space dedicated to study and learning will likely make its way onto your list.

Increasingly, institutions are finding that implementing lecture recording tools in labs and other dedicated research facilities provides faculty with an easy way to record and share demonstrations without having to reproduce those demonstrations in an ill-equipped classroom — enriching students' learning experiences without creating new cost or safety concerns.

In this example, recording digital course content for a biology course, lecture capture software simply needs to be installed on the teacher's laptop, or on a dedicated lecture capture computer in the lab.

A USB microscope camera is attached to a stereomicroscope, and then connected to the laptop along with a desktop microphone. The instructor can then simply use the microscope as normal, allowing the camera to capture and share what can be seen in the viewfinder and narrating what's in view for the desktop mic to record.

Alternatively, a smartphone or other mobile device with a lens attachment could be used to capture the microscope view. This mobile recording would then be synced with the audio and any additional presentation content in the cloud.



Click to view a sample recording of a flipped lecture given in a lab.

Basic Connections, Diagrammed

In The Field

In many areas of study, the latest information and cutting edge research won't be found indoors. Yet for dozens of valid reasons ranging from logistics to safety to cost, faculty are unable to bring students out to where today's work is being done and new discoveries are being made. This deprives students of the opportunity to really experience a field — and may actually discourage students from investing themselves in the subject.

If students are unable to visit educational opportunities in the field, video is an excellent means to bring the experience of the field back to the students. And while on-location recording used to be an expensive proposition, today, most faculty already have the only tool they need right in their pocket.

The ready availability of mobile devices makes them ideal for on-site recording.

This example field demonstration shows how an instructor might capture digital course content using a mobile device that's had a lecture capture app installed. In this example, an archaeology professor leads a dig in the field. She records the dig with her mobile phone, which sits on a tripod so she can move around and keep her hands free to demonstrate the dig. To ensure useable audio is captured (often the key challenge of recording in the field), the professor wears a wireless lavalier microphone that connects to the audio jack on one of her mobile phones.

While the first mobile device is positioned to capture the full context of the activity, a second mobile device can also be used to capture close-up video, or record from another angle during the dig.

All that's required to sync the feeds is for the instructor to indicate both devices should record to the same video session when they press "record". The lecture capture software will process everything together in the cloud.

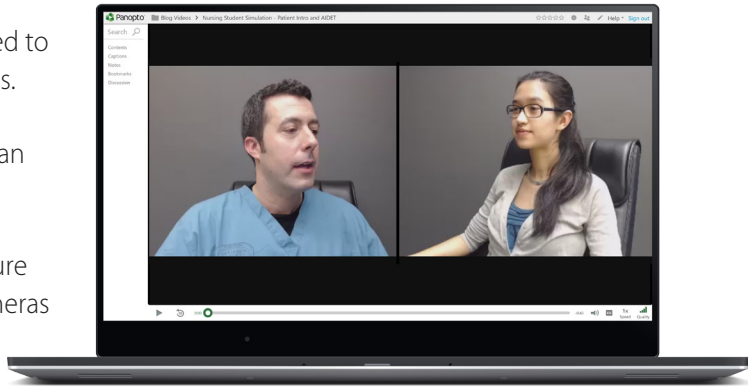
Basic Connections, Diagrammed

Demonstration Spaces

In a number of fields, performance is a crucial part of the learning process. This includes everything from student role-play activities under the supervision of an instructor (for example, where students studying elementary education might practice working with children), to actual performances in front of live audiences put on by students of the arts.

In this example, we'll consider how to provision a space intended to allow medical school faculty to demonstrate patient interactions. This setup can also record medical students (physician assistant students, in this case) practicing working with patients, which can be reviewed and critiqued post-recording.

In demonstration spaces, the most important element of a lecture capture implementation will be ensuring there are enough cameras to capture every relevant view of the activity. If possible, there should be at least one camera focused on each participant — that will provide the best view of each student's performance for faculty to review and critique.



Click to view a sample recording of a nursing student role play demonstration.

The specific video equipment needed will depend on the type of demonstration typically performed in the room. A role-play of a conversation, as in this example, may be more than adequately captured by a pair of webcams, or by the students' own mobile devices. More detailed activities, like an artistic performance or a surgical theatre walkthrough, may benefit from higher quality and/or specialized cameras.

Audio needs will likewise be directed by content. In our example, a desktop mic (ideally, one with a figure 8 pickup pattern) will be perfect for capturing a conversation. Other activities may benefit instead from a lapel mic to better hear

the specific student performing, or boundary mics to better capture the overall sound of the room.

No matter the setting, your demonstration room will simply need to be provisioned with a computer with your lecture capture software already installed. Each recording device will need to be connected to that computer (or a capture card as needed). Once those connections are made, participants simply press "record" and begin.

Basic Connections, Diagrammed

Student Presentations

Recording student presentations and other individual assignments could potentially be considered part of the demonstration room example above, but given the rapid growth of this use case, we felt it warranted specific attention here.

Instructors in virtually every field of study have long recognized the value of assigning students to learn about a particular detail and present their findings in class. The practice gives each student a chance to dig deeper into a given subject matter, and also helps to hone their overall research and presentation skills.

The challenge, however, has been scheduling the resulting presentations. For a simple 10-minute presentation with time for Q&A, a class of 20 students meeting for an hour three times a week would have to block almost 2 full weeks of class time just for students to present — time that can't be used for any other teaching.

Click to view a sample recording of a student coursework presentation.

Your lecture capture system can change that equation. With a well-implemented system in place, teachers can give students the same assignments, but instead require each student to record their presentations either in a breakout room on campus, or at home using their own laptop or mobile device. Instructors can review these recordings on their own schedule, without the need to dedicate class time to them — thereby freeing up more class time for instruction, activities, or even additional presentations.

The following example considers implementing lecture capture for use in a breakout room, designed to enable MBA students to practice their business pitches and improve their presentation skills.

In this case, all that's needed is either a laptop or a mobile device, with your lecture capture software (or app) already installed. This is typically all that's required in a small space, however, an external HD webcam and USB microphone can also be added for improved sound and video quality in the recordings. Stationing a desk lamp in the room would also ensure there is adequate lighting available, and improve the visual appearance of the final recording.

With this minimal setup in place, students can be instructed to either record their presentations into a main recording folder for their class, or into a personal video folder if available in your lecture capture solution. Once the folder is selected, students need only to press "record" and present.

Because scalability is key when provisioning spaces and equipment for student recordings, our recommendation for this use case prioritizes making it easy to repeat this setup in as many breakout rooms or other spaces as needed.

Basic Connections, Diagrammed

"We created a 'media lab' without spending any money. We took student meeting rooms, set up a laptop with Panopto, and just hit record. With six rooms, we could record 40 presentations in under 90 minutes."

The Sauder School of Business at the University of British Columbia has discovered a secret: The best way to prepare MBA students for the business world is to give them practical, hands-on experience. Their approach? Create a new course in which students practice delivering better business presentations, and recording every presentation for self-reflection and instructor review.

Click here to read the full story.

Some of Our Favorite Lecture Capture Gear

Our team has been working with colleges and universities for over ten years to help set up lecture capture systems in their classrooms, and in that time we've had the opportunity to test and implement a variety of AV equipment in a number of different settings.

While the best tools for your institution will depend on the considerations discussed above, below is a list of some of our favorite equipment for capturing high-quality recordings.

Rack-Mount Appliances

Seneca Video Capture Appliance

The Panopto-Certified Video Capture Appliance by Seneca is a single-unit, rack-mountable PC that comes preconfigured to work as a Panopto Remote Recorder out of the box.

Puget Systems Video Capture Appliance

The Panopto-Certified Video Capture Appliance by Puget Systems is a whisper-quiet, two-unit, rack-mountable PC that comes preconfigured to work as a Panopto Remote Recorder out of the box.

Video Recording Devices

USB Webcams

Logitech C930e

This small but mighty webcam can capture 1080p HD video at 30fps. It provides a wider, 90-degree field of view for getting more of your scene into the video. The video is crystal clear, and for a webcam, the built-in microphone is more than adequate for recording in a quiet office.

Logitech C922

The defining characteristic of the C922 is its ability to capture 1080p video at 60 frames per second (60fps) for smoother, more lifelike playback. Its 78-degree field of view is more traditional when compared to the C930e, its optics are similarly crisp, and its mic is appropriate for recording in a quiet office.

Point and Shoot Camcorders

Canon VIXIA HF R600
The HF R600 is a small form factor camcorder that sets itself apart with an incredible 57x zoom range. It captures video at 1080p resolution and 60fps.

Sony HDR-PJ540
The Sony HDR-PJ540 is a quality mid-range camcorder that, similar to the Canon VIXIA, features an incredible zoom range of 60x and 1080p60 HD video. This camera's standout feature is its projector screen that allows you to preview video in full HD as well.

Professional Camcorders

Canon XA25
Canon's XA25 is a professional-grade video camera that features great zoom capabilities and beautiful optics with 1080p video capture quality. With a full manual mode, the videographer can control the image quality to achieve desired visual effects.

Sony HXR-NX100
Sony's NXCAM camcorder is known for 24x Clear Image Zoom, 60fps optics with 1080p HD quality imaging, and its big one-inch sensor, which makes this a versatile camera that can performs well low-light situations.

DSLR and Mirrorless Cameras

Panasonic Lumix GH4
When it comes to SLR and mirrorless cameras, the Panasonic GH series continues to set benchmarks for high quality video. It can capture in up to 4k with excellent dynamic range and low-light performance.

Nikon D800
This DSLR is among the best on the market for video capture. With its full-frame sensor, it excels at low-light performance and has incredible dynamic range.

Pan-Tilt-Zoom (PTZ) Cameras

Sony SRG-120DH
PTZ cameras are one of our top picks for almost any lecture capture scenario in rooms of varying size and shape, and the Sony SRG series cameras are among the best. 1080p60 HD optical quality, 12x zoom capability, easy setup, and easy control of the camera's view frame make this an ideal camera for most lecture recordings.

Sony SRG-300H

If you're looking for a PTZ camera with stunning image quality coupled with smooth robotic control, you won't be disappointed with Sony's SRG300. This camera features 30X optical zoom and Sony's high sensitivity Exmor CMOS sensor, so you will capture clear, quality HD video in most rooms and lighting scenarios.

Motion Tracking Cameras

iSmart Lecture Tracking Camera

The iSmart motion tracking PTZ camera can record HD quality video at 1080p and 60fps, and features a 20X optical zoom. The motion tracking technology can follow the lecturer, who does not need to wear a tracking device. It also features a board writing detection system, that will automatically move when it detects the presenter writing. The camera has the same sensor used in the Sony SRG series PTZ cameras, which will perform well in low light.

Specialty Cameras

WolfVision VZ-8plus Document Camera

This document camera features 1080p HD video with a framerate of 60fps, allowing for smooth motion and faster autofocus compared to other document cameras. Its advanced light system doesn't require adjustments and it has an impressive 14X optical zoom that can enlarge objects smaller than a postage stamp. The white surface also functions as a white board, projecting and recording notes from the lecturer, without the need for other complex in-room setups to capture anything a lecturer may need to write out for students.

VSN Mobil V.360 360° HD Camera

This great little camera captures 360-degree HD video. Its relatively small sensor size (1/2.3") may degrade video quality when used in low light areas. We'd recommend trying this camera in a discussion class or possibly for mock situations like trials for legal students or board room presentations for MBA students.

Audio Recording Devices

Desktop USB Microphones

Blue Microphones Yeti

The Blue Microphones Yeti is among the best USB microphones on the market in terms of sound quality. Adding to its versatility, you can select from four different pickup pattern settings, which allows you to record audio from one person, from an interview or other situations that would typically require more microphones. With its zero-latency audio monitoring, you can plug headphones directly into the microphone to test sound quality in seconds.

Samson Meteor Mic

This USB condenser microphone will capture rich audio from a lecturer in most small to medium size rooms that don't have a lot of background noise. It is compact, portable, and also features zero-latency audio monitoring for live sound checks.

Boundary USB Microphones

HuddlePod Air (wireless USB speakerphone)

This wireless USB speakerphone is great for capturing group discussions, with its 12' x 12' pickup range. The HuddlePod Air is completely wireless with a 30' range and can transmit more data than Bluetooth. You'll get great audio quality in small rooms without any cables to worry about.

MXL AC-404

This small, but mighty boundary microphone features easy plug-and-play USB connectivity and a design that can capture sound from a broad 25' pickup area with a 180° arc. The MXL AC-404 will capture good audio quality in most small- to medium-size classrooms.

Wireless Lavalier Microphones

RodeLink Wireless Lavalier

We recommend the RodeLink Wireless Lavalier system for recording in most lecture halls and auditoriums. With a signal range of over 100 yards, your presenters will have plenty of space in which they can move about, hands-free as they present. This system features one-button pairing, and can be powered by either AA battery or USB.

Revolabs xTag Wireless Microphone System

This innovative wireless microphone system from Revolabs combines the receiver and charger into one device and connects easily to lecture capture systems via USB. This system is plug-and-play and doesn't require you to download drivers for setup. The lecturer can clip on the wireless microphone or wear it around his or her neck on a lanyard.

Lavalier Microphones For Mobile Recording

Sony ECM-AW4

We recommend this wireless lavalier microphone set for mobile recordings since it can be used easily with most smartphone devices. The presenter clips the small, compact microphone on his or her shirt, which will record quality audio up to 164 feet from the receiver. Data is transmitted via Bluetooth, but can also be attached to any video recording device with a mic input jack.

Lecture Capture Accessories

Capture Cards (Internal PCI — Express)

Datapath VisionAV-HD

The Datapath VisionAV-HD capture card is one of our favorite internal capture cards. It's a reliable and well-tested capture card that will capture and synchronize all video channels simultaneously and buffer them into onboard storage for tear free video, alongside an audio stream that can be selected from one of the HDMI or one of the analog audio ports. This data can then be processed and copied using DMA transfers to the lecture capture system for display, storage or streaming.

Capture Cards (External USB Dongles)

Magewell (HDMI to USB) Capture Plus

This is our top pick for external capture dongles. Magewell builds a quality dongle that will work flawlessly to pull in visual and audio feeds to your lecture capture system. With this capture card, you can capture audio from an external mic as well as the video feed from your camera and send it to the computer as a single AV feed. It also offers ports that allow you to monitor audio and visual feeds while recording.

Audio Mixers

Behringer Xenyx 802

Manage all your audio signals easily with the Behringer Xenyx 802 mixer, which works well for both recordings and live broadcasts. This versatile mixer has flexible input and output options that will allow you to mix and control all of your in-class audio feeds.

Visual Recording Indicators

Delcom USB Visual Signal Indicator

If you're utilizing the scheduled recording with your lecture capture software, you're going to want to add this useful accessory. A visual signal indicator or "On-Air" light lets presenters know that the system is recording as scheduled. It's small and unobtrusive, and won't distract from the lecture recording. Not only does it indicate that the system is recording, but also pressing the light can start, stop, pause and resume recordings.

Start with Panopto in less than one day

Fill out a free trial form at panopto.com/try/

Our team will contact you to discuss how you'd like to put video to work in your institution, and help you determine if Panopto would be a good fit.

We'll set up your video platform site with you that same day, help you connect it with your LMS, and include a set of welcome and how-to videos for first-time users.

From there, you'll be ready to go!

You'll have complete access to upload existing videos, record new videos, share and view recordings, and search your videos for specific details.