360° Immersive Video for Internationalizing Teaching and Learning – A Tool for Future Education Abroad

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THE NEED

There is a growing need in the Education Abroad profession to create new strategies that facilitate the internationalization of students and curricula. With only a fraction of students that physically study, work, or intern abroad, institutions work hard each year to excite more and more students to travel during their tenure at University. Although, professionals and faculty also realize that many more students on their campuses will not have the opportunity to travel and must be exposed to global concepts in their general education and disciplines.
These are traditional and long-standing challenges. Since the worldwide pandemic, new realities are beginning to surface that drive this need for new strategies for internationalization, including war and social conflict in many regions, increased programming costs due to inflation across many nations, the associated increased costs of air transportation since the pandemic, and growing sensitivity to elective travel due to carbon footprints and their impact on global climate change.

This creates a real dilemma for faculty and institutions – how do we provide high-impact teaching and enhanced learning about global issues if it becomes too costly, dangerous, or inefficient to travel?

While research collaboration and co-teaching with overseas partners have been enhanced since the pandemic with the global adoption of videoconferencing technologies, this is not a substitute for traveling and experiencing different environments and cultures. Frankly, there is no substitute for this kind of travel. While intra-continental choices can be made to minimize impacts like carbon buildup and climate change - train travel fueled by renewable energy, for example - inter-continental travel, is more of a challenge.

At Auburn University, we have begun to explore the use of 360° video to provide the immersive environment needed for high-impact experiential learning outside the classroom. Such technology enhances the static collaborations we use today through the COIL-type efforts that started in the 2000s, allowing a more immersive environment and augmented-reality approach to experiencing an international environment. And it is through this 360° experience faculty create and guides students through their teaching content/material to confront, interpret, and reflect on the cultural and environmental differences they experience. True immersion on-site allows all senses to interpret surroundings, some of which are impossible without physical presence. The choices described below illustrate how an instructor can compensate for these limited travel shortcomings, recognizing that today's technology will never really substitute for actual travel.

360° Videos in Education: Immersive Learning Experiences for Synchronous and Asynchronous Teaching

360° video is an emerging technology that has gained a lot of popularity in recent years, especially in the field of education. These videos offer a unique and immersive learning experience that can be both synchronous and asynchronous.

Synchronous education is a real-time teaching modality where the instructor and students are online simultaneously.
In this mode, 360° videos can create a unique learning experience for students because they are embedded in the environment with the instructor, just as if they were on-site. The student experience is enhanced in real-time as if they were on a tour or field trip as part of their regular class. Applications in this mode are easy to understand and interesting applications for 360° videos in synchronous education would be in field experiences in disciplines like archaeology, which we are beginning to see in the literature. Archaeology students can participate in virtual field trips using 360° videos in real-time, for example.
They can join a live video conference call with a professional archaeologist who uses a 360° camera to show them around a specific site. The instruction would be as it would be if all were present, and the questions and answers would be in real-time, addressing needs, conditions, and ideas. Other natural resources would have similar requirements. Engineering or building science students can participate in virtual reality simulations of complex projects using 360° videos in more modern human applications.

The students can use phones or a virtual reality headset to experience a 360° view of a construction site and better understand the construction process.
Commercial applications today are used by real estate agents showcasing rental offices and living spaces to distant potential customers. Such examples could be found in most academic disciplines, wherever field examples or experiential education techniques are used today.

Asynchronous education is a mode of teaching where the instructor and students are not online simultaneously.
In this mode, 360° videos can create self-paced learning modules. In geology, for instance, students can use 360° videos to participate in virtual field trips to geological sites worldwide. For example, a 360° camera can be used to explore the Grand Canyon, allowing students to observe different rock layers and learn about the area's geological history.
History students can also benefit from 360° videos in asynchronous education by using a phone or virtual reality headset to experience a 360° view of famous historical landmarks of Spain, such as the Alhambra in Granada, the Sagrada Familia in Barcelona, or the Royal Palace of Madrid. They can learn about the history and significance of each location and even take virtual tours of ancient cities like Toledo and Segovia. This immersive learning experience in the asynchronous mode provides students with a more flexible and personalized way of learning, allowing them to pause and rewind the video to review complex concepts.

An instructor can add features in post-processing to enhance learning, such as voice-over audio to guide the students through the experience in a 360° format ('now look over your right shoulder to see…') and also labels and tags to identify specific needs in the image as well as forcing the view of the student to look in a particular direction by default, even though the student can look all around in 360° (e.g., following a moving object, not looking at the instructor).

An Overview of 360° Video Cameras: The Process of Capturing, Stitching and Enhancing Immersive Video Footage

360° cameras capture video from all directions using multiple lenses, creating fully immersive experiences for viewers. The cameras use fisheye lenses to capture a wide-angle view, and the images from each lens are digitally stitched together using specialized software to create a seamless 360° view. There are two types of 360° video cameras: monoscopic and stereoscopic. Monoscopic cameras capture a single image projected onto a 360-degree sphere, while stereoscopic cameras capture two images from slightly different angles to create a 3D effect. Popular software tools for stitching 360° videos include Adobe Premiere Pro, VideoStitch, Pano2VR, and Kolor Autopano Video. Some 360° cameras, such as the Insta360 ONE R, Ricoh Theta V, and GoPro MAX, have built-in software for stitching footage together.

However, the software embedded in the camera may have limited capabilities compared to professional stitching software, which offers advanced features like color correction, stabilization, and dynamic stitching. Once the stitching process is complete, the 360° video can be viewed on compatible devices such as virtual reality headsets, smartphones, laptops, and tablets. Users can move their devices around to explore the virtual environment from any angle, just as if they were on-site.

Professional-Grade vs. Amateur/Hobbyist 360° Cameras: Differences and Key Features

360° cameras have gained popularity in recent years due to their ability to capture immersive video that allows viewers to look around and explore the scene. However, not all 360° cameras are created equal, and there are significant differences between cameras designed for professional-grade videographers and those geared towards amateur or hobbyist use.

Professional-grade 360° cameras typically offer higher quality image and audio, more advanced stitching software, more comprehensive dynamic range, and additional features such as GPS and gyroscopic stabilization. These cameras are designed for videographers who must create high-quality content requiring advanced features and capabilities.
The other features of professional-grade cameras, such as GPS and gyroscopic stabilization, can help to create more immersive and engaging 360° video, though the cost is high for education.

On the other hand, amateur or hobbyist 360° cameras are more affordable and user-friendly but may not offer the same level of quality or features as professional-grade cameras. These cameras are typically designed for casual users who want to capture 360° footage for personal use or social media. While they may not have the same level of quality as professional-grade cameras, they are more accessible to the average user and offer a more cost-effective way to capture 360° footage. More importantly for education, they are much more portable and can be mounted on a tripod or used with a selfie-stick application.

Exploring 360° Cameras and Livestreaming for Education: A Comparative Study of the Insta360 One R and Ricoh Theta V Cameras

At Auburn University, we have been experimenting with the Insta360 One R and Ricoh Theta V cameras for recording and livestreaming of 360° videos for educational purposes. The Insta360 One R is a modular camera that allows for interchangeable lenses and sensors, capturing 5.7K resolution video at 30 frames per second. Two wide angle lenses give the 360° view. It also features advanced image stabilization, a wide dynamic range, and a built-in GPS system for geotagging footage. With an IPX8 waterproof rating, it can be used in challenging environments. The Ricoh Theta V, on the other hand, is a compact camera that captures 4K resolution video at 30 frames per second, also featuring two wide-angle lens, giving a 360° field of view and built in microphone to give spatial audio. It also has advanced image processing and a built-in gyroscopic stabilizer.

Both cameras have built-in post-processing features for enhancing the quality of 360° video footage after recording,
such as color, exposure, and stabilization adjustments. Third-party software like Adobe Premiere Pro and Final Cut Pro can also be used for more advanced editing for asynchronous applications. These features can create more engaging video for remote education and collaboration. The Insta360 One R's advanced features make it a versatile option for amateurs and professionals, while the Ricoh Theta V's compact size and user-friendly interface make it a popular choice for casual users and educators. Ultimately, the choice between these cameras will depend on the specific needs and budget of the user.

Technical Requirements for High-Quality Livestreaming of 360° Video with Insta360 One R and Ricoh Theta V Cameras

Both the Insta360 One R and Ricoh Theta V cameras require firmware updates and specific software for stitching and editing footage. The Insta360 Studio software is recommended for the Insta360 One R, while the Ricoh Theta app is recommended for the Ricoh Theta V. Both cameras are compatible with popular editing software like Adobe Premiere Pro and Final Cut Pro. Both the Insta360 One R and Ricoh Theta V cameras require firmware updates and specific software for stitching and editing footage. The Insta360 Studio software is recommended for the Insta360 One R, while the Ricoh Theta app is recommended for the Ricoh Theta V. Both cameras are compatible with popular editing software like Adobe Premiere Pro and Final Cut Pro. Both the Insta360 One R and Ricoh Theta V cameras require firmware updates and specific software for stitching and editing footage.

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For laptops, a minimum of 8GB of RAM, 64-bit Windows 10 or macOS 10.13 or later, and a discrete graphics card are recommended. Both cameras have built-in 360° spatial audio systems, and the Ricoh Theta V has a four-microphone system that captures spatial audio in 360°. External microphones, like Rode Video Micro, can be used to improve the audio quality of live streams. A stable and strong internet connection with at least 5Mbps upload speed is required for livestreaming 360° videos. To livestream at 4K or 5.7K resolution, a minimum upload speed of 15 MB/s or 60 MB/s, respectively, is recommended for the memory card. Livestreaming platforms such as Facebook, YouTube, and Vimeo have their own requirements that should match the camera's settings.

Tethering and Cellular Bonding for Remote 360° Video: Comments for the Insta360 One R and Ricoh Theta V Cameras

360° video has revolutionized the way we capture and share immersive experiences, especially in the field of remote education and collaboration. Perhaps the best use of immersive video in teaching is found at remote sites, where wireless infrastructure is spotty and weak, if present.

Many countries would not have cellular signals in remote regions. However, to ensure a seamless and high-quality, real-time immersive experience, it is crucial to have a stable and reliable internet connection. This is where tethering and cellular bonding technologies come into play. Data transmission in livestreaming of 360° video is much greater than standard streaming of normal, flat video of one frame or direction of view, and until 5G cellular technology is available in many locations by network providers, these other technologies will be important for livestreaming 360° signals.

Tethering is a technology that enables remote control of your camera by connecting it to a computer or mobile device. It can be used to adjust camera settings, capture footage, and livestream. The Insta360 One R and Ricoh Theta V cameras support tethering via USB and Wi-Fi. For USB tethering, you need to connect the camera to your computer using a USB cable and install the required software. For Wi-Fi tethering, you can use the camera's built-in Wi-Fi hotspot or connect to an existing Wi-Fi network, which will allow you to control the camera from a mobile device or computer.

However, the quality of the internet connection used for tethering can limit its effectiveness. To overcome this, cellular bonding technology is utilized and this technology, used by agencies like law enforcement and emergency responders, combines multiple cellular network signals to create a stable and reliable single internet connection for your camera. Using a combined cellular signal (think tapping into all cellular providers' signals in an area, and having full bars of signal on your phone), the technology allows transmission of high-quality 360° video in real-time, enabling remote collaboration and education.

By using cellular bonding, users can stream 360° video from remote locations with low latency and high reliability. Popular cellular bonding devices include LiveU Solo, LiveU HVEC, Teradek Bond, TVU One, Dejero EnGo, and Haivision Makito X4.

At Auburn University, we conducted successful tests using LiveU HEVC and Dejero EnGo 260 devices with Insta 360 One R and Ricoh Theta V cameras for livestreaming 360° video.
LiveU HEVC is a mobile bonding solution that can bond up to 14 different network connections to enable live video transmission from remote locations. Dejero EnGo 260 is a portable mobile transmitter that provides reliable and high-quality live video transmission over cellular networks. To livestream 360° videos, we connected the camera to these devices using a suitable cable and configured the camera settings. We then used compatible video encoding software to output the video in a compatible format and streamed it on Google and Facebook.

There were several challenges that were involved in conducting these test runs. These included high bandwidth requirements in the remotest of locations, compatibility issues as machines were built for stationary use by agencies and not mobile use, related sizing of machines that were built for reliability for agency use and not for portability and light weight, the overheating of the respective electronics of machines built for the air-conditioned interior of vehicles and not outdoor environments used in teaching, and the physical hardware compatibility between the camera, tethering, and bonding devices by the use of different connectors.

But all the technology exists today, and device connectivity options all exist, and so the solutions can be created with matching camera to bonder, with or without tethering. Therefore, it's essential to consider these factors when choosing cellular bonding devices and cameras. Despite these limitations, we believe that bonded cellular technology holds promise for the future of remote education and collaboration, as it enables high-quality, real-time 360° video streaming from remote locations. Finally, it is important to have a backup plan in case of technical issues or internet connectivity problems, such as having a pre-recorded version of the video available to show if needed. We will continue to explore and evaluate new technologies that can overcome these limitations and provide more accessible and user-friendly solutions for remote synchronous education.

LEARNING OUTCOMES

Imagine a student on a fieldtrip with an instructor. The student follows along and listens to the instructor, watching him or her while they speak, and observing buildings or activities, etc., as directed by the instructor. The fieldtrip is a different experience than a PowerPoint presentation of slides of the same content and associated images. Additionally, presence in the moment allows the student to receive the content of the instructor and any other desired information that surrounds the student as they can choose to look in different directions. They are not limited in their view.

As instructors, we understand this difference; the field trip is immersive and provides for active learning, making it high-impact. It allows the learner to choose the received, absorbed, and processed content. And it will enable connecting that information to simultaneous sensory details like smells or tastes and hearing contextual sounds. We know from how the brain functions that this is better for retention and recall. And the student's learning is enhanced. The outcome desired by the use of 360° video is a similar order of magnitude more significant in terms of learning than traditional video or a PowerPoint presentation of the same content.

We cannot always replicate a new or different environment, nor provide the international content and context we wish for our students due to cost and other factors, but an instructor's use of 360° video technology allows an immersive experience much closer to actual travel than today's alternatives and does so at limited cost of time and money while providing greater access for all students. At Auburn, we find this tool valuable for many uses, and in the future, education abroad will take advantage of the technology to broaden what our students experience.