Implementation of 360˚ videos in higher education: Guide for educators

SEPA360

https://www.sepa360.eu/
Published in October 2021

Author: Vassilis Barkoukis, Maria Nikopoulou, Triantafyllos Christodoulidis, Theopistos Kenanidis, Vassilis Papacharisis (Aristotle University of Thessaloniki). Maria Ranieri, Damiana Luzzi, Stefano Cuomo, Isabella Bruni (University of Florence).

Disclaimer: The project was funded by the European Union through ERASMUS+ Key Action 2. The European Commission support for the production of this publication does not constitute and endorsement of the contents which reflects the views of the project consortiums, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Co-funded by the Erasmus+ Programme of the European Union

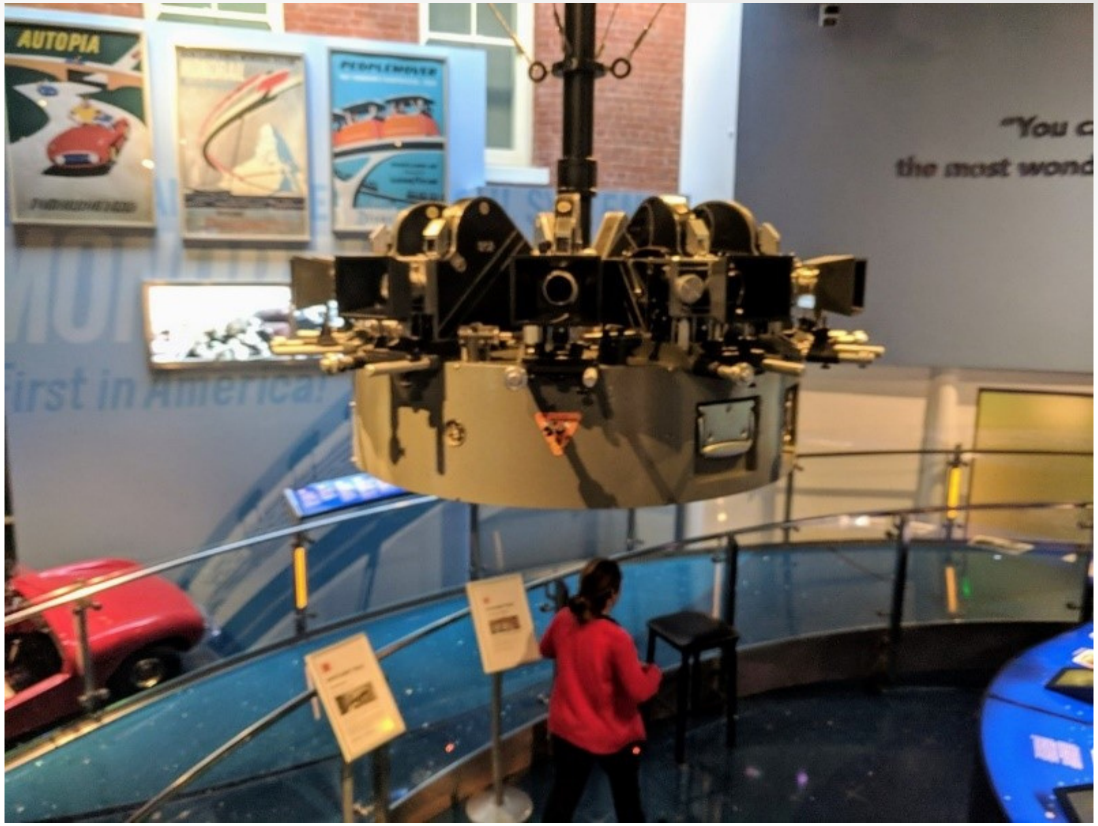
SEPA360

CONTENTS

CONTENTS

Introduction to 360° videos

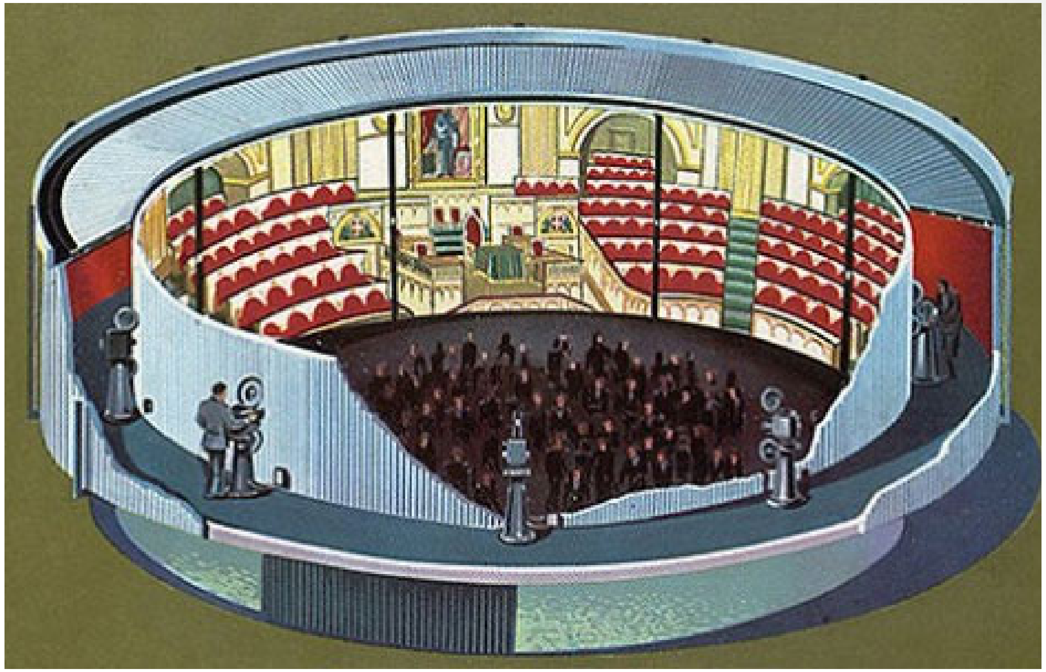
360° video technology has brought innovation in various fields and is offering new perspectives in the use of video. By placing the user/viewer at the center of the action and conceding the control of the direction of the projection, provides complete freedom of exploring outside the frame and makes each use unique.



Evolution of 360° vision

Seeing the whole picture and transferring it to the audience was an idea that occupied a lot of people from various specialties. For example, panoramic 360-degree imaging was coined in 1787 by the English painter Robert Barker. His paintings were shown on a cylindrical surface and for the first time, the limits of the conventional scale of pictorial representation were expanded, giving the sense to the audience that they are actually in the landscape. Additionally, As far as it concerns the moving screen, the first attempt for a 360° Vision was refined by the visual effects pioneer, Ublwerks, a member of the Walt Disney Company, as a film technique in the film America the Beautiful (1955 version) in the Circarama theater.

He used eleven-lens cameras, 16mm film and 11 projectors arranged in a circle. Consequently, he used a 9-lens camera, 35mm film, and 9 projectors. The idea of using an odd number of screens, and a small space between them, was for the projector to be placed in each gap, projecting across the space to a screen. The screens and projectors were arranged above head level, and lean rails were provided to viewers to hold or to lean against while standing and viewing the film (Wikipedia)



SEPA360

Walt Disney's Circle-Vision (1967)

In 1958, the first 360° camera with 35mm film was released. However, since the demand for high-resolution images was better met by larger format films and the cost was secondary in the professional sector, this camera was the only 360° machine working with 35mm film until the early 1980s.

360° video technology

The first 360-degree camera was invented in 1857 in England. M. Garrela M. Garrela patented a camera that, using fan-operated clockwork, could rotate its lens 360 degrees around its axis. Following the coining of the flexible film (instead of heavy glass plates) in 1888, many panoramic cameras were invented but they weighed a lot and were difficult to carry. The first small 360° camera, the Japanese Panorax Zi-A, was built in 1958 which was the only 360 degree machine working with 35mm film until the early 1980s.

SEPA360

Nowadays, 360° video technology has evolved and the use of 360° cameras is gaining popularity. There are many types of 360° cameras, but the majority use two different wide-angle lenses placed on opposite sides of the camera to film the full 360° footage. Placing the camera in a fixed position, filming is achieved simultaneously with overlapping angles in a 360° range.

More specifically, a 360° camera captures two images or video files from dual lenses with a 180o field of view and either, automatically, stitches them together to the camera or offers free companion software with which everyone can staple files. Stitching converts individual videos into a single, high-resolution, seamless panoramic video. They can be displayed as panoramic or spherical depending on the user's preference. Spherical videos are often in a curved perspective with a fisheye effect. 360° videos are recorded using 360° cameras but can be viewed on any 360°-compatible device, including various applications, smartphones, computers and others.

360° videos, also known as immersive or spherical videos, are those where a view in every direction is recorded at the same time, using an omnidirectional camera. As already mentioned, 360° video provides users with the freedom to explore the surroundings, making every attempt unique. In comparison to the typical, 180o video, users can navigate in every direction and dimension of the surrounding and select multiple and multidimensional information. They can even zoom in and out, something that cannot be achieved with the human eye.

There are no hidden spaces behind the camera, so a 360° video recording requires the entire space to be incorporated into the concept. Therefore, it should be decided whether the filming objective will be developed around a defined camera position, or whether the camera itself will be mounted at the "point-of-action" and the dynamics of action will be directly related to the camera tracking (Hebbel-Seeger, 2017).

Today, videos are being used in different facets supporting the e-learning experience. While technology has become a superior vehicle for transmitting and receiving knowledge, 360° video offers new innovative features, which can prove useful in teaching & learning scenarios where a need for self-directed control of view direction, immersion, and a feeling of presence is required (Feurstein, 2018). This unique sense of immersion and presence that a 360° video can offer to users is not possible to be achieved with the typical 180o video.

According to Reyna (2018), 360° videos are a new frontier and offer vast opportunities to explore fresh and innovative digital media communication. Also, this new technology can be a powerful tool that brings learners into a real learning and practice environment that would otherwise be impossible.

360° video allows students to make better connections to their learning by providing specific, visual explanations and examples. The 360° technology is more attractive and stimulates the interest of users in a fascinating way, creates a real learning environment, and brings it to reality, in the classroom or at home.

According to Ranieri (2020) research in the application of 360° video in educational settings is in its infancy but it progresses fast. Below will be represented some indicative studies to highlight the progress of the relevant research as well as the main research findings.

Improving teaching in higher education

An exploratory case study about the utilization of 360° video in educational settings was conducted by McKenzie et al. (2019) in order to understand the impact of the integration of 360° video into the content of the class and educational settings on teachers and students. In specific, researchers carried out classroom experiments with the use of 360° video in order to identify whether they affect the participants' feelings of presence with the content of the class and how the incorporation of 360° video impacts the teaching experience. Results revealed that 360° videos can provide an alternative immersive means of content presentation for students and facilitate the improvement of their sense of presence. It was also shown that these interactive and immersive experiences could constitute a distraction of attention from the teachers and that the required file size and quality of image for the learning environment should be considered.

Furthermore, 360° videos, especially in combination with VR glasses, are an innovative technology. According to Feurstein (2018), 360° cameras can simplify and accelerate the creation of VR content. In the common 360° videos, the locations of viewers are fixed, and users can navigate to the right, left, up, and down but cannot interact with the environment. Using VR glasses as a projection medium of a 360° video, the "immersion" aspect and a real-time interaction of the user and the virtual environment can be achieved.

Benefits and challenges from using 360° videos

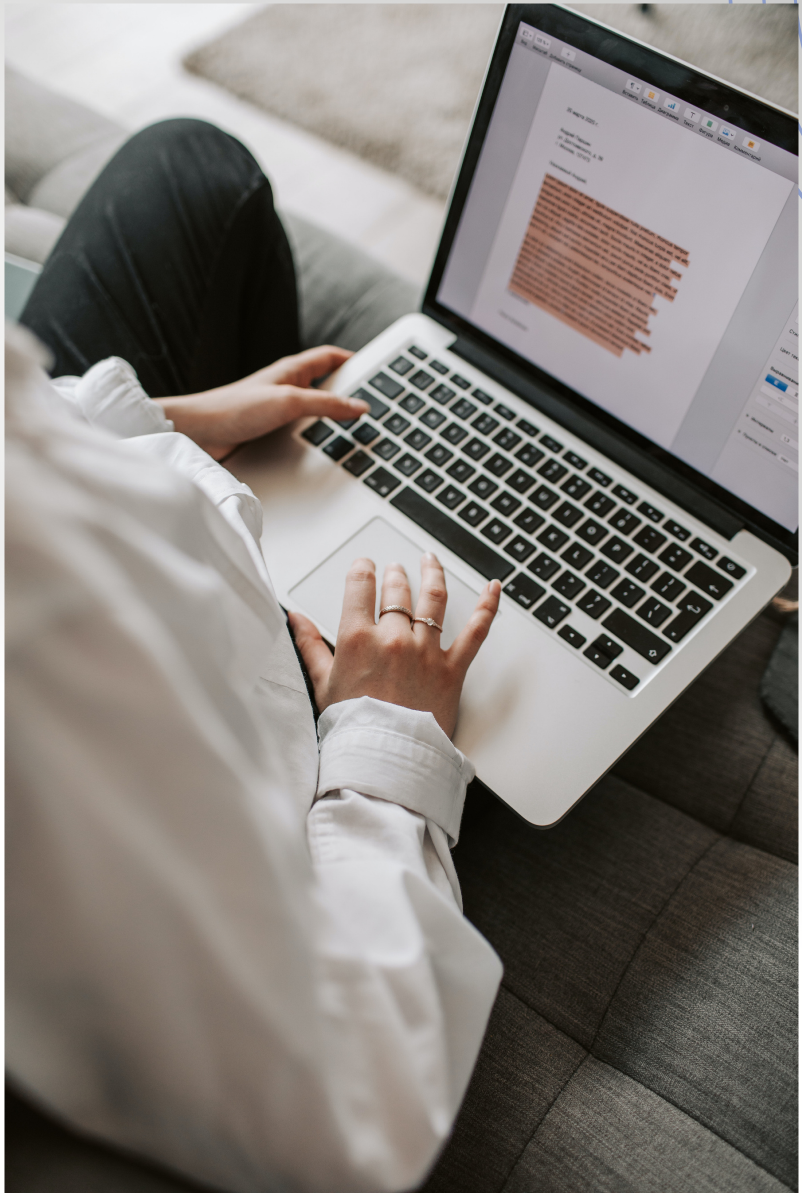
A growing body of research indicates the prominent role of video in teacher education. Much of reflective practice within pre-service education uses text-based approaches or the use of regular, standard video-based reflection (Jaeger, 2013). The fast familiarization of the preservice teachers (PST) with cheap or costless video technology, is widening the possibilities of recording and studying educational activities, teaching strategies, teaching episodes, and teaching practices. Accordingly, the possibility of planning video-based activities as a potentiality for a large group of PST to witness the same video and to share in a conversation.

In contrast to field observation, the use of video technology can provide samples of a wider range of teachers, settings, pedagogies, and contents. Furthermore, video based education may enrich their learning and understanding by emphasizing particular points of interest or by focusing on certain aspects of the episode watched. Despite the advantages though, conventional video technology faces certain limitations such as lack of detailed visual clarity, because of the need for extra wide lenses. A wide angle field view, aiming at a full field display, deprives the viewer of detailed information concerning the very action in the class. In case a closer look is needed, for further processing of the didactic episode under consideration, then more cameras have to be used and more videos have to be elaborated to provide a "whole field" depiction.

.

The evolution of the 360° video technology responds to the challenges that arise by using the video technology for the PST training. 360° media is gaining popularity fast, and as fast as the interest to observe how such novel technology can be applied in various fields of pedagogy (Ardisara & Fung, 2018). Recent research revealed the beneficial impact of 360° video use in teachers' education. There are findings suggesting that 360° videos helped PST to acquire more knowledge compared to printed material (Fokides, Atsikpasi & Arvaniti, 2021). Roche and Gal-Petitfaux (2017)reported that 360° video allows preservice teachers to live an immersive experience and that must be used with wide-angle or point of view video in order to understand the situation in depth. Immersive, 360° video can play an intermediary role in real-life classroom settings. This capability allows pre-service teachers on how to deal with the immediacy of the context (Didi, 2015). Ibrahim-Didi (2015) further reported that "the immersive nature of the video facilitates analogous connections with the complexity of the context while simultaneously enabling the potential to sustain the metacognitive distance. The situated and embodied experience that results from immersion offers pre-service teachers the potential to sharpen the observational skills required to increase awareness of the causal link between the multiple cues that influences practice at the moment".

Even when no statistically significant differences were noted when comparing 360° and regular videos, participants expressed a more immersive, motivational, and enjoyable learning experience and the view that all tools fostered their learning. Although scholars have found a little beneficial effect of 360° video for teacher education (Gold & Windscheid, 2020), there are scholars that found positive interaction with learning (Ferdig & Kosko, 2020; Roche & Gal-Petitfaux, 2017; Walshe & Driver, 2019).



Walshe & Driver reported that:

- The use of 360° video develops more nuanced reflections of microteaching.
- The embodied cognitive experience of watching 360° video is significant.
- An immersive reflection of microteaching supports student self-efficacy in teaching.
- Facilitation of an active, student-centered approach to teacher education within Higher Education.

Despite identified challenges, preliminary reports of the use of 360° videos show that this technology has been embraced positively and perceived as more useful than regular video for reflection (Feurstein, 2019).

SEPA360

Accordingly, the aforementioned research evidence along with empirical data and observations, there are some preliminary conclusions to be drafted:

- 360° videos allow users to see what is happening in any direction around them, providing a new layer of control and involvement of the experience observed.
- This degree of autonomy and the spherical field of view makes 360° videos potentially more immersive than standard videos.
- Regarding the interest, the point of view may vary. PST may aim for more immersion in order to relieve teaching performance, when a lecturer assessing the performance may be interested in a less immersive overview.
- 360° video makes learning self-administered.
- 360° video's embodied potential for a wide variety of enrichments makes 360° video interactive, therefore even more immersive.
- The open-access software for enrichments (vivista software) facilitates PST's unhindered, immersive engagement.

SEPA360

- 360° video enrichments facilitate the creation of independent, targeted, teaching scenarios for study, better understanding, and individualized learning.
- 360° video enrichments facilitate PST to carry out learning on his/her own.
- 360° video helps weaker learners have the autonomy to revise and learn at their own pace.
- 360° video with enrichments provides the potential to develop multiple teaching scenarios on the same video.
- 360° video with enrichments facilitates distal learning of PSTs
- 360° video with enrichments facilitates designed face to face learning of PSTs
- 360° video with enrichments facilitates asynchronous learning of PSTs
- 360° video with enrichments facilitates teachers' asynchronous preparation, for synchronous teaching

SEPA360

Learning pedagogies with the use of 360 videos

The research and use of 360 video in education is relatively recent with an increase over the last three years in experimentation and its application in education, particularly referring to higher education (see SEPA 360 Scoping Study). Studies on immersive technologies generally point out that they have a positive influence on remembering and understanding visual and spatial dimensions (cognitive skills), on visual scanning or observational skills (psychomotor skills) as well as on controlling emotional response to stressful or difficult situations (affective skills) [Jensen L., Konradsen F. (2018) A review of the use of virtual reality head-mounted display in education and training. Education and Information Technologies, 23, 1515–1529)]. In this framework, the pedagogical reflection on the added value of 360 video for learning, and the related implications for the design and implementation of educational interventions, grounds in pre-existing theories that are partly transversal to the family of immersive technologies 360 video belongs to.

SEPA360

360° videos offer a fundamentally richer experience than traditional video since they are based on a concept that rarely applies to standard visual content: presence. In the case of 360° videos, presence is created by positioning the users in the same position as the lens of the camera and offering them autonomy to direct their gaze in any direction. This creates the illusion of presence in a location, either through the small window of a smartphone display or cardboard or a more advanced and immersive VR headset. The feeling of presence also allows the users to spatially orient themselves in a place, giving them a sense of scale and position which is not possible to feel, when viewing regular photos or videos. Users can become familiar with novel or foreign spaces, discovering scale and position through their own eyes. This immersive relationship to the virtual environment quickly allows content to become more real and powerful. These affordances of presence and spatial orientation create an experience unlike anything previously available.

These characteristics of 360 video, especially the immersive and interactive type, align with the principle of situated learning theory, experiential learning theory, and transformative learning theory.

Situated learning

According to the theory of situated learning proposed by Lave and Wenger [Leave J., Wenger E. (1991). Situated Learning: Legitimate Periperal Participation. Cambridge, Cambridge University Press] in the 1990s, learning is situated in a specific context and embedded in a particular social and physical environment. Rather than just abstract knowledge in a classroom, learning should be embedded in the activity, context and culture in which it occurs. Situated learning allows the learner to take an active role in the learning context in the system under study. Another useful concept to better understand the idea of situated learning is authenticity, which has been developed within the constructivist tradition (see for example Jonassen, Peck and Wilson, 1999 [Jonassen D.H., Peck K. L., Wilson B.G. (1999). Learning with Technology: A Costructivist Perspective. Merrill: Prentice Hall.] and which is based on the assumption that providing students with authentic tasks increases the significance of learning in relation to real-world experiences and promotes the active construction of meanings by the subject.

More specifically, task authenticity means that the task requires addressing a realistic and potentially real-world problem. There are two main models of authentic learning environments, that is: simulation-based and participation-based [Kearney M., Schucka S., Burden K., Aubusson P. (2012). Viewing mobile learning from a pedagogical perspective. Research in Learning Technology. 20, 1-17]. Thinking of 360° videos, the reference model is simulation-based. Indeed, 360° video faithfully reproduces the real environment, providing the context in which the learner can practice similar real-world activities. This specific immersive technology can scaffold situated learning processes by simulating the real world and integrating authentic tasks, thus allowing students to be put into the situation, to learn in the real context in which knowledge is applied. Some of the features of 360° video that can facilitate situated learning include:

- the ability to control and observe the surroundings from a personal perspective: the student becomes a director, standing in the middle of the scene and choosing the best shot, varying the point of observation, deciding what is important to observe;
- portability and relocation of the educational experience;
- the contextually rich & highly realistic nature of the learning environment;
- the flexibility to allow teachers to adapt the difficulty of the problem to the students through the insertion of interactive points (text, image, audio, video, quiz. links, hotspot). The students can go deeper and verify the knowledge acquired through the interaction and activation of the points.

:

SEPA360

Experiential learning

Experiential learning is referred to as learning through action process, learning by doing, learning through experience, and learning through discovery and exploration. According to the model theorized by Kolb [Kolb D. A. (1984). Experiential Learning Experience as the Source of Learning and Development, New York; Prentice Hall], experiential learning can be represented through a cyclical process made up of four main elements:

- concrete experience
- observation and reflection
- abstract conceptualisation
- active experimentation.

Based on this model, learning is a process of knowledge construction carried out through observation and transformation of what has been experienced, so the passive acquisition of notions, concepts, and relations is no longer necessary. Through a concrete experience, the subject puts his or her skills, attitudes, and behavior to the test. Following the situation experienced, a reflexive observation, taking into account multiple perspectives, allows the learner to develop his/her awareness and transform his/her perceptions. The subject who reflects on his/her own experience analyses the ways of responding and interpreting it, comparing it with the strategy with which peers have faced the same situation, being able to know new ways of responding that can be considered more or less valid by the learning subject. It is at this juncture that the individual re-elaborates what he has experienced, allowing the integration of his/her own operational models with the alternative models elaborated. When, at the end of the analysis and reflection phase, there is a real reworking of the operational models that leads to a modification of the structure of thought, we are in the phase of abstract conceptualization. The experience is then understood and reformulated in a general theoretical manner. The cycle is completed when the student has the opportunity to apply in a practical way (active experimentation) the generalization achieved in the previous phase.

The first phase of Kolb's cycle or concrete experience does not need to take place in a particular physical place, which is why at this stage "we give technology the merit of being able to expand the opportunities for experience in terms of time and space action". [Celentano M. G., 2009. Un approccio elicoidale al modello di apprendimento esperienziale. Colazzo S. (a cura di). Formare gli adulti, Lecce: Amaltea Edizioni, 227-240].The 360 videos may support the learning process by offering an immersive experience of reality, even when the access to reality is limited. Therefore, it provides the opportunity to learn and experience in a protected environment, through discovery and exploration. In addition, when viewed with the viewer (HMD), it increases the ability to engage the emotional, sensory, and motion experience. It is a form of experiential learning that encourages the student to challenge themselves by building knowledge similar, in many ways, to that which is developed through real field experience.

SEPA360

The 360° video allows students to "get to know the world" through sense-motion learning, which is more natural for humans than the symbolic-reconstructive learning mediated by writing, typical of school environments. Through perceptual-motion learning, the subject operates on reality through perception and action, observes phenomena and behavior, intervenes with his/her own action to modify them, observes the effects of his/her own action, and tries to intervene in a continuous learning cycle. In repeating cycles of perception and action, knowledge emerges while experiencing.

Transformative learning

The theory of transformative learning was developed by Mezirow in the early 1990s. Learning for Mezirow can be understood as the process of using a previous interpretation to construct a new or revised interpretation of the meaning of one's experience as a guide to action for future action. Learning becomes a process by which we dialectically interpret the situations before us from a framework of meanings that governs the perception and reworking of our knowledge. This framework through which we interpret reality is a set of expectations, defined as a meaning perspective that involves the cognitive, affective, and volitional dimensions. In practice, the way we see the world is the result of the perceptions of our experiences. According to Mezirow [Mezirow, J. (1991). The transformative dimensions of adult learning. San Francisco, CA: Jossey-Bass] we develop habitual expectations based on past experiences. We expect things to be as they were before, or, to put it another way, we uncritically assimilate perspectives from our social world, community and culture.

These perspectives are distortions, stereotypes, and prejudices. They guide our decisions and actions until we encounter a situation that is not congruent with our expectations. At that point, we can either reject the discrepant perspective or enter a process that might lead to transformation. Transformative learning occurs when there is a reshaping, a change in the perspectives of meaning with which we relate to life, experience, ourselves, and the world, and this change leads to new ways of thinking and especially new ways of acting.

The perception of the world, therefore, defines the perspectives of our actions. Without going into the merits of this, metacognitive and psychological studies have shown that the more a scenario resembles a real one, the more the brain feels comfortable and gets involved and implements processes to change our internal models of perception of the world around us.
Thus, 360° video providing real scenarios, and even more specifically virtual reality, allow us to be in the experience, to be immersed in a situation to which we attribute a meaning according to our perceptive faculties when these come into conflict with an internal necessity, then a criticizing process begins [Freire, P. (1970). Pedagogía del Oprimido. Montevideo: Tierra Nueva] and it is triggering a transformative learning process.

SEPA360

Didactical design scenarios

After this brief excursus on the theories, we take a look at how 360 videos is used in the context of higher education by highlighting three didactical design scenarios in which 360° video is used, identified by the analysis of the literature (see SEPA 360° Scoping Study).

The three didactical design scenarios are:

1. Lecturing/Instructional: the 360° video is used to record and disseminate information as in traditional lectures or through an instructional video. It may facilitate the comprehension and communication of complex subject theories or concepts of a discipline. For example explainer (using a 360° video to explain certain concepts or theories, without showcasing them) or lecture recording (using a 360° video as a supplementary lecture recording).

2. Modelling: The 360° video is used to show (model) a specific behavior/task/skill in order to comprehend it and/or being able to reproduce it or reflect upon it. A video-based model shows the desired performance which often involves motor skills. This might be an expert performing a task in a flawless and error-free mode or a novice exemplifying common mistakes and pitfalls. For example: observe teaching (using 360° videos to record a certain teaching behavior in teacher education, either to reflect upon it or to show a best practice), surgery (using a 360° video operative procedures and activities in a medical environment can be shown); sports education (using a 360 video a sample class setup is shown in a sports hall).

3. Exploring: the 360° video has the ability to transport learners to different locations to explore any place: natural landscape and site, cities, internal environment, or mixed environment (internal and external). It puts a learner in control and encourages him/her to discover.

In the next section, through a selection of case studies from the literature, examples of the use of 360° videos in higher education are provided.

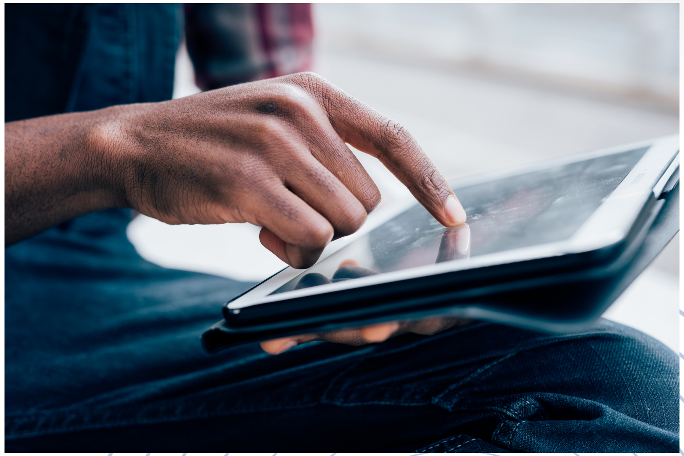
Implementing 360° videos into teaching practice

The well-integrated use of technology by trained teachers was the reason that gave great impetus to teaching and the educational process generally over the past century. The use of technology resources such as computers, mobile phones, tablets, digital cameras and much more are key elements of this integration.

SEPA360

Indispensable condition of a successful model of modern learning

- Regular / high frequency
- Easiness
- Accessible and immediately available
- Support (program goals/ student goals)



SEPA360

Methods of integrating technology in the classrooms as well as training in teachers' knowledge refer to the following models:

SAMR (substitution, augmentation, modification, redefinition)

Substitution and Augmentation are the first two key steps of the model and refer to the improvement of the existing teaching model, while modification and redefinition refer to the transformation of the model. Therefore in the first step of the replacement, we refer to the use of new technology tools such as laptops and tablets instead of paper and pens as was traditionally done by the students. Going to the second step, the substitution becomes even greater and requires attention so that it can serve and not delay the students in understanding the content. Steps 3 and 4 now refer first to the **Modification** and then to the **Redefinition** of the teaching model. In these last steps of the model, students use larger databases, collaborate with students from other schools worldwide, and gain a completely different experience from the previous one. The use of high technology (hardware/software) is now imperative since the volume of data is now very large due to the high resolution of the image and videos used.

SEPA360

TPACK (technological, pedagogical content knowledge)

The model **TPACK** developed by Mishra and Koehler (2006), refers to Technological Knowledge (TK), Pedagogical Knowledge (PK) and Content Knowledge (CK). The model also states how important the role of the subject (teaching content) and the pedagogical (teaching method) of the teacher is for the successful implementation of the model.

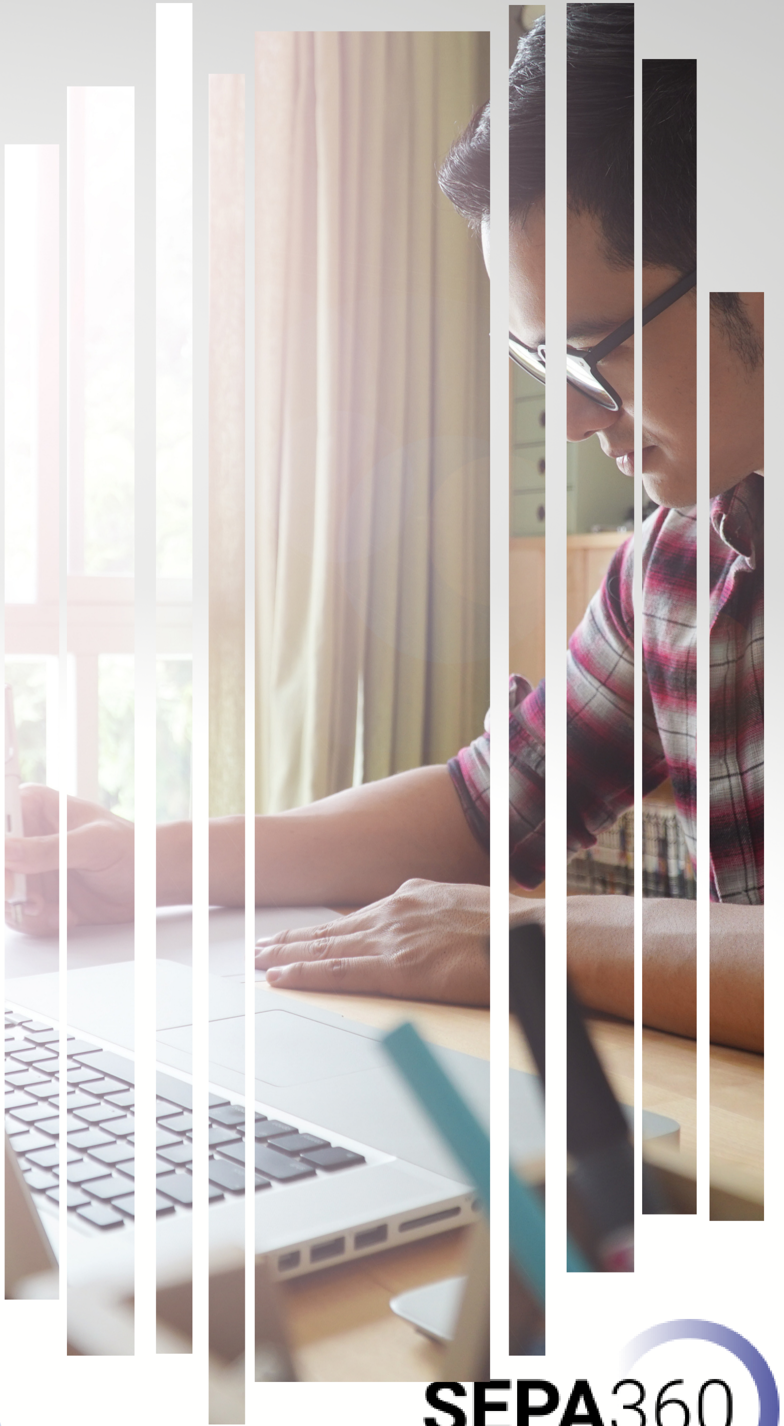
Content knowledge (CK)- Refers to the teacher's knowledge of the subject matter. Theorems, theories, basic concepts and historical references always depend on the subject of teaching.

Pedagogical Knowledge (PK)- Refers to the teacher's knowledge of teaching methods and practices. It refers to the teaching models that each teacher adopts in his / her classroom.

Technological knowledge (TK)- Refers to the knowledge that the teacher has on the new technology and its use. This knowledge must enable him to choose the appropriate tools according to the course and the subject of teaching, so that the purpose of the course is best served.

Content Technology Knowledge (TCK)- Refers to the teacher's full understanding of how technology and content will build a good relationship to promote each other.

Technological Pedagogical Knowledge (TPK)- Refers to the teacher's understanding of the great change that the right use of the right technology can bring to the teaching and learning experience



SEPA360

Use of 360° video in the learning process

The use of 360° video in the learning process can be achieved in the following ways:

1. As a helpful tool in lifelong learning.

2. As a key part of the lesson (watching 360° video / commentary / discussion)

3. As a parallel tool of learning

4. Using 360° video in the classroom with VR AR glasses with the teacher guiding the whole process.

5. Asynchronous Use of the 360° video by students outside the classroom, from a mobile phone, tablet or computer.

6. Asynchronous Use of the 360° video by students outside of class (asynchronously) using VR AR technology.

How to use 360° video?

The following tips have been found useful in implanting 360° videos in educational practice:

1. The teacher, after devoting enough time to the interpersonal contact with the student, always serving the learning objectives, starts showing the 360° video on the big screen. The use of the 360° video will help students differently, always depending on the subject of the lesson and the learning objective.

2. The teacher, after welcoming the students, begins the screening of the 360° video, emphasizing the points that must be specially noticed in order to make an analysis afterward. In that way, it is necessary for each student to have his own screen (mobile, tablet, or computer) in order to use the 360° video through his own prism. The correct observation of the 360° video depends on the education and practical knowledge of the students in the use of the 360° video but also on their critical ability.

3. The teacher also uses the 360° video in joint projection, parallel with the lifelong teaching, giving the students a more complete picture of the subject. It is suggested to use individual screens if we want to develop the critical ability of the students through the different viewing angles of 360° video.

4. After welcoming the students to the room, the teacher uses the 360° video. The students watch the 360° video through special equipment (VR and AR glasses) and the teacher guides the whole process. The course process is done exclusively through the use of special equipment (maybe some breaks according to the instructions of the experts). The individual observation of the 360° video by each student will have the corresponding effect on the questions that will be asked during or at the end of the lesson.

5. The use of the 360° video is made by students asynchronously in addition to the curriculum program. The use is made through the computer screen, mobile, tablet, or TV. Students through the 360° video try to answer the questions posed in the course but also to better understand the theory.

6. The use of the 360° video is made by students asynchronously with the use of VR AR technology of glasses. The 360° video contains all the information and instructions so that the student can through virtual reality better understand the theory and solve his questions.

Examples of 360º videos

Examples of the SEPA360º research team

360º video: Case study in the University of Hull

General Information

- **Title**: Help Callum/Help Sally
- **Key Concept**: Immersive storytelling and co-creation of hot spots
- **Case study description**: We are adding hotspots to 360º animations that use immersive storytelling to put the viewer in the world of a child recovering from flooding. The stories are based on real flood testimonies. The interactions and teaching materials for secondary schools will be co-produced with young people and teachers through workshops.
- **Teaching area**: Geography/public engagement

This project is a collaboration between the Energy and Environment Institute, University of Hull, University of Lancaster, and the Environment Agency. It has been funded by the Environment Agency. Development has been completed by Lampada Digital Solutions.

Team: Chris Skinner, Katie Parsons, Dan Parsons (EEI, University of Hull), Maggie Mort, Alison Lloyd Williams, Maggie Mort (Lancaster University), and Jo Coles (Environment Agency).

Link to the 360° video on YouTube:
Help Callum - https://www.youtube.com/watch?v=4gpOOcQV1fw
Help Sally - Coming end of July 2021
Screenshots from video:

Information about target and context
N/A - we are working with young people and teachers to co-create a tool for public engagement around flood risk and resilience issues.

SEPA360

Screenshots from video:

Information about target and context

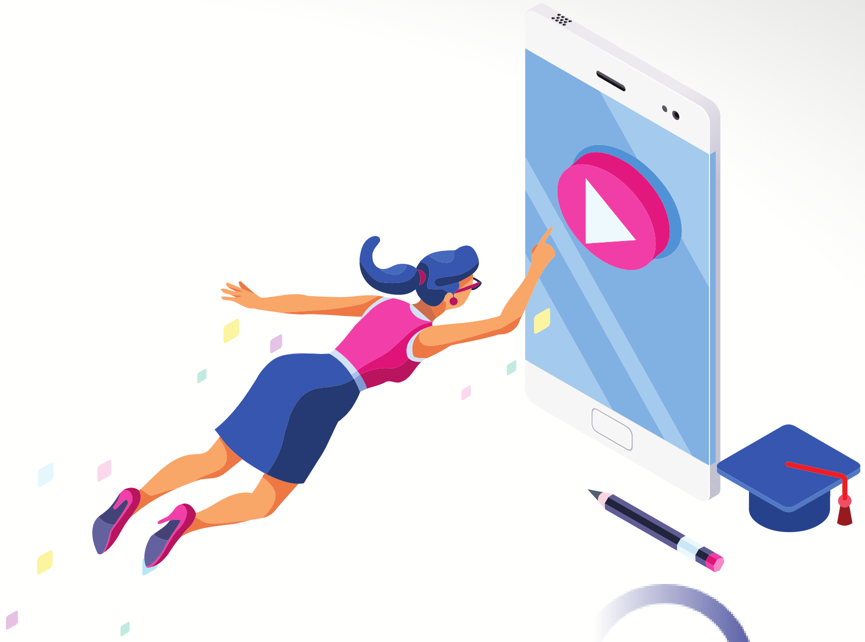
N/A - we are working with young people and teachers to co-create a tool for public engagement around flood risk and resilience issues.

Goal:

To raise awareness of the role children can play in flood recovery by telling real flood recovery stories using immersive storytelling. Hot spots will be used to add interaction and additional learning points - the nature of these will be determined via the workshops with young people and teachers.

Learning Objectives:

These will be determined via the workshops with young people and teachers.



SEPA360

Technical Information and delivery setting:

- **Camera type**: N/A, using a UNITY-based animation
- **Viewer type (Carboard, HMD (Oculus Quest, Viva, Valve, etc.)**: Cardboard, Quest, Rift
- **Device type (notebook, tablet, smartphone)**: Desktop only at the moment
- **Platform or software standalone (YouTube, Vimeo, Vivista)**: YouTube, Vivista (if available)
- **Immersive dimension (Flat screen; VR Headset; Mobile device + cardboard)**: All possible, but currently flat screen only

Teaching delivery setting:

Animations are available currently on YouTube. An interactive activity will be face-2-face unless the Vivista platform is available.

Teaching Methods:

These will be determined via the workshops with young people and teachers.

Didactical Design Scenario (Lecturing/Instructional; Modelling; Exploring (more information see: https://www.sepa360.eu/didactical-design/): Exploring

Teaching Methods:

These will be determined via the workshops with young people and teachers.

Didactical Design Scenario (Lecturing/Instructional; Modelling; Exploring (more information see: https://www.sepa360.eu/didactical-design/): Exploring

Teaching challenge (Which added value is addressed/Which present limitations are tackled?):

The animations and interactions immerse students into the world of a young person recovering from flooding. They see the world through the child's eyes and hear the story in their words, based on real flood testimonies. No other media is able to create this experience.

360° video: Case study in the University of Florence

3 General Information

- **Title**: Introduction to SensoryLab
- **Key Concept:** Overview of the Sensory Laboratory of the University of Florence enriched with interactive contents
- **Case study description:** We are adding interactive points to a 360° video in which students can navigate the main areas of the Sensory Laboratory and learn how sensory tests are carried out.
- **Teaching area:** Sensory Science/Food Technology/Nutritional Science

This project is a collaboration between the FORLILPSI and DAGRI departments of the University of Florence. The video has been recorded using a 360° action camera and enriched with interactive content using Vivista software.

Link to the 360° video on YouTube:

The video will be used synchronously during university lessons using head-mounted displays and/or flat screens. Vivista Player can be used to watch and interact with 360° video.

A short preview could be found also on YouTube: https://www.youtube.com/watch?v=yGeZt6EwGcE

Team:

Erminio Monteleone, Lapo Pierguidi, Caterina Dinnella, Sara Spinelli, Maria Ranier, Damiana Luzzi, Isabella Bruni, Stefano Cuomo

Screenshots from video:

Information about target and context

- Name of Degree: Food Science/Nutritional Sciences
- Name of the Course: Sensory Analysis of food/Perception and acceptability of food products
- Number of students: 60/80

Learning Objectives:

To facilitate students in applying the knowledge acquired in the classroom (through frontal lessons and exercises),when they move to the SensoryLab where sensory tests are organized. Interactive points will be used to add interaction and additional learning points.

Technical Information and delivery setting:

- Camera type: Insta360 ONE X
- Viewer type (Carboard, HMD (Oculus Quest, Viva, Valve, etc.): Oculus Rift S
- Device type (notebook, tablet, smartphone): Desktop PC
- Platform or software standalone (YouTube, Vimeo, Vivista): Vivista
- Immersive dimension (Flat screen; VR Headset; Mobile device + cardboard): Flat screen, VR Headset

SEPA360

Teaching delivery setting:

In presence: classroom and laboratory

Teaching Methods:

The video will be delivered to students synchronously during lessons or before taking part in practical activities.

Didactical Design Scenario

Exploring and Modelling

Teaching challenge

Students usually experience difficulties in applying the knowledge acquired in the classroom (through frontal lessons and exercises), when they move to the SensoryLab, where food tasting takes place. When they first arrive in the lab, they feel lost and may not be able to connect the experience to the theoretical knowledge of contents, procedures, and instruments previously learned. The 360° video anticipates the experience, enabling students to explore the laboratory through the integration of interactive content. Thus students are not passive spectators but active explorers. Furthermore, in this time when the pandemic is limiting face-to-face teaching in the lab for safety reasons, 360° videos can be exploited, successfully, as an effective alternative.

SEPA360

360° video: Case study in the PXL

General Information

- **Title**: 360° construction site
- **Key Concept**: Analysing a construction site
- **Case study description:** One and the same construction site was filmed with a 360° camera from different perspectives, which were collated in the editing. The only enhancements added with Vivista were chapters, as the focus was mainly on exploring and analysing the environment. This 360° video was then in an exam context, with each time one student taking turns in the exam room. In this room there was one laptop and one VR headset ready for the student, which gave him/her an immersive experience of the construction site. The examiner who was also present in this room could constantly follow what the student was looking at on the laptop. Meanwhile, the examiner also asked questions, which the student had to answer by analysing the site.

- **Teaching area:** Construction

Information about target and context

- **Name of Degree:** Bachelor
- **Name of the Course:** Construction training
- **Number of students:** ±70

Learning Objective: Analysing and assessing students' competences on a construction site

SEPA360

- **Technical Information and delivery setting:**

- **Camera type:** GoPro Fusion
- **Viewer type (Carboard, HMD (Oculus Quest, Viva, Valve, etc.):** HTC Vive Cosmos
- **Device type (notebook, tablet, smartphone):** Laptop Lenovo Thinkpad
- **Platform or software standalone (YouTube, Vimeo, Vivista):** Vivista
- **Immersive dimension (Flat screen; VR Headset; Mobile device + cardboard):** VR Headset
- **Teaching delivery setting:** Students entered the examination room one at a time, as one student at a time was able to put on the VR headset
- **In presence (classroom or laboratory, and if it views individually or in group):** Individually in a classroom, with the examiner

Teaching Methods:

Didactical Design Scenario (Lecturing/instructional; Modelling; Exploring (https://www.sepa360.eu/didactical-design/): Exploring

SEPA360

Teaching challenge:

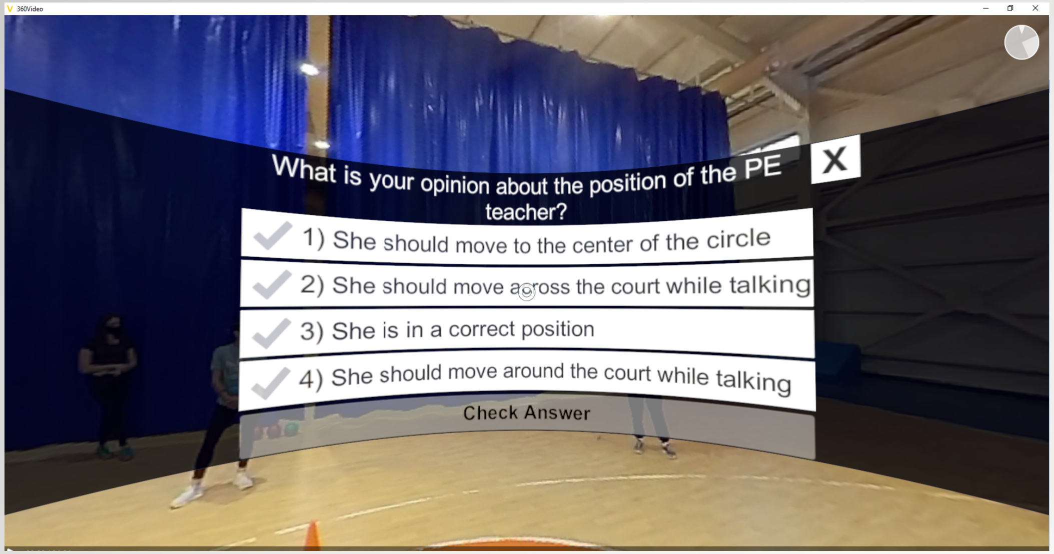
Because of the corona pandemic, it was not permitted or possible to take students to a construction site in order to assess and analyse their competences. By bringing students to a construction site through a VR headset, we had a very authentic alternative where students themselves indicated that it felt like the real thing. The limitation that was mentioned was the quality of the video material, but it is possible that this was influenced by the eye mask that the students wore. After the well-known mouth mask, there are also eye caps for VR headsets with which you can limit the physical contact with the VR headset even more. The disadvantage is that this makes it more difficult to place the VR headset correctly on the head, so that the eyes look straight into the lenses, which results in a clear image. If the VR headset is not worn correctly, the image will appear much more blurred/ less detailed.

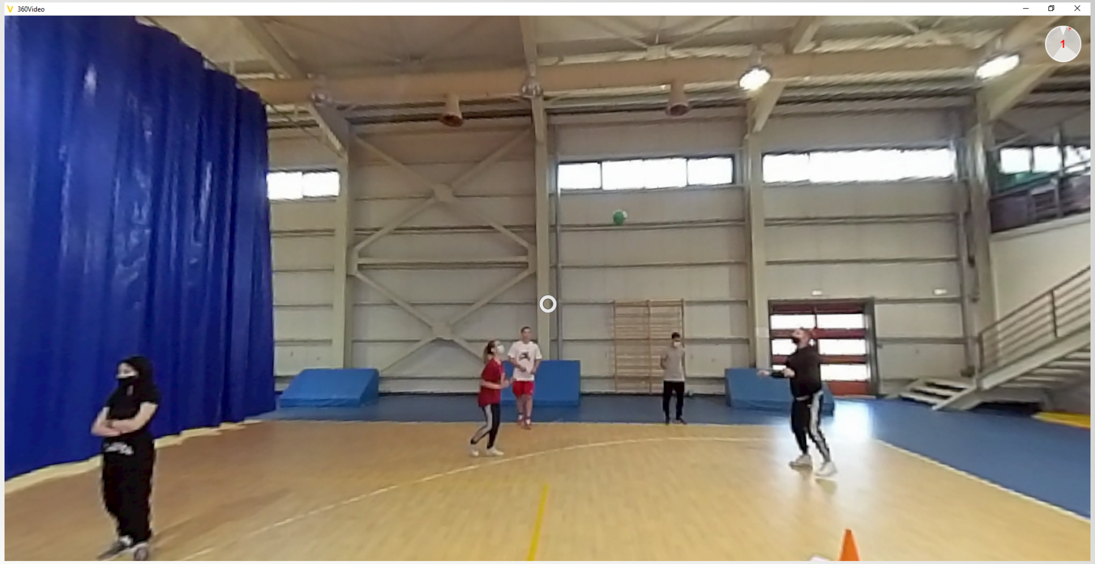
360° video: Case study in the Aristotle University of Thessaloniki

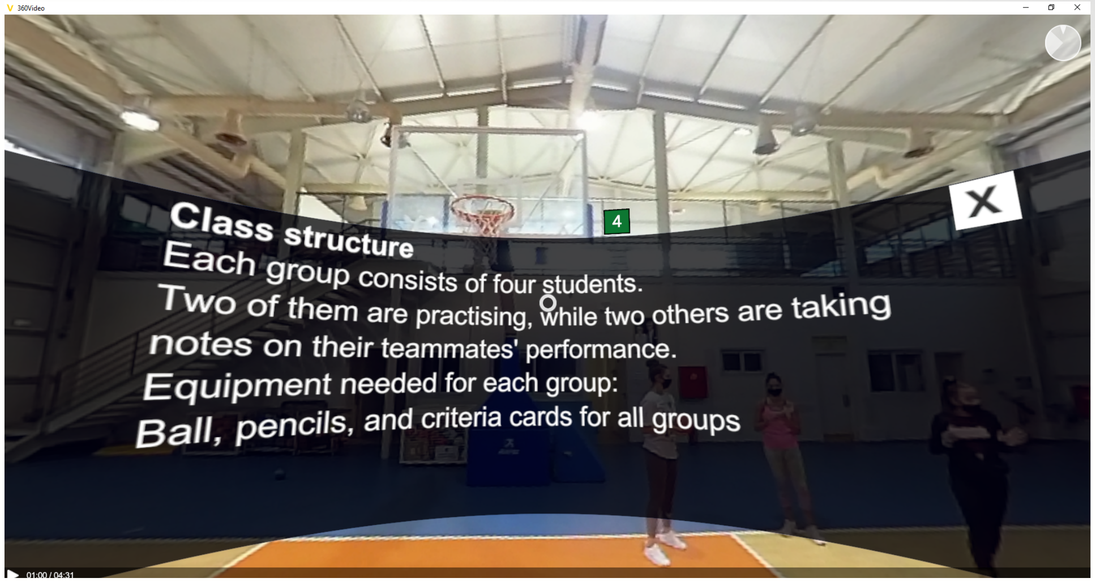
General Information

- **Title**: Reciprocal teaching style in physical education
- **Key Concept**: Demonstration of the implementation and key features of the reciprocal teaching style in physical education
- **Case study description**: The video describes the structure of a lesson implementing the reciprocal teaching style in physical education. Interaction points have been added to provide information on the key features of the teaching style and quizzes to confirm students; understanding of these features.
- **Teaching area**: Volleyball court/ schoolyard

Screenshots from video:







SEPA360

Information about target and context

- **Name of Degree:** Bachelor
- **Name of the Course:** Teaching Physical education in secondary education
- **Number of students:** 40-50

Learning Objectives:

The learning objective of the 360° video is to demonstrate the key features of the reciprocal teaching style and assist students to understand how it is implemented in practice (e.g., the position of the teacher, the position of the students, etc).

Technical Information and delivery setting:

- **Camera type:** Insta360 ONE X
- **Viewer type (Carboard, HMD (Oculus Quest, Viva, Valve, etc.):** Oculus Rift S
- **Device type (notebook, tablet, smartphone):** Desktop PC
- **Platform or software standalone (YouTube, Vimeo, Vivista):** Vivista
- **Immersive dimension (Flat screen; VR Headset; Mobile device + cardboard):** Flat screen, VR Headset

Teaching delivery setting
The video will be delivered to students during lessons or before taking part in practical activities.

Teaching Methods:
Didactical Design Scenario (Lecturing/Instructional; Modelling; Exploring (more information see: https://www.sepa360.eu/didactical-design/): Modelling

Teaching challenge:

Physical education students do not usually have experience with the implementation of the spectrum of teaching styles. Therefore, it is difficult to understand how teaching styles, such as the reciprocal teaching style, is implemented into practice

Examples in the literature:

In this section, some case studies from the literature are presented in order to provide concrete examples of the use of 360° video in university teaching. The case studies have been organized by topic.

SEPA360

1.HEALTH

Case study: Surgical training [in Huber, T., Paschold, M., Hansen, C., Wunderling, T., Lang, H., Kneist, W., 2017. New dimensions in surgical training: immersive virtual reality laparoscopic simulation exhilarates surgical staff. Surgical Endoscopy 31, 4472–4477].

“We combined a VR HMD with the VR laparoscopic simulator and displayed the simulation on a 360° video of a laparoscopic operation to create an IVR laparoscopic simulation.” (p. 4472) “Virtual reality (VR) laparoscopic simulation has been used for training of the basic psychomotor skills used in laparoscopic surgery.” (p. 4472). “The simulator tasks “peg transfer,” “fine dissection,” and “cholecystectomy” were used for the study. The tasks combined navigational maneuvers, fine preparation, and procedural aspects; thus, they are capable of analyzing a participant’s general surgical skills.” (p. 4473) “A 360° camera (Samsung Gear 360, Samsung AG, Seoul, Korea) was used to record a video sequence inside the OR, including an audio recording.

The setting was an artificial scenario during a laparoscopic surgery. Real members of the departments acted as the patient, two scrub nurses, laparoscopic assistant, anesthesiologist and anesthesia nurse. of routine processes during a standard laparoscopic procedure." (p. 4473). "We used a HDMI to USB 3.0 video frame grabber (Startech online®) to transfer the video output signal of the simulator to a VR-ready laptop computer (MSI; GT72VR- 6RE16H51). The software development platform Unity3D ® was used to integrate the simulator display into the recorded 360° OR-video. The fused environment was displayed on the VR HMD. Audio signals of the video and from the laparoscopic simulator were also synchronized and transduced by noise-canceling Bluetooth headphones (Bose® Quietcomfort® 35)." (p. 4473).

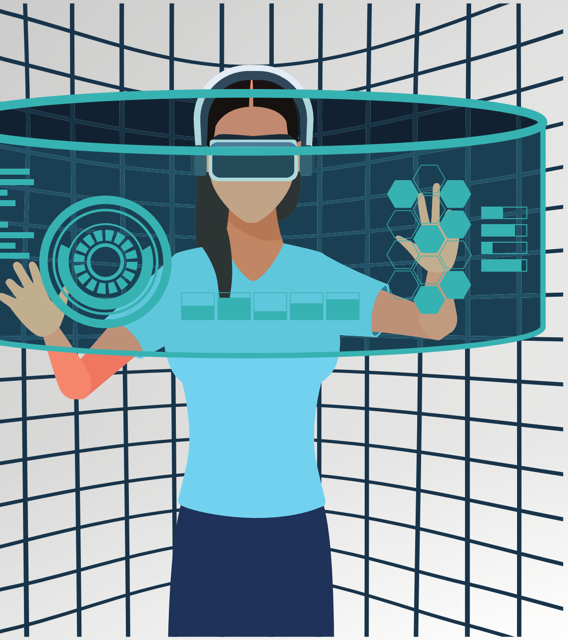
“In surgical training, VR HMDs have been used to create an abstract virtual OR for team training scenarios. No comparable highly immersive laparoscopic simulation scenario has been described so far. The only other description of laparoscopic simulation using a HMD [15] had a surrounding that was part of a virtual scenario of a simple plain room with only a 45° surrounding abstract environment. The current setup represents the latest high-end commercially available VR HMD technology in combination with an up-to-date VR laparoscopic simulator in a 360° surrounding for the first time. This approach enlarged the immersion compared with the previous study due to the display of a real or environment using a 360° video sequence.” (p. 4476).

Case study: Medical training [in Izard, S.G., Méndez, J.A.J., García-Peñalvo, F.J., López, M.J., Vázquez, F.P., Ruisoto, P., 2017. 360° Vision applications for medical training, in: Dodero J.M., Ibarra Saiz M.S., Ruiz Rube I. (Eds.), ACM International Conference Proceeding Series. Presented at the 5th International Conference on Technological Ecosystem for Enhancing Multiculturality, TEEM 2017, Association for Computing Machinery].

"We present a teaching experience of 360° immersive visualization of an operating room and an anatomical dissection room, with the aim of generating a virtual environment for learning, training and valuing the equipment that exists in these medical rooms." (p. 1). "We analyze how recording actual surgeries with 360° technology can improve students' ability to understand surgical procedures. At the moment the medical students come as spectators to the surgeries with the objective to familiarize themselves with the environment, to know the mechanics of work, the medical procedure of action. The problem is that the number of students that can enter the operating room is limited so that students can have this experience a few times. Thanks to the 360° recordings, we have been able to relive the experience of being spectators in a surgery as many times as they wish.

SEPA360

In addition, on these spherical or 360° recordings, interactive systems can be implemented in which the user can interact with the environment, thus opening up to new possibilities, ranging from being able to perform a simulation of surgery to obtaining information about the elements that surround to user. A spherical recording of an operating room and anatomical dissection room has been performed, in addition to different surgeries and the implementation of a system in which the user can perform a small interaction with the environment. These systems are intended to demonstrate the potential that spherical recordings offer to medical training. It is no more than a part obtained from a spherical image, which allows the student not only to see this portion visualized here, but the whole environment that surrounds it. In addition, a small 360° video has been made so that the student can check how other students perform anatomical dissection of a human being. With 360° video streaming technology, surgeons will also be able to operate remotely using virtual reality technologies. In combination with haptic devices that allow the surgeons to manipulate medical equipment remotely, this will be the future, not only for the possibility of remote surgeries, but also for the precision that devices can get in comparison with human hands. This technology will be soon available, and will also allow other surgeons to be present during the surgery as support." (p. 2)



“We recorded a dissection room in 360° degrees with the aim of allowing the user (student), to observe in a virtual way the most relevant elements available in an anatomical dissection room. We also recorded different operating rooms to create virtual environments, with immersive characteristics, to analyze the most representative elements of an operating room. For the development of our technological procedure, we used multiple hardware devices, which allowed us to generate different immersive Virtual Reality environments. A 360° camera was used to record different clinical environments both in an operating room and an anatomical dissection room. To this end, we use the camera Samsung Gear 360° (Fig. 3), which has a spherical design, 6 cm in diameter, and 152 grams in weight. It has two sensors on opposite sides, each comprising 180° of visual field and 180° apertures f/2.0; With a maximum processed video resolution of 4K 30fps. Among other technical features of this device, the following should be highlighted: Dual 15 Megapixels sensor; Dual fisheye lens with f / 2.0 aperture; Video resolution of 3840 x 1920 pixels at 30 fps; Image resolution of 7776 x 3888 pixels (equivalent to 30 MP); Modes: Video, photo, time-lapse, video looping; Size: 66.7 x 56.3 x 60.1 mm; microSD slot.

We can find many different 360º cameras in the market, however, we used Samsung Gear 360º because it offers good quality images and videos if we have in mind that performance is a very important requirement in the development of the system described in this article. Although it is true that there are many other cameras that offer better quality, the problem is that if we use high-resolution images and videos our application will have two problems. First of all, its size will be too high, and on the other hand, the performance will be lower, and the users will need better devices to run the system and get a quality experience. Once the images were recorded, they were assembled using Gear 360º Action Director software. It is an editing program to create videos at 360º that can be viewed with both traditional devices, such as a computer, and with Reality glasses (stereoscopic glasses). Even videos can be viewed by taking advantage of the 360º recording on smartphones and tablets, where the user can look at any direction of the video by moving the mobile around. One of the tasks carried out by this program is the stitching of the images, which consists of joining the image captured by a lens with that of the opposite lens, avoiding imperfections of the resulting image. For optimizing the visualization of results, the ideal is to have stereoscopic glasses, since this device offers us a complete immersion in the 360º images and generated videos.

The sense of realism is much greater than with other techniques previously mentioned. So far we have recorded a video with 360º technology, assembled and edited, stitching the images to create a spherical video. This video could already be visualized in glasses using distribution platforms such as YouTube. However, we wanted to take a step further by adding Virtual Reality and user interaction to our system. In this sense, we created a spherical image of the operating room and we added virtual 3D elements that provide information about different devices that the user can find in the operating room. (p. 3). “To this end, we used the Unity3D video game engine. This program allows creating three-dimensional environments and programming interfaces and different behaviors for each of the 3D elements.” (p. 4). “Please follow this link to see the video: https://youtu.be/IQCSzc7oACA “ (p. 5).

SEPA360

2. LANGUAGE LEARNING

Case study: Use of 360° Video for Foreign Language Learning[in Repetto, C., Germagnoli, S., Triberti, S., Riva, G. (2018). Learning into the Wild: A Protocol for the Use of 360° Video for Foreign Language Learning. Springer Verlag]

"Learning a second language could be a boring task if accomplished by repeating bilingual words lists. Laboratory research demonstrated that second language learning is more efficient if the material is enriched by pictures or gestures during the encoding phase. Here we want to test the impact of 360° videos on foreign language learning. The 360° videos are spherical videos that allow a lifelike exploration of the environment if experienced immersively (namely, by means of a Head-Mounted Display). The protocol includes ten 360° videos representing natural landscapes, sports performances, and adventures; each video has been enriched with a narrative that guides the subject's attention towards the relevant elements named in English (the second language)." (p. 56).

“In this study, we will focus on the effects of action towards language processing. The idea that language and motor system are not independent, nor free from reciprocal influences is not that recent: Lieberman's Motor Theory of Speech Perception is one of the first theoretical proposals in this direction. In the last decades, however, a huge amount of experimental proof has demonstrated the crosstalk between the two systems. At a behavioral level, performing an action while processing language has specific consequences on the latter. For example, in the classical Action-sentence Compatibility Effect (ACE) paradigm, participants are required to make sensibility judgments on sentences that describe actions towards the body (“John opens the drawer”) or away from the body (“John closes the drawer”). Crucially, the response is provided by making an arm movement either away or towards one’s body; the effect is underlined by faster reaction times in providing the response when the action performed by the participant matches that described in the sentence. Another way to use action in connection with language is through object manipulation.

SEPA360

It has been demonstrated that children, who act out a just read sentence by means of toys representing the sentence components, perform better on a comprehension task compared to other children that only read the sentence. It has been suggested that the manipulation task forces the child to connect words to particular objects and syntactic relations to actions, resulting in better comprehension of the sentence.” (p. 57). “Studying a foreign language could be a boring task if the learner tries to memorize bilingual words lists. However, the task could become more engaging and the performance more efficient if the words are enriched by other stimuli. Empirical studies have shown that multisensory enrichment promotes verbal learning. The reason why enrichment enhances memory performance is accounted for by two influential cognitive theories: the Dual Code Theory and the Level of Processing Theory. According to the Dual Code Theory, the combination of visual and verbal information during the encoding phase yields better memory performance.” (p. 58). “In this study we aim to employ enriched 360° videos displayed on the smartphone and experienced immersively by means of cardboard, to improve second language learning in high school students.

Ten 360° videos have been selected, among those available on the web, with the purpose of catching the adolescents' attention. 360° videos are spherical videos recorded by means of a special camera with omnidirectional lenses. During the playback, a user, after having worn cardboard, can control the viewing direction by means of the head movement in a very realistic way (looking up one can see the sky/roof, looking down one can see the floor/ground, and if one wants to see what happens on the left/right, it is sufficient to turn the head accordingly, as in the real-life situations). Of note, within 360° videos, it is not possible to select the direction of the navigation, nor to interact with the elements of the environment. Selected videos represent natural landscapes, sports performances, adventures, and interior environments. " (p. 59) "Each video was carefully inspected to identify the relevant elements included and the actions performed by the characters." (p. 60).

SEPA360

Case study: 360° videos within a climbing [in Gänsluckner, M., Ebner, M., Kamrat, I. (2017). 360° degree videos within a climbing MOOC, in Spector J.M., Ifenthaler D., Ifenthaler D., Sampson D.G., Isaias P., Rodrigues L. (Eds.), 14th International Conference on Cognition and Exploratory Learning in the Digital Age, CELDA 2017. Presented at the 14th International Conference on Cognition and Exploratory Learning in the Digital Age, CELDA 2017, IADIS Press, pp. 43–50].

"It is a beginner climbing course called "Klettern mit 360° Videos" (climbing with 360° videos) and the online part has been implemented as a Massive Open Online Course (MOOC)".(p. 43) "Most traditional climbing courses take place in indoor climbing halls and cover theoretical and practical basics. During these courses, a lot of time is used to teach and learn the theoretical basics that are required to ensure safe climbing. Of course, in many courses, the time for the practical part is limited, and important practical basics are handled as briefly as possible.

SEPA360

To use the time more efficiently and to enhance the practical part, the course was designed to teach the basic knowledge beforehand by using an online course. Providing those contents online allows the participants to learn independently and more accurately. Therefore, the essentials are provided in videos and additional content is offered for a more detailed study. The MOOC itself consists of five chapters, each building on the one before. Each chapter covers a different subject in one or more videos. Self-assessments are provided at the end of each chapter, to enable individual learning progress. The self-assessments are not mandatory, but allow the participants to check their acquired knowledge by doing some multiple-choice questions. Following the idea of blended learning, the final face-to-face course extends the MOOC with a practical lesson for each chapter. Due to safety reasons, the blended learning course has been designed for only a small group of attendants. The practical lessons are a follow up to the weekly topics of the MOOC and rely on the theoretical part. This allows the participants to apply the learned techniques and procedures right away. To increase the improvement achieved through the course, in the first lesson a video of each participant's climbing techniques is recorded. At the end of the last lesson another video is recorded to compare and analyze the progress." (p. 44)

“The currently upcoming 360° video technology allows capturing engaging and immersive videos. By recording beyond the common field of view, many advantages of 360° videos can be used. On one hand, everything happening around a 360° camera is captured and on the other hand, while viewing the video, the viewer is able to interactively control his/her personal field of vision. By allowing the viewer to interact with the video, more attention is paid to the video and to the content, which enhances the learning experience. During planning and recording the videos, it was attempted to make as much use of the 360° camera as possible. This ensures that the viewer can continuously follow the events on the screen.” (p. 45) “All videos were recorded in an indoor climbing hall in Graz. In some videos, 360° video technology has been used to capture spherical videos. In order to use the full potential of the 360° videos, well-structured film scripts were produced beforehand. To allow viewers to have efficient learning progress, a lot of testing of camera mountings was required.

“Especially when watching 360° videos with virtual reality headsets, fast movements are very confusing. Even though climbing is a sport with a lot of movement, a chest mount for the 360° camera created steady videos. This mount also simulates a first-person view. In some videos, the camera has been positioned in the middle of the room while events are happening all around the camera. In climbing one of the partners stays on the ground while the second one tries to climb to the top. In this situation, the viewer can change the point of view between the two climbing partners, depending on what is considered as important.” (p. 46).

SEPA360

4. RELIGIOUS STUDIES

Case study: 360° video in religious studies [in Johnson, C.D.L., 2018. Using virtual reality and 360° video in the religious studies classroom: An experiment. Teaching Theology and Religion 21, 228–241].

“It describes and reflects on the experimental incorporation of these technologies [n.d. 360° video and VR] in two sections of an introductory religious studies course at a small two-year campus in the University of Wisconsin System. The advent of relatively inexpensive 360° cameras and virtual reality headsets brings new possibilities to the study of religion by allowing students to become virtually immersed in religious experiences anywhere in the world at very little cost. One no longer needs to travel abroad to get a taste of what it is like at the Kumbh Mela or to chant with Tibetan monks in the Himalayas. These tools can bring these experiences to the classroom and enliven the material for students in a way that is completely unprecedented.” (p. 229) “The religious studies classroom benefits greatly from VR technology, which places students in the midst of religious places and events that may be distant, expensive, restricted, foreign, or even dangerous.

While this technology is not fully immersive in the way that a physical visit is (though the Oculus Rift comes close, adding the sensation of touch), it is the closest thing to immersion available and offers some benefits that face-to-face immersion and conventional video do not. Students can watch and re-watch religious events from various angles to notice intricacies that go unnoticed when seen only once in person, and can do so anywhere in the world.Assignments that incorporate these tools also allow students a new perspective on more familiar religious realities that are physically closer to home by giving them a critical distance to safely observe and study without anxieties, protocols, and lack of accessibility that can come with physical fieldwork. This is especially helpful for students in online programs and for students who have difficulty traveling. In fact, one of the most promising applications of this technology is to allow students with disabilities that prevent them from physically visiting locations to feel virtually immersed in these settings (the technology does have limitations that can adversely affect some students, such as not being able to see the entirety of 360-degree videos easily without standing up and turning around)." (pp. 229-230).

“In Fall 2017, I incorporated 360° videos and VR headsets into two sections of a course I have taught many times at the University of Wisconsin-Fond du Lac: REL 101, “Introduction to the Study of Religion.”16 This popular course, which introduces students to several theories of religion and a handful of the world's religions, offers interdisciplinary studies or humanities credit and was taught through the University of Wisconsin Colleges (UWC). This course and several others on the topic of religion are offered at the various campuses of the UWC by a small religious studies program run by one tenure-track faculty member (myself) and several Instructional Academic Staff members (adjunct instructors) and is housed within the philosophy department. For many UWC students, who often have families and hold multiple jobs, these classes are the only formal academic instruction they will ever receive in the study of religions. Like many institutions, the access mission at the UWC is bolstered by a strong emphasis on self-reflective teaching practices. I was first introduced to the use of 360° videos and VR in the classroom at the summer 2017 Digital Teaching and Learning Conference in Madison. Like many, I initially associated these versatile tools primarily with house tours and video games but was inspired by the conference to think more about how the tools could improve my teaching.

SEPA360

I began incorporating 360° videos and VR headsets into my Fall 2017 courses by carefully choosing a 360° video for each religion covered in class and then constructing assignments around these videos that were keyed to certain religion-specific topics covered in class. The assignments were designed to promote the course learning outcomes: (1) Demonstrate knowledge, critical reflection, and empathetic understanding of the diversity of human religious experience, belief, and practice; (2) Articulate and evaluate various approaches and theories in the study of religion; (3) Apply these approaches in understanding diverse religious traditions; and (4) Perform thoughtful analysis of the role of religions in the contemporary world. The VR assignments typically had several general goals related to these learning outcomes for students: to explore more deeply some aspect of religious practice seen in the video by bringing in knowledge about the tradition covered in class; to describe and personally reflect on details in the video to elicit self-awareness and empathy, and to apply theories of religion covered early in the course to specific religious practices (these assignments were called Putting Ideas To Work [PITWs]). For example, for the Confucianism assignment students reflected on a video of a temple in China in light of the close historical interactions of the Three Teachings of China, an idea that was discussed in class.

The person who posted the video raised the question of authenticity by describing the religious "mish-mash" found in the temple as dubious, and students were to contrast this view with the complex religious reality on the ground that the temple 360° video reveals. The assignment on Buddhism included students deducing what form of Buddhism they were viewing from cues in the narration (based on material learned in the course [the name of Amitabha was mentioned in the video, along with other hints]), attempting a mini-meditation session, and then discussing what William James would have said about the meditation described in the video, based on his four marks of mystical experience. The video on Judaism shows how the oldest synagogue in London was only allowed to be built in a concealed location and had to blend in by looking like a church. Students reflected on a time when they felt stigmatized or out of place because of who they are, and if they would assimilate or separate in this situation, considering the psychological and social effect of diaspora. As these examples show, students were asked to take on or consider the perspectives of the groups they were studying and the assignments included a mix of theoretical analysis, empathetic understanding, and self-reflection. Each assignment also encouraged active learning by asking students to describe the details they noticed in the video and relate them to the course (for example, by pointing out how the details of an Orthodox Divine Liturgy fit into Ninian Smart's seven dimensions of religion).

This descriptive strategy had the additional benefit of making students actually watch the videos, since by doing this, they effectively proved they watched it. I provided a transcript for each video to ensure students could understand what was being said, could "prepare" for the video by reading the text first, and could focus more on the visual details while actually watching the video. Students were encouraged to view the videos multiple times, which was reasonable given their short length and their rich visual content that is difficult to fully register on first viewing.

The process I used to select videos was to search YouTube for keywords related to each religious tradition, filter search results by the 360° feature and duration, (typically under five minutes), and then find the right video that met the criteria mentioned above. Some videos were tours of religious sites, such as guided tours of al-Asqa mosque, while others were more ethnographic or documentary in nature, such as an unnarrated clip of an Antiochian Orthodox Liturgy in Bloomington, Indiana, or a narrated account of the Hungry Ghost Festival in Malaysia. The videos were intended to be viewed by students on VR headsets that they checked out from the library. These seven assignments were worth a total of 20% of the student's grade, which also relied on quizzes (20%), tests (40%), and a group constructed wiki page (20%). The assignments were completed during the last two months of the course after various theories of religion had been covered.

One assignment was typically completed and due at the end of each week. After selecting the videos, I created an unlisted (more private) “Virtual Religion” playlist on YouTube and made that link available to students in instructions for each assignment. 18 I considered having students assemble inexpensive cardboard VR headsets in class, but decided this would be too time consuming and assembled them myself for students to try out with their smartphones. Assignment instructions were emailed to students each week. I also posted a drop box item created for each assignment on the course's D2L/Brightspace page, where students uploaded their completed submissions. In addition to an initial VR trial in class to familiarize students with the technology, the assignment instructions always included “Viewer Instructions” to remind students of how to operate the VR viewers, access the playlist, navigate to the Cardboard View on the YouTube app, and so forth” (pp. 231-232).

SEPA360

Case study: Integrating 360° videos in an chemistry laboratory [in A. Ardisara, F. M. Fung, "Integrating 360° videos in an undergraduate chemistry laboratory course", Journal of Chemical Education, 95(10), 1881–1884, 2018].

"360° videos were produced by recording several laboratory techniques using a 360° camera (Ricoh Theta S), which was mounted over a tripod stand during the recordings (Figure 2). After recording, the videos were subsequently annotated using a video editor (Camtasia 9) and injected with 360° spatial metadata, which took about 3 h in total (see Supporting Information). The edited videos were then periodically published on public viewing platforms that support 360° viewing (YouTube, Facebook, and Veer. TV). Generally, we found that the 360° camera was compact, lightweight, and easily operable. Compared to the use of conventional cameras, one typically does not need to worry if a part of the demonstration is out of the scope of view in the camera frame. With the 360° panoramic field of view, we were able to capture laboratory procedures without continually moving the camera around.

This wide field of view would be advantageous particularly when filming videos in a laboratory environment that is confined and cluttered, e.g., at a personal fume hood. The advantage of the 360° field of view is evident especially when a complete and unobstructed view of the apparatus used in the fume hood is desired. An example of this is the glovebox, where the gloves might obstruct the view of the apparatus used inside (Figure 3). In addition, the use of 360° cameras would be advantageous in situations where there are no additional personnel who are available to record the laboratory demonstrations. This new filming method is independent of an additional camera operator and can be performed solely by the lab instructor. In our Schlenk line video, we were able to simultaneously capture the demonstrator's action of turning off the Schlenk line knob and the resulting flow of nitrogen gas, which resulted in the bubbling of oil. In another laboratory technique video, we could capture the careless removal of a Keck clip resulting in the clip catapulting across the fume hood. These additional visual details further highlight the value-adding attributes that 360° videos have in situations that involve complex apparatus. For instance, during the operation of the Schlenk line and the glovebox, their individual parts/ components cannot be easily seen from one angle only.

Besides the more extensive scope of view, we believe that 360° videos provide a novel and fresh view of the laboratory apparatus layout, which may help to capture viewers' interest and increase their appreciation for laboratory classes. According to King-Thompson, 360° videos could possibly provide unparalleled novelty and engagement that can help to incite such excitement in students, which can in turn engage them to learn and understand the laboratory experiments better. One problem we encountered was low video resolution. However, this technical inadequacy could be suppressed by using a higher resolution, albeit costlier, 360° camera, such as GoPro Fusion, Ricoh Theta V., or Samsung Gear 360.

SEPA360

Other pertinent problems include simulation sickness induced by the shaky movements produced when viewing and navigating around the 360° videos. Simulation sickness occurs because there is a discrepancy between what is seen (i.e., fast moving images) and the actual motion experienced by the body. Simulation sickness can be aggravated when videos are recorded with a moving, rather than static, 360° camera, due to the vigorous movements in the viewpoint involved. Fortunately, this discomfort can be reduced by mounting the 360° camera at a fixed position. Difficulty in viewing and navigation can be caused by the way the viewing device is held. For instance, the YouTube mobile app makes viewing of 360° videos such that slight tilting would change the orientation of the video.

SEPA360

This problem would be resolved by holding the mobile device with both hands or placing the device on a flat surface during viewing. Another potential problem is the loss of focus in 360° videos: difficulty in finding the right angle of the video at the right time. Improving on this loss of focus is admittedly challenging and requires further work. Kavanagh et al. reported a remedy by creating a time delay to provide buffer time for the viewer to reorientate themselves at pivotal time points in the video, e.g., when a demonstrator is conducting a critical step in an experimental procedure. In our trials, we added annotations to indicate the point of focus to mitigate this loss of focus. A possible workaround would be to decrease the pace of the instructional material in a way such that when students explore the video, the impact of losing focus is not as prominent. Another possible solution is to zoom out the video to a fish-eye view, such that video details can be observed more easily. We have summarized several general suggestions on recording better 360° lab demonstration videos: First, decide whether a full 360° view is required to demonstrate the technique. Several techniques that may benefit from a 360° field of view include the Schlenk line, glove box, and the Grignard reaction, where setup is often large and elaborate, i.e., requiring many large equipment items that are placed far apart from one another.

If close-up details, e.g., a small apparatus like the Keck clip, are crucial to the demonstration, select a high-resolution camera for recording. A low-resolution camera would be more acceptable otherwise, although the viewer might be dissatisfied with the lower video quality. • Ideally, choose a camera with a good audio recording capability. If the audio recording capability is poor, minimize scripted speech in the recorded video. Alternatively, record a separate audio as a voiceover and mix the voiceover during post production. To avoid simulation sickness, attempt to record static, rather than moving/hand-held videos, by mounting the camera onto a tripod stand and placing them on a stable, flat surface. Check with the mobile app that is monitoring the recording to preview that the camera is positioned properly (i.e., all salient objects are captured by the camera's 360° view)." (pp. 1881 - 1883).

Case study: Potential of 360° Video to Support Pre-Service Teacher Development [inBalzaretti, N., Ciani, A., Cutting, C., O'Keeffe, L., White, B. (2019). Unpacking the Potential of 360° Video to Support Pre-Service Teacher Development 11, 63–69].

"Video has become a useful tool in Initial Teacher Education for self-evaluation and reflection by pre-service teachers (PSTs). The availability of 360° video cameras and web-based applications, to review and annotate 360° videos, allows PSTs greater flexibility to view and review their practice from a variety of perspectives. This study explores PSTs' use of 360° video for reflection on their teaching practice. 360° video provides PSTs with the capacity to pan 'around' the video, and in doing so has supported PSTs to detach and reflect on their own practice. The findings suggest that the PSTs valued the additional perspectives afforded by the 360° nature of the video, which had a particular impact on their understanding of their presence, interactions, and explanations" (p. 63)

“Ferretti et al. (2018) and Balzaretti et al. (2018) suggest that there are four key phases in the use of video for reflection, which are:

- Noticing and describing,
- Looking for cause-effect links,
- Exercising analytical thinking,
- Identifying possible alternatives to those observed.

They also suggest that going through the ‘video noticing phase’ is key in moving from video viewing to a deep reflection. The effectiveness of these different phases is linked to the consistent and intentional use of tools to support PST reflection. ” (p. 64).

SEPA360

Case study: Developing preservice teachers' interpersonal knowledge with 360° videos [in Theelen, H., van den Beemt, A., Brok, P.D. (2020). Developing preservice teachers' interpersonal knowledge with 360° videos in teacher education. Teaching and Teacher Education 89].

"We present a mixed-method study about a classroom simulation using 360° videos combined with theoretical lectures in teacher education, intended to improve PSTs' interpretations of noticed events. Furthermore, this study examined how PSTs evaluate the technological and educational affordances of 360° videos. Results indicate that participating PSTs improved in noticing classroom events and in applying a more theory-based terminology to describe these events. PSTs perceived observing other teachers teach as an educational affordance for mastering theory and for developing insights about interpersonal teacher behavior. Concerning technological affordances, mainly physical discomforts and technical hindrances were reported by PSTs. The results of this study imply that 360° videos can be useful for teacher education to improve PSTs' interpretation of noticed events." (p 582).

SEPA360

“The 360° videos are more useful in teacher education than traditional videos for watching experienced teachers teach because 360° videos enable PSTs to continuously choose their own perspective when observing classroom interactions rather than viewing from a fixed perspective, which can help PSTs to understand classroom dynamics.” (p. 584). “PSTs can watch 360° videos with VR headsets.” (p. 584) “Real-life classroom events can be displayed via VR and provide learners sensory and imaginary experiences similar to real-life experiences”. (p. 584). “Watching 360° videos with VR headsets appear to be more attractive to learners because of the immersive user experience.” (p. 584). VR experiences can help bridge the gap between theory and actual teaching practice” (p. 584). “Three 2-hr sessions were created to combine theoretical lectures via a regular setting and watching 360° videos, which provides an addition to the regular teacher education setting. [...] The composition of the three sessions was adapted from the Learning to Notice Framework. Before watching a 360° video, PSTs were theoretical. lecture about interpersonal teacher behavior, which guided the PSTs on how to watch 360° videos.[...] Guided whole class 360° video watching was conducted to encourage PSTs to observe systematically, to make PSTs aware of relevant classroom events, and to activate their knowledge about interpersonal teacher behaviour.

SEPA360

After watching a 360° video, PSTs discussed their interpretations of observed classroom events first in small groups, and later on with the entire class. These discussions provide PSTs with the opportunity to learn from examples of different teachers, students, settings, and pedagogies, to reflect on classroom interactions, and to analyze and reason about teacher and student behavior. During three sessions, PSTs watched fifteen 360-degree video fragments of 10 experienced teachers within secondary education, using YouTube on their mobile phones in a VR headset. The videos each contained one or more of the following classroom events, which are important for the teacher-student relationship: (a) the beginning of a lesson, (b) a moment of instruction, (c) stimulating students to work, (d) disruptive behavior, (e) comments of students, (f) disappointed students' performances, (g) questions or feedback from students, and (h) the transition between two different phases of the lesson (e.g., from instruction to work independently on the teaching materials. The length of videos varied from 47 s to 4 min and 48 s, with an average time of 3 min and 8 s." (p. 585).

Case study: Reflective trainee teacher practice with 360° video[in Walshe, N., Driver, P. (2019). Developing reflective trainee teacher practice with 360° video. Teaching and Teacher Education 78, 97–105].

“Video self-reflections can be an effective self-development tool for student teachers; however, its value is often limited as video provides only one perspective of the classroom, an interpretive case study, used think-aloud protocol and interviews to explore how the use of 360° video can support student teacher reflection. Results suggest that the immersive, embodied experience of reflecting using 360° video develops a more nuanced understanding of microteaching practice, as well as supporting student teachers’ self-efficacy towards teaching. This has the potential to facilitate a more active and student-centered approach to initial teacher education within Higher Education.” (p. 97)
“Differing approaches also used varying methods of video reflection, means of scaffolding teacher reflection and ways of assessing any subsequent benefits. Tripp and Rich (2012) identify six key dimensions along which studies tended to differ: (1) type of reflection tasks student teachers were asked to complete, (2) the level of the scaffolding of reflection, (3) whether reflection was undertaken individually or collaboratively, (4) video length, (5) number of reflections undertaken (both on the same video, or teach-reflect cycles using separate videos), and (6) methods of measuring reflection.” (p. 98).

“Taking an embodied approach through the use of 360° video, student teachers might effectively re-experience the classroom setting, the video acting as a proxy for real-life, providing them the ‘opportunity to ‘read’ the environment, examine their own immediate responses to classroom situations and learn to exercise metacognitive control over their own responses in context’. According to constructivist and sociocultural perspectives (e.g., Piaget, 1990; Vygotsky, 1978), the situated experiences of student teachers within the space and time of their classroom teaching construct understanding. [...] The suggestion is that the “situatedness” (Gibson, 1977) of 360° video would enable student teachers to develop a sense of body awareness that might allow them to reflectively examine their practice, in doing so increasing their ability to ‘notice’ aspects of practice that have particular significance in educational settings and inform their professional responses'' (p. 99). “Libby, Stefanie, Dawn, and Kay completed all stages of the research; these are pseudonyms in an attempt to provide anonymity but with the understanding that in such a small sample it is likely that participants will be recognisable to their peers.

SEPA360

The nature and experience of student participants broadly reflected the significant diversity of the student cohort as a whole: Libby came to university straight from school and has a range of experience working with children within educational contexts, including volunteering work through which she has led small group activities, as well as volunteering within a summer school. Stefanie is a mature student with her own daughter. Like Libby, she has also undertaken a range of volunteering across a number of primary school year groups, as well as a brief period of paid work in a nursery. Dawn is also a mature student with two young children. She has had only a small amount of previous experience working with children in nursery and school holiday club settings. Kay, like Libby, came straight to university from school; she has had a wide range of experience working with children. For example, she has regularly volunteered in a number of primary schools through which she has taught a number of lessons, as well as undertaking paid work at an after school club and summer camps." (pp. 99-100). "All students taught their 10 min micro teaching activity to their peer group to enable reflection; this was the first time that students had been asked to plan and peer teach, and for many was their first ever practical teaching opportunity." (p. 100).

SEPA360

“The research built on this microteaching activity in the following way: 2.3.1. Stage 1: teaching recorded with 360° video Students taught their 10-min teaching excerpt to a class of 30 Year 5 (nine and ten year old) children within a semi-rural Primary Academy School. Microteaching was recorded using two cameras to provide two perspectives: a stereoscopic 360°, 3D camera with binaural (surround) audio; and a consumer-level 360° (but not 3D) camera with lower resolution. The stereoscopic camera was mounted on a monopod on a central desk within the classroom; the second camera was suspended from the overhead projector and, therefore, provided an alternative ‘birdseye’ perspective of the room. 2.3.2. Stage 2: post-teaching reflection (without video) Five days after their teaching, students undertook a two-stage reflection activity. Initially they were asked to reflect on how their microteaching activity had gone without the benefit of video. This took the format of a semi-structured reflection process based on the Deweyan idea that learning is contingent upon the integration of experience with reflection and of theory with practice. In this way, the student was encouraged to reflect individually but a range of prompts were used to support this reflection..

2.3.3. Stage 3: post-teaching reflection using 360° video. The third research stage incorporated 360° video into the students' reflections. Students watched their micro-teaching activity whilst wearing a standard VR headset (VR Shinecon) in which we inserted a smartphone to stream the video, and the audio to a pair of headphones worn by the student; this creates a fully immersive, first-person perspective. They then used ‘think-aloud protocol’ to reflect on their teaching. The think-aloud protocol involves observing students watching their microteaching, noting their pedagogical decisions, and asking them to articulate their thoughts and feelings as they watch (Cotton & Gresty, 2006). Ericsson and Simon (1984) suggest that the think-aloud process facilitates exploration of the thought processes of someone performing a specific task. Within traditional think-aloud protocol, the researcher generally should not interact with the participants after having provided the initial task instructions to avoid influencing participants' thoughts. However, our experiences echoed those of Cotton and Gresty (2006) who found that participants required significantly more guidance with the task; without this, they found it very difficult to know what kind of thoughts or reflections to articulate. As a result, we provided occasional prompts during extended pauses within the think-aloud commentary, such as ‘what are you looking at?‘, or ‘can you explain what you are seeing now?’ in an attempt to support students' reflection without invalidating the subsequent data.

There was no specific structure for providing prompts; they were given where necessary with each student. Whilst the prompts were considered useful, they did not comprise a significant amount of the data collected but merely acted as a reminder to think aloud after periods of quiet watching. 2.3.4. Stage 4: individual research interviews. During the final stage, we undertook individual, semistructured interviews with each student, comprising both direct questioning and discussion following unprompted comments, to explore their experience with using the 360° video and its impact on their reflections on practice." (p. 100). "Results of this study show that 360° video supports students' reflection of their practice and, as a result, both develop a more nuanced understanding of their microteaching and support their self-efficacy. The immersive, embodied experience of watching the 360° video footage appears particularly significant as it becomes a proxy for real-life classroom settings through which students are able to re-experience their teaching, emplaced within its space and time, being there in an embodied sense (after Heidegger, 1962) and with the agency to select where and with what to engage. This "situatedness" supports students to produce reflections which show a much better understanding of their and their pupils' behaviors, priming them on ways in which they can respond to the immediacy of the context and developing in them a better appreciation of pupil engagement and learning.

Further, the use of 360° video also appears to provide opportunities to develop authentic mastery experiences through which trainees can develop their self-efficacy towards teaching (after social cognitive theory. This meshes well with situated learning which is a socio-cultural process that is the result of bodily interactions with the world. One of the novel aspects of this study is, therefore, that it brings together multiple conceptual frameworks of situated learning, embodied cognition, and social cognitive theory through 360° video to transform the way that we support student teacher reflection and, thereby, practice. An additional point of note is that through the process of watching and reflecting on 360° footage, student teachers are not merely an audience observing and analysing the practice of others, but they become active participants in the learning process, generating and analysing their own primary data (or practice). As such, this methodological approach illustrates practice urged by authors such as Healey and Jenkins (2009, 2018) or Kuh (2017) to increase student engagement through research and inquiry.

SEPA360

The study, therefore, has implications for broader Higher Education practice within ITE as it facilitates student-centered, research-based active learning. However, there are a number of limitations to the project; for example, this is a small case study both in time-scale and participant size - further research is needed to explore the impact of 360° video on a larger group of students and over a longer period of time. As such, future work would also benefit from exploring in more depth how 360° video might be used most effectively with student teachers, for example observing video multiple times, providing peer watching, reflection, and collaboration opportunities (as suggested by Barber, 1990), and undertaking repeated micro-teaching reflection-replanning cycles (active experimentation, as suggested by Kolb, 1984)."(pp. 103-104).

Assessment and evaluation strategies of the learning outcomes and learning process.

The evaluation of training and learning processes is not a specific field of immersive technologies, and hence of video 360°, but of transversal relevance for the educational domain. However, it presents specific challenges that are still under investigation, especially referring to the educational effectiveness of this particular technology. First of all, it should be noted that the use of a 360° video takes place through devices with varying levels of immersion: a PC, tablet, or smartphone, cardboard, a HMD visor. The use of more immersive devices induces greater induction of place illusion, greater positive affect, and better learning outcomes. [cfr. p. 256 in Rupp, M.A., Odette, K.L., Kozachuk, J., Michaelis, J.R., Smither, J.A., McConnell, D.S. (2019). Investigating learning outcomes and subjective experiences in 360° videos. Computers and Education 128, p. 256-258].

For the evaluation of the learning process and its outcomes, traditional solutions and well-established and widely accepted methods for assessing learning activities can be used. Amongst these methods, one can mention short essays, oral interviews, structured assessment tests (e.g. multiple-choice, true/false, matching, or completion questions).

It should be noted that the 360° video is an element which is inserted in a learning process, therefore formative assessment should be provided offering both immediate feedback to the student on his/her learning progress and to the teacher to immediately assess the formative effect of the content conveyed by a 360° video.

An example of a methodology for formative assessment with a 360° video viewed through devices with varying levels of immersion comes from Rupp et al. (2019) [(pp. 258-259) Rupp, M.A., Odette, K.L., Kozachuk, J., Michaelis, J.R., Smither, J.A., McConnell, D.S. (2019). Investigating learning outcomes and subjective experiences in 360-degree videos. Computers and Education 128, p. 256-258]. It is a questionnaire covering both effectiveness and congruence. The 360° video under investigation, in this study, is that of the ISS (International Space Station). The amount of information recalled by viewers from the video was measured by creating a knowledge check containing a total of 38 multiple-choice questions with four possible answers (only one correct). 1 point was attributed to each correct answer, 0.25 of a point was deducted for each wrong answer, while 0 was attributed if it is declared not to know the answer. The 0.25 penalty for the wrong answer was used to discourage guesses or attempts. The questions were of two types:

- auditory posed on the information presented in the video narration
- visual by presenting screenshots of the 360 video in which to identify a specific part of the ISS.

Before administering the survey, a pilot study was conducted to determine whether the survey should be administered before and after the simulation, and to determine which questions could be used in the questionnaire. Five people participated in the pilot study and watched the video on their smartphone. These same 5 participants then completed the same questionnaire as a post-test. Five other participants, on the other hand, completed the same procedure without carrying out the pretest first. The results showed no significant differences between participants who were given the pretest before and participants who were not given the pretest. 10 questions were removed, the ones that received the highest incorrect answers and that were not significantly correlated with the overall score. Then, the remaining 28 questions (18 auditory; 10 visual) were used for the survey. An additional 12 questions survey was administered to assess participants' expectations on virtual reality and the topic. Each question asked participants to rate how enthusiastic they were about VR technology (eg, “How positive are your expectations for VR in the future or how excited they would be to learn more about NASA or the ISS in the future.” For the answers a 7-point Likert-type scale was used (1 = strongly disagree; 7 = strongly agree).

As far as the students' experience is concerned, a survey based on a five-point Likert-type scale (ranging from "strongly disagree" to "strongly agree") can be run for assessing the effectiveness of a 360° video in terms of motivation, ease of use, enjoyment/fun, usefulness, and immersion. An example of questions that can be asked is:

- Motivation:
  - The 360° video did not hold my attention
  - When I viewed the 360° video, I did not have the impulse to learn more about the learning subject
  - The 360° videos did not motivate me to learn
- Ease of use:
  - I think it was easy to learn how to use it
  - I found it unnecessarily complex
  - I imagine that most people will learn to use it very quickly
  - I needed to learn a lot of things before I could get going with this device (HMD cardboard)
  - I felt that I needed help from someone else in order to use it because It was not easy for me to understand how to use it

- It was easy for me to become skillful at using

-Usefulness:

- The 360° video was a much easier way to learn compared to the usual teaching
- The 360° video made learning more interesting I felt that it helped me to increase my knowledge
- I felt that I caught the basics of what I was taught with the 360° video
- I will definitely try to apply the knowledge I learned using this too

-Enjoyment/fun:

- I think the 360° video I've seen is fun
- I felt bored while viewing the 360° video
- I enjoyed viewing the 360° video
- really enjoyed studying with the 360° video
- It felt good to successfully complete the tasks with this 360° video
- I felt frustrated

- Immersion:

- The 360° video did hold my attention
- When viewed the 360° video, I did not have the impulse to learn more about the learning subject
- The 360° video did motivate me to learn.

SEPA360