

Resources for Integrating Immersive Experiences in an Educational Setting¹

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Abstract: The term, immersive experiences, is overarching and encompasses 360° imagery, 360° video, augmented reality (AR), mixed reality (MR), and virtual reality (VR). Each aspect of immersive experiences is unique and offers different functionality and affordances for the classroom. This high-level document is meant to briefly describe these technologies and provide guidance for developing classroom-based activities that are aligned with learning goals and that enhance the student learning experience.

Key Words: Immersive experiences, immersive reality, 360° images, 360° imagery, 360° video, Augmented Reality (AR), Mixed Reality (MR), Virtual Reality (VR)

Introduction

Immersive technologies have been available for classroom use for several years. But, despite this, it is still very much an emerging field. With recent more user-friendly and cost-effective developments, these technologies are quickly becoming broadly adopted in educational settings. As with the integration of any new educational technology, careful thought and planning should be used to choose the right tool for the right instructional goal. Once this happens, then best practices should be employed to develop meaningful activities that align with course goals. Immersive technologies provide a way to enhance the student learning experience like never before, and while it may feel quite complex to think about integrating these experiences into instruction, the learning payoff can make it a very worthwhile effort. Figure 1 shows an example of what one type of immersive experience hardware looks like and utilizes a phone in a headset viewer.



Figure 1. Woman wearing head mounted display that utilizes a phone for 360° video. This photo was taken by Samuel Zeller and it is available on Unsplash through a Creative Commons license.

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A brief description of each of the main types of immersive technologies is given in the next section. This is followed by several biological examples currently being used in the college classroom. The next section of the paper provides guidance for choosing the most appropriate technology for the instructional purpose, and the final section of the paper describes a model that can be used to guide the design of meaningful learning experiences using technology.

Types of Immersive Technologies

There are several main types of immersive technologies currently being employed in classrooms. Each aspect of immersive experiences is unique in their own way.

The first type of immersive technology is 360° imagery and videos. With 360° photography, the position of sight is fixed, meaning the viewer cannot interact or move directionally due to the fact that the media was captured from a specific location. These differ from traditional types of images in that they do allow the viewer to look around the space in every direction.

The next type is augmented reality (AR). This technology superimposes additional digital information, visual- or text-based, on top of the real-world image. This is often used in conjunction with cell phone applications that allow, for example, travelers to discover additional information about places in a particular geolocation.

The third type of immersive technology is mixed reality (MR). This technology takes AR one step further by anchoring the superimposed information so that it is attached to the real object in the image. Classrooms of the future could use this technology to make it seem as if students from a distant learning site were actually present in the home site.

Finally, there is virtual reality (VR), which places the viewer inside an entirely artificial environment, the result being something that can look and feel like a real-world experience. This provides the most interactive possibilities of the four types.

Examples of Immersive Experiences Within Biology

In order to develop a better understanding about the affordances of each type of immersive experience described above, an example of each, embedded in a biological context, is provided.

The 360° technology can be used with static images when particular aspects of an object need to be explored more fully. For example, Charles Kazilek (Arizona State University) overlays clickable information on top of the 360° image and embeds a repeating audio track to mimic the natural noises of the geographical biome as seen in Figure 2 (Kazilek 2016). The clickable information towards the bottom of the image allows viewers to navigate the experience - including zooming in and out, turning around, showing image copyright information, changing the control mode used, and seeing the information in full

screen (for computer use). The clickable information embedded on the image is designated with an “i”, and when clicked, provides information about particular areas on the image. Other target icons do things like enable viewers to move to additional 360° images within the same biome.



Figure 2. Photo from Desert Biome VR 360. Desert Biome VR 360 images were taken by C. J. Kazilek and they are available through a Creative Commons license. Location: Lost Dutchman State Park, Sonoran Desert east of Picacho, South Mountain Park, Arizona, USA (August 24, 2016).

In addition to static images, video can also be used with 360° technology to provide a richer experience. Penn State Teaching and Learning with Technology, in partnership with Penn State Lehigh Valley faculty, created an underwater learning experience with coral reefs. A faculty member used a 360° camera to film the underwater scenes. In the editing process, numbers were added to help viewers locate specific areas to be explored (Kackley-Dutt et al. 2019). Each number correlates to a point of interest on a student handout that offers a brief

description of the site. Within Figure 3, the number 1 correlates to mounding coral. Students remember this information and then read the detailed description in detail at a later time. Once the viewing experience begins, participants have the freedom to look in any direction, so this anchoring system is important to provide a reference location for the different elements to be learned.

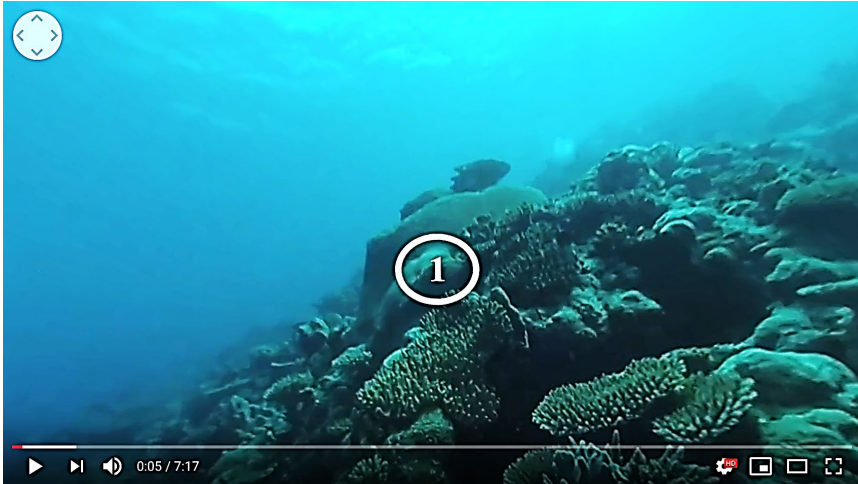


Figure 3. Photo from *Coral Reef Biome – Palau* taken by Eileen Grodziak, Amy Kuntz, Carla Seward, and Dr. Karen Kackley-Dutt (all affiliated with Penn State University). Video footage from Hannah G. Reich, M.S. Location include Lost Dutchman State Park, Sonoran Desert east of Picacho, South Mountain Park, Arizona (late November and early December 2018) by Creative Commons license.

A powerful biological example of AR technology (superimposed images along with text on top of real-world views) is the application *After Ice* (Guariglia 2018). Using a cell phone, the viewer's location is found through geolocation software. The AR application then transforms the image to model what that particular location will look like with rising sea levels, using prediction data from NASA.

VR technology places the viewer inside an entirely artificial environment that typically looks like the real-world experiences to be explored. An example of this technology in use is *Sea Level Rise Explorer* (Virtual Planet Technologies LLC 2019). In this experience, the viewer is first placed in a conference room that provides a superimposed top view of Fleming Park, Turner Station, Maryland, along with a navigational menu that allows for exploration and change of sea levels. From there, the viewer can move to a realistic top down perspective from a helicopter to view sea level projections at different periods of time. The experience is all computer-generated although it looks very realistic.

Designing Effective Activities using an Immersive Experience Check

Understanding the affordances of the different technologies is important but aligning the right tool with the desired instructional goal is also critical. To accomplish this, course goals, learning objectives, and instructional challenges should first be clearly articulated. Then instructors can begin to design learning experiences that meet learning goals and enhance the student learning experience.

The questions below can serve as a good check to determine the appropriateness of the tool and lesson design.

- What learning should take place?
- What should the students experience?
- Which tool is most appropriate for these goals?
- What is the viewer expected to do during the activity?
- Are students going to interact in a space that exists in the real world, but they do not have access to it due to geographic location/availability of the space?
- Are they going to interact in a space that exists in the real world with a change in perspective not possible in physical reality such as,
 - Flying
 - Scaling down in size
 - Traveling back in time
 - Experiencing a career first-hand from the professional perspective
 - Exploring the ocean/space/inside the human body
 - Getting a different perspective to develop empathy for someone else
- Are you trying to achieve a controlled environment of the same experience among students –such as preparing nursing students how to speak/stand in front of a judge for medical judicial hearings?
- Are you trying to have a controlled environment to collect data about how students interact with a virtual field trip, later having them analyze the data for scientific purposes – such as being lost in a maze and what steps each student completes to escape the maze?

There are endless possibilities for design and utilization of immersive technologies in the classroom with some more observational than others. Within Figure 4, the HTC Vive virtual reality room-based system includes hand-held controllers for added interactivity and spatial movement. Working with a learning designer or educational technologies and content can be complex to create and

expensive to use, so in some cases, 360° video might be less complex and still able to get the point across. Other times, VR might actually be the best choice, if its affordances and functionality are needed. Is the viewer interacting with the content in some unique way? Is that a necessary enhancement? If so, then VR may be ideal.

These questions and examples may help guide the type of immersive experience selected to achieve a particular instructional goal. Another tool that can be useful in the design process is the SAMR Model, described in the next section.



Figures 4 and 5. 4. HTC Vive controller used to navigate virtual reality experiences. This photo was taken by [Jesper Aggergaard](#), was posted on [Unsplash](#), and it is available through a Creative Commons license. 5. Man wearing Samsung Gear head mounted display. This photo was taken by [Hammer and Tusk](#) and it was posted on [Unsplash](#). Both images are available through a Creative Commons license.

SAMR Model Check

The SAMR model (Figure 6) is a framework created by Ruben R. Puentedura as part of his work with the Main Learning Technologies Initiative (Puentedura 2006). The model describes and categorizes technology use in four levels from enhancement through the transformation of learning. The model can be used to understand the current use of technology in a given situation as well as in the design of new learning activities, such as the integration of immersive technologies. The higher levels in the model represent best practice in the use of technology as it seeks to transform learning and learners through the learning tasks (Puentedura 2013).

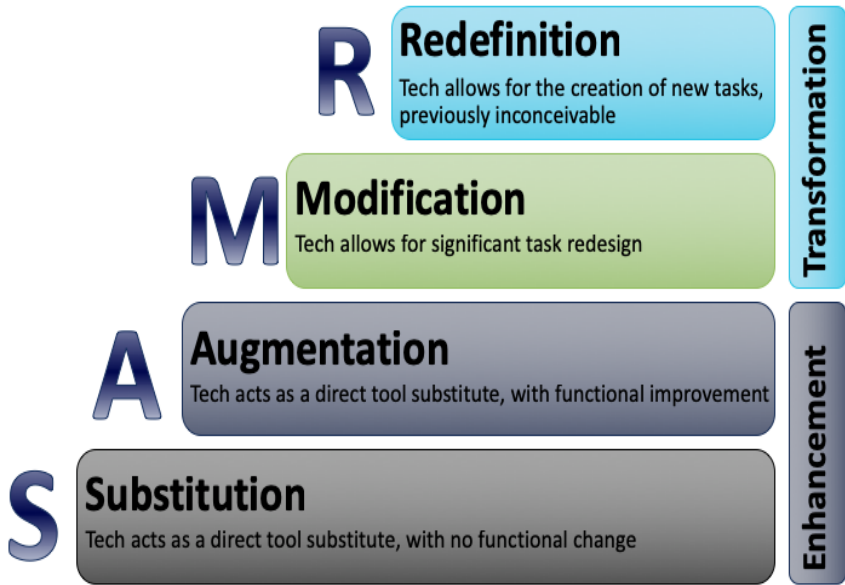


Figure 6. The SAMR model from: Ruben R. Puentedura, SAMR: Moving from enhancement to transformation. (2013). Graphic created by Amy Kuntz.

The four categories in the model (from lower level to higher) are as follows:

- **Substitution:** The technology acts as a direct substitute for other learning activities, with no functional change.
- **Augmentation:** The technology acts as a direct substitute for other learning activities, with functional improvement.
- **Modification:** The technology allows the learning activity to have a significant task redesign.
- **Redefinition:** The technology allows the learning activity to have tasks, previously inconceivable.

For immersive experience integration, it is important to think about the intended purpose of a selected experience. Is it replacing something that is already done in the classroom? If so, does it add a functional improvement or significant modification? If not, does it allow for something previously inconceivable to happen? Utilize the SAMR Model to evaluate where the designed experience falls into a particular category. Ideally, the immersive experience would be aligned with Modification or Redefinition levels of the model.



Figure 7. Substitution Example: 360° video of mangrove biome with audio, but without any narration, guidance, or points of interest. Photo taken by Eileen Grodziak, Amy Kuntz, Carla Seward, Dr. Karen Kackley-Dutt (all affiliated with Penn State University). Video footage from Dr. Karen Kackley-Dutt available through a Creative Commons license 4.0.

The following is an example of how an activity using 360° video can fulfill all four levels of the SAMR Model in which the video allows viewers to explore a mangrove biome as seen in Figure 7.

Substitution – With having only one position, a 360° video can provide a first-person point of view of an experience without audio, guidance of what to observe, and/or interactivity. This observational piece in nature substitutes what was previously accomplished with traditional images provided by the instructor or textbook.

Augmentation – When audio and reference points are added to the 360° video, more in-depth exploration can occur as seen in Figure 8. Narrative guidance enhances what the viewer observes, providing a more cohesive and expansive experience. As the viewer looks around, reference points and narration draw their attention to important information.

Modification – Integrating additional tools to a 360° image such as clickable points of interest for more information, image overlays, and links to additional pictures or multiple viewpoints helps to extend the learning into a more in-depth and extensive interactive lesson.

Redefinition – This can be achieved by utilizing the enhancements to 360° video described above – audio, narration, attention points, and navigation to additional images - and then by adding the ability to view the video from different scales. Scaling allows the viewer to consider the image from different perspectives, impossible in traditional videos. This experience provides a new perspective, previously unimaginable.



Figure 8. Augmentation Example - 360° video of mangrove biome with audio and visual guidance of points of interest. This paired with a corresponding handout for more information and an associated activity to hold students accountable. Photo taken by Eileen Grodziaik, Amy Kuntz, Carla Seward, and Dr. Karen Kackley-Dutt (all affiliated with Penn State University). Video footage from Dr. Karen Kackley-Dutt. The video is available through a Creative Commons license 4.0.

Planning the Experience, (Including the Inevitable Glitches), Accountability, and Reflection

Plan the Work and Work the Plan

An example of an immersive experience lesson plan is available in Appendix A. This can be a useful tool in designing your initial immersive experiences. With immersive technologies, just like with any technology, it is always good to have a back-up plan in case things go wrong, especially if you are having students go through the immersive experience as part of class time. One way to be prepared is to plan for glitches directly within a lesson plan, such as what to do if the technology is not working, or if students come to class unprepared. In addition, be sure to allocate time and resources for students to practice navigating this potential new medium before the actual learning event. Use the lesson plan template to plan both the lesson and any possible glitches that might arise. The first time will rarely go perfectly. Take time to reflect on what happened and jot down notes so the lesson can be modified the next time. This style of lesson plan can also be applied when students interact with the immersive experience as part of an out of class activity as seen in Figure 9. With this, give detailed guidance of what students should do before, during, and after the experience.



Figure 9. Small group of three students navigating the computer of a 360° video via an Internet browser. Photo taken by John Schnobrich, posted on Unsplash, and it is available through a Creative Commons license.

When creating your lesson plan, utilize your pedagogical expertise in your discipline as a way to utilize the immersive experience as an entire activity toward meaningful educational goals. Due to the ability to navigate many immersive experiences in non-linear fashion, 360°perspective, or both, make sure you decide how you want to guide students, or let them explore in the way they choose, and plan accordingly. In addition, be sure to clearly articulate the purpose of the use of immersive experience to the students and how it will help them achieve the stated learning outcomes.

Accountability

Whether you are conducting an immersive activity in the classroom or as an assignment, ensure your students are held accountable for their own learning. If the activity takes place in the classroom, just like in a science lab, students might rely on fellow students to do their work for them. Careful consideration of this possibility should be built into the design process. If students are working in pairs or small teams, how will students be held accountable for their individual work and learning?

Reflection

Having the experience is important but reflecting on the experience is also an important element when using immersive experiences. If you do not have an obvious way for students to reflect on the experience, you might want to consider the inclusion of something as simple as asking them, “What are five new facts learned through the experience?” or you could include the inclusion of Harvard Business School’s, “Think, See, Wonder” questions, as illustrated in Figure 10, (Mansilla 2019) which are:

- What do you SEE?
 - o Describe what you see in detail.

- What do you THINK?
 - o As you are experiencing this, tell your audience in detail what you are thinking using sequence words (first, next, last).

- What do you WONDER?
 - o During your virtual field trip what are you wondering about?
 - o What questions come to your mind?



Figure 10. See, Think, Wonder represented by eyes, brain, and lightbulb. Graphic created by Amy Kuntz.

Additional Considerations

- Allocate time and resources to experience the immersive technology and practice conducting the activity in advance.

- Although Generation Z might be considered “tech savvy”, do not assume all students will be on-board for using the technology. To overcome any apprehension of “Why are we doing this?” be sure to emphasize that the immersive experience is a technological tool to support their learning.

- Start small with a manageable amount of immersive experiences, a number that makes it worthwhile for students to learn the technology while also making it

manageable for you to create the activities associated with the immersive experience.

- Try different methods of implementation/consumption of material and evaluate student preferences, as well as, differences in student grade outcomes.
 - Consider small group experiences outside of class time or in a hybrid/blended course.
 - Include a debrief with your students after the immersive experience.



- After integrating an existing immersive experience, consider creating your own immersive experiences or content for your classes. One method includes utilizing the Garmin Virb 360 video camera, as seen in Figure 11, to plan and capture 360 video content.

- After creating your own immersive experiences or content, encourage your students to create their own content including 360° video.

Figure 11. Garmin Virb 360° video camera. Photo by Amy Kuntz.

Conclusion

This guide provides a general description of some common types of immersive technologies available for today’s classroom. Guidance is given for developing classroom-based activities that are aligned with learning goals and that enhance the student learning experience. There are many other areas for future consideration such as: availability of immersive technologies, connectivity to the Internet, accessibility for disabled students, technical support, risk management considerations, and locating existing resources for immersive experiences.

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Appendix A

Virtual Reality Field Trip Template

Lesson Title
Lesson Background
Subject: Number of Students Per Device: Objectives: Essential Question: Guiding Questions: Vocabulary: Place in Unity of Study: Grouping of Students:
Field Trip Preparation
Before the Field Trip (thought-provoking questions and guidance before experience)
Discussion Questions:

During the Field Trip (guided or exploratory experience)

Discussion Questions:

Student Activity:

(repeat one or both of the above as necessary)

Harvard Business School, Think, See, Wonder Questions:

- What do you SEE?
 - Describe what you see using WOW words.

- What do you THINK?
 - As you are experiencing VR tell your audience in detail what you are thinking using sequence words. First, Next, Last.

- What do you WONDER?
 - During your field trip what are you wondering about? What questions come to your mind?

After the Field Trip (synthesize and analyze)

Discussion Questions:

Student Activity:

(repeat one or both of the above as necessary)

Harvard Business School, Think, See, Wonder Questions geared toward Text Connections:

- What do you SEE in the VR Field Trip that you can CONNECT to the text/lesson?

- Be sure to cite specific examples from the field trip and text/lesson
- How do you THINK the VR Field Trip enhanced your understanding of the text/lesson?
 - Be sure to use evidence from the text/lesson to support your response.
- What do you still WONDER after experiencing the VR field trip and completing the text reading/lesson?
 - Write a reflection to extend your thinking i.e. What are you still curious about? What more do you want to know?

Extension Ideas (additional learning and inquiry)

See, Think, Wonder Adapted from Veronica Vox Mansilla @ProjectZeroHGSE Aspects of template adapted from Google Expedition template.