Week 7: Project Proposal

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From Physical to Digital: Accessing Anatomy Models Inside and Outside of Class

In courses such as Anatomy and Physiology, students typically participate in laboratories that utilize physical models of organs or systems to reinforce the learning of many body systems covered throughout the course. Students, for example, may use a physical model of a heart in class to identify the different parts of the heart's anatomy. While these physical models are helpful in a laboratory, students cannot take them home with them, often relying on 2D images in their textbooks to study. Students in the laboratory are then tested on their knowledge of the anatomy using the physical 3D models. Moving from a physical 3D model to a 2D model and back to the 3D model may present a challenge for students in accurately identifying the anatomy of an organ or system.

This proposal recommends using photogrammetry to create digital 3D models of the physical 3D models used in the Anatomy and Physiology lab. The digital 3D models would be accessible to students through a web browser on their laptops, Chromebooks, tablets, or smartphones. This project aims to make digital 3D representations available to students so that they can study using the same models they use in class, with the added benefit of having labels and customized information on the digital 3D models.

Significance

The target audience for this proposal is faculty at Abilene Christian University who teach biology, speech pathology, kinesiology, nursing, animal sciences, plant sciences, or other courses that utilize physical 3D models to teach human, animal, or plant anatomy. These faculty could teach either in-person or online courses. For online classes at ACU Online, this proposal will be for program directors in health and human performance, pre-nursing, and the RN to BSN programs since the instructors are not the ones who design the courses. While the proposal is for faculty in these fields, this plan is intended to benefit and address the learning needs of the students in these courses. Therefore, the learning needs addressed in this proposal will focus primarily on student needs.

Learning Needs

Faculty considerations: Faculty in these programs often need to be made aware of the potential technology-enhanced learning (TEL) tools available for their courses. It is easier to understand the effectiveness of some TEL tools when they are demonstrated or shown visually rather than just explained verbally. These faculty need a hands-on demonstration showing the capabilities and customizability of digital 3D models in their courses.

Student considerations: Undergraduate anatomy and physiology courses are a prerequisite for many health sciences programs and use physical 3D models in the laboratory. However, other programs within animal and environmental sciences also require learning the anatomy of animals and plants. Because of this, a wide range of students with very basic knowledge of anatomy are necessary to learn the anatomy of a human, animal, or plant by using 3D models in a laboratory. In an anatomy and physiology laboratory, for example, students will learn the brain's anatomy with the help of a physical 3D brain model. When the student goes home to study, they will most likely study using a 2D (flat) image of the brain in their textbook or a handout. When the students return to the laboratory, they may be given a test on the anatomy of the brain based on the 3D brain model. Students gain a better understanding of the body's anatomical structure through participation in hands-on dissections (Davis & Pinedo, 2021). Offering students a way to study anatomy hands-on while at home may help bridge the gap between transitioning from 3D models to 2D and back to 3D models.

Equitable access for students outside of class to the TEL tool is important. Providing digital 3D models across multiple devices (computers, tablets, and smartphones) ensures that students can access the models either on a device they own or a device that can be used or checked out from the university library. This solution addresses barriers to accessibility regarding students' economic situations and geographic locations, and to some extent, students with disabilities (Baldwin & Ching, 2021), by making the digital 3D models adjustable and rotatable and ensuring good contrast between the elements and the background (Talamantes, 2023).

The technology-enhanced learning tools that will enhance learning in anatomy courses are digital 3D models identical to the models used in the laboratories and customizable with the knowledge and information that each faculty member wants to focus on and address in their lessons. In order to produce these digital 3D models, the Creative and Academic Technology team will use a process called photogrammetry, which uses a sequence of digital images to produce a digital 3D model. Faculty will first provide our team with the physical 3D model that needs to be digitized. After the model is created, the faculty member will customize the models by providing our team with a list of the desired labels and annotations. The digital 3D model will be uploaded into a web-based service called Sketchfab, where the labels and annotations will be added, and a URL of the final model hosted in Sketchfab will be delivered to the faculty members to be distributed to their students. Students can access these models in a web browser on a computer, tablet, or smartphone. These digital 3D experiences are very similar to Augmented Reality (AR). Instead of the digital object being placed in a physical space through a mobile device, the 3D model is in a virtual space, but the ability to interact with the 3D model is the same. Several studies that compared AR with other anatomy teaching tools found that AR was generally accompanied by positive outcomes and a positive impact on academic performance (Chytas et al., 2020).

Learning Environments

Community of Inquiry

Community of Inquiry is an effective informal learning framework that identifies fundamental elements of learning, such as teaching presence, cognitive presence, and social presence, to improve online learning, ultimately fostering community, collaboration, and promoting engagement and participation (Majeski et al., 2018). Teaching presence involves the role of the instructor in designing the course by establishing course content, activities, timelines, monitoring and managing discussion, and providing instruction (Warner, 2018; Majeski et al., 2018). Cognitive presence involves practical inquiry that includes defining problems, identifying relevant information, understanding and connecting information, and testing solutions (Majeski et al., 2018). Social presence includes "students making themselves known as "real people" and developing trust, group cohesion, and a sense of membership in a collective effort" (Warner, 2018, p. 435). Because this project is primarily for faculty at ACU implementing the 3D models into their face-to-face classes, the principles of Community of Inquiry will be examined and included in this proposal. The goal is to build a virtual environment that utilizes 3D models and would support face-to-face instruction (Warner, 2016).

In order to promote community, collaboration, engagement, and participation through a Community of Inquiry framework, a virtual learning environment will be created in Canvas LMS using discussion boards where students are in groups of 3 to 4. Some Community of Inquiry principles can also be used during face-to-face instruction. To ensure teaching presence, course content and instruction using digital 3D models in and out of class will be needed (Warner, 2018). The instructor will provide 3D models with annotations that can be used during or outside of class to study the anatomy of organs or systems being studied within a unit. Clear instructions and learning objectives for using the digital 3D models will also be included. The instructor will also design discussion board assignments for each unit. In-class exams or quizzes that utilize the 3D models for each unit will also be created.

To ensure cognitive presence, three steps can be taken. First, the instructor could use the digital 3D models or allow the students to use the digital 3D models in class to support student learning. Second, students using the digital 3D models will be able to manipulate the models (rotate, zoom in, open annotations) to construct knowledge about the anatomy of the organs or systems being studied. Third, the discussion boards within Canvas will be centered around relevant case studies that will move students through identifying a problem and relevant information and connecting that information with their knowledge and understanding of the anatomy and physiology of the organ or system. Case-based discussions stimulate the complexities and ambiguities of real-life problems, allow diverse perspectives, engage students in real-life problems, and facilitate critical thinking (Sadaf & Olesova, 2017).

To ensure social presence, the discussion boards will have students working in small groups using digital 3D models to work through the case studies. Each student can be assigned a different aspect of the case study that would help promote a sense of belonging or value for each student in the group. After a few weeks of working with the models, students could participate in a discussion board where they share their experiences or helpful strategies for studying with the digital models. The discussion groups can build trust and teamwork, giving students the confidence to ask other students for help whenever they do not understand something (Parrish et al., 2021).

Gamification

Gamification is "the process of utilizing digital game mechanics in originally nongaming contexts to engage learners, enhance learning, and solve problems" (Zhang & Yu, 2022, p. 1). Along with enhancing learning, gamification can also enhance motivation and problem-solving skills (Facey-Shaw et al., 2019). Using gamification strategies to enhance learning can be used in various learning environments. Using digital 3D models identical to the physical 3D models used in labs makes it possible to integrate digital 3D models into study resources that utilize gamification strategies. The two gamification strategies that are being recommended are the use of badges and challenges or quests.

The first strategy for gamification is to implement a digital badging system that provides recognition of a student's participation in a learning activity, encourages learning, pinpoints progress, increases time on task, and scaffolds learning activities (Dowling-Hetherington & Glowatz, 2017). The plan for this strategy would be to create digital badges corresponding to completing tiered activities of increasing difficulty within Canvas LMS using the Mastery Paths feature. Each digital badge would be tailored to a different unit within the curriculum. For example, to earn a digital badge for the circulatory system unit, a student would need to earn a digital sub-badge for the heart and another for the blood vessels. In order to earn the "Heart" badge, the student would have to complete four scaffolded activities. The first activity would be a quiz that focused on the exterior anatomy of the heart and utilized the digital 3D model of the heart. When the student earns 80% or higher on the quiz, they can progress to the second activity, a quiz on the interior anatomy of the heart. Completing this quiz with the same required score would unlock a third activity, a quiz about the physiology of the heart, and then a fourth activity about heart diseases. Research on the use of digital badges suggests that they function as a guiding mechanism for students, providing them with information on expectations and immediate feedback on their learning progress (Dowling-Hetherington & Glowatz, 2017). Some research suggests that motivation for badging may wane over time when required (Facey-Shaw et al., 2019), so making the badges optional with a reward (i.e., bonus points on an exam) may help provide longer-lasting motivation.

The second strategy for gamification is to implement challenges or quests in the form of collaborative digital escape rooms. Digital escape rooms are virtual “rooms” filled with clues, puzzles, or information that must be figured out in order to unlock a digital “lock” to progress to a new level (Tolen & Moura, 2020). Digital escape rooms would be created as study reviews for some or all of the units within the curriculum. These virtual rooms can be designed within a Google Site to provide a navigation structure requiring a code to unlock new “quests” or pages within the site. ThingLink and SketchFab are both tools that can utilize digital 3D models and be embedded into a Google Site page. Google Forms would be used as a “digital lock.” When a team solves the puzzles or uncovers the clues, their answers are entered into the Google Form. If the answer is incorrect, they are instructed to try again. If the answer is correct, a code is revealed that unlocks the next page in the quest. Students in small groups would have a fixed amount of time to work together to answer the questions and solve problems to uncover the clues necessary to beat the escape room. The positive effects on students who engage in learning through gamified digital escape rooms include increased engagement and learning experience, a sense of accomplishment, improved motivation, increased knowledge, and improved teamwork skills (Pozo-Sánchez et al., 2022).

Immersive Learning Environment

“Immersive learning conceptualizes education as a set of active phenomenological experiences that are based on presence” and can be implemented digitally through virtual or augmented realities (Mystakidis & Lympouridis, 2023, p. 396). This proposal recommends the use of virtual reality, a “digital, computer-generated three-dimensional environment that is completely separated from physical reality” and uses a head-mounted display that “creates the sense of occlusion,” separating the human senses from the physical environment (Mystakidis & Lympouridis, 2023, p. 399). Because this TEL utilizes digital 3D models of physical models to study and learn anatomy and physiology, the immersive learning environment that will be utilized is a virtual reality experience called Sharecare Virtual Reality. This immersive VR experience allows users to interact with virtual 3D models that go beyond the anatomy by demonstrating the physiology and/or effects of disease on the anatomy. Ideally, this immersive learning environment would utilize the same 3D models that are used in the anatomy lab and would be created for this project, but the virtual models within Sharecare are similar enough and realistic enough that they would be very effective. Future implementation of VR could utilize the digital 3D models created from the physical 3D models, but this would require significant time to develop.

Three important factors for successfully designing and implementing this VR experience are scaffolding, a generative learning strategy of teaching, and technological affordances. Scaffolding within an immersive VR experience would include pretraining, segmentation, and reflection, which helps manage cognitive load and increases the effectiveness of learning in immersive VR (Makransky et al., 2021). If students enter into a VR learning experience that has a large amount of information, interaction, and options, there is a risk of high cognitive load, which would result in less retention of knowledge. Having students jump into the Sharecare VR experience without adequate preparation would risk this negative effect. Therefore, if students are using Sharecare VR to learn more about the circulatory system, they can be pretrained with knowledge of the heart's anatomy and prepared with specific tasks that they should explore within the VR experience. This would allow the students to explore only the areas of the experience that are necessary for the assignment, rather than being overwhelmed by the wealth of options and interactions available.

Generative learning strategies for teaching are activities that prompt learners to produce something meaningful that goes beyond the information provided by a teacher (Brod, 2021). Generative learning strategy activities such as summarization, mapping, drawing, imagining, self-testing, self-explaining, teaching, and enacting stimulate learners to integrate prior knowledge with what is being learned in order to construct or generate new knowledge and a deeper understanding of the content and increase motivation (Makransky et al., 2021; Beard et al., 2021). Within Sharecare, the student experiences can be segmented by specific tasks in which they are asked to summarize, reflect, or self-explain what they learned or experienced and connect it with prior knowledge they learned in the pretraining phase.

Technological affordances refer to the ability of students to access customizable learning spaces, abstract concepts, inaccessible locations, or unique but replicable scenarios through virtual reality (Beard et al., 2021; Beck, 2019). Sharecare VR affords students the ability to enter into the human body and experience it in a way that resembles the experiences of the characters in the books and TV show, "The Magic School Bus."

Abilene Christian University already has access to the necessary equipment needed to implement this technology as a supplement to the anatomy and physiology labs. ACU has two Oculus Rift S headsets and computers that are capable of running the Sharecare VR application.

Faculty can use Sharecare in their classes and teach from the headset while the image is being projected onto a large screen (Beard, et al., 2021). Students can also make appointments outside of class to use Sharecare VR for themselves.

Program Evaluation

The success of the technology-enhanced learning tools used in this proposal will be measured using Kirkpatrick's evaluation model. This model proposes four levels of evaluation that have been modified for technology: reaction criteria, learning criteria, behavior criteria, and results criteria (Alsalamah & Callinan, 2021).

The level 1, reaction criteria describes how users feel about or are satisfied with the technology-enhanced learning tool. For this evaluation, reaction will be measured using an end-of-course survey that quantitatively measures student satisfaction with the digital 3D models using a Likert scale.

The level 2, learning criteria measures for learning that has taken place after the technology-enhanced learning tool has been implemented. For this evaluation, learning will be measured through the comparison of unit exams that used digital 3D models with unit exams that did not use digital 3D models.

The level 3 behavior criteria evaluate how users transfer knowledge and skills and if positive behavioral changes have occured. In the end-of-course survey, an open-ended question will be included that asks students to explain how the digital 3D models impacted how they studied and prepared for quizzes and exams.

The level 4 results criteria measure the effect of the technology-enhanced learning tool on the class overall in terms of reduced cost, improved quality, and improved quantity. This evaluation will track and compare final exam grades each year after implementing the digital 3D models.

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