The Same World:
Education Through Shared Augmented Reality Experiences

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Introduction

In the field of education, institutions are constantly seeking ways to present difficult material to students in a format that provides an easier understanding of the information provided. The creation of AR has led to new advances in visual aids in student education but not without a cost. Many AR platforms have subscriptions or high cost related to their initial use, making them unaffordable for many teaching institutions (1). To broaden the classroom learning experience, an AR environment has been developed that provides an affordable shared experience amongst the teacher and students. By use of an AR app on compatible mobile devices, users may participate in the shared experience. In chemistry, visualization of molecules is necessary to interpret macroscopic observations. AR removes the need for physical models by displaying the virtual object within the AR shared experience.

Background

Chemistry is a difficult subject for many students because a complete understanding of macroscopic phenomena require knowledge of what is happening on a microscopic/molecular level. A.F. Marais' study stated that some students, "cannot envision what occurs at the molecular level of matter during processes such as phase changes of water, will understand more easily if allowed to start at the concreate level using models" (2). In Chemistry, physical model kits are typically forgotten by students or not utilized in class due to the inconvenience and time constraints of building each model by hand. Mobile AR remedies these problems by providing access to pre-constructed virtual models through your mobile device, removing the need for physical model kits. With a shared AR experience, professors can display, interact, and explain various chemical models without students building ball-and-stick models each time, providing a seamless and convenient learning experience. Augmented reality "is an enhanced version of the physical, real-world reality where elements are superimposed by computer-generated or extracted real-world sensory input such as sound, video, graphics, or haptics" (3). Augmented reality put simply is an overlay for your present reality by providing supplemental information and visuals without removing the user from the shared classroom experience. Educational studies have shown that active learning pedagogies can improve learning outcomes and student satisfaction when compared to passive learning pedagogies (4, 5). Augmented Reality provides an active learning environment because it engages students in the learning process with object interactivity and promotes interaction with the professor and other classmates in relation to the virtual objects.

Purpose

Ongoing research and development work can is focusing on three components, formation of a controllable AR environment, activation of the AR objects, and the integration of multiple users for a shared learning experience. As of this writing, there is not an easily accessible or affordable tool available that provides a shared multi-user AR experience that includes the host controller (teacher) in the AR environment and allows the AR objects to be manipulated by the teacher. Bringing interactive AR into the classroom setting provides another avenue in which teachers can engage students in the learning process and help them better understand the content of the course (6). Presently a single user AR environment has been created. The multi-user functionality has been developed but currently lacks the AR environment. With the integration of the multi-user functionality into the single user AR environment, a shared AR multi-user experience can be achieved.

Method

Creation of the single user AR environment was developed using Unity just like the multi-user experience to allow for easier integration. Single user environment uses specific triggers to activate the construction of different virtual objects (7). The triggers also act as place holders for the location of the virtual object in the user's reality. The triggers utilized are 2D chemical skeletal structures of the AR object. Once the trigger is activated, the assigned object is pulled from the cloud and displayed for the user. This allows users to compare the physical representation of a molecule with its corresponding skeletal structure, thus bridging the gap of conceptualization. User can further enhance their learning by swiping their finger to interaction with the virtual molecules.

By utilizing the capabilities of the Unity software, an instance can be created by a host controller that allowed multiple users to join simultaneously and still maintain the ability to modify and interact with objects materialized within the instance (see Figure 1). Object manipulation is controlled on all devices by the host controller during multi-user experiences. This control helps keep the students on task with the activity (8). Upon activation by the host controller, other users will have the ability to manipulate the object on their mobile device without interfering with the displayed object on other user devices. This allows for self-discovery by the students. The teacher, at any point, can regain control of the shared user experience.

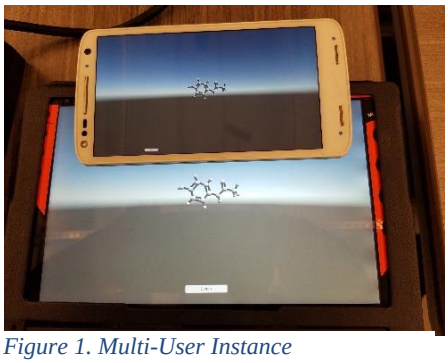

Figure 1. Multi-User Instance

For multi-user experiences, a shared pathway (see Figure 2) is necessary for participation of users (9). Connection to the instance is performed at the local level by means of wireless access points. The host controller generates the object and sends that information to connected users through the WAP. The object is then generated for each user and any modification in the environment is relayed from the host to the users. Non-host user interaction with the object is not relayed to other users.

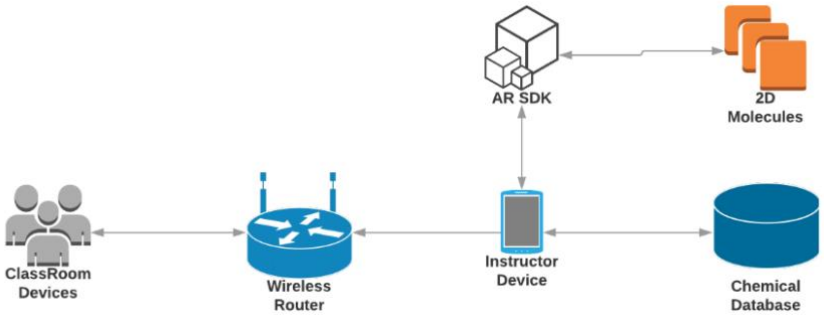

Figure 2. Object Materialization and Shared Experience Workflow

Currently users can utilize a single user AR environment for superimposing objects on their present reality or a multi-user non-AR environment where users can share objects in a virtual space that does not interact with their reality. Adding functionality to the multi-user experience, and the integration of AR environment into the multi-user experience are the top priorities of the research and development team.

Conclusion

Mobile device AR interfaces offer seamless interaction between the real and virtual world regardless of location. The research and development team has created a multi-user non-AR environment and a single user AR environment in which teachers and students have multiple avenues to teach and learn about molecules. The current focus is on the combination of the two environments to provide a seamless multi-user AR application.

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