The Environment Is Virtual, The Experience is Real.

A three part practical guide for implementing Virtual Reality in the education space.

Part 2:

Real Suggestions for Implementing Virtual Reality-Based Learning Opportunities

Applying VR For the First Time: Lessons Learned and Future Plans

This piece is the second of a three-part series that explores Envision's experience and lessons learned implementing virtual reality (VR) in our experiential, career-focused summer program. Education providers of all types (e.g., schools, curriculum developers, education technology companies) are well aware of the potential teaching and learning benefits of VR. However, given the relative newness of VR overall, especially in education, many education providers struggle with basic implementation questions -- what, how, when, and where? This is where we, the Envision education team, can contribute to the growing body of information concerning VR teaching and learning practices.

In this second paper, we describe the student experience with VR in our *National Youth Leadership Forum: Advanced Medicine & Health Care* program for high school students. Throughout this description, we comment on why we made the VR choices that we did. We also share the results of a student and instructor survey from our 2017 program. We hope that understanding both the VR choices we made, as well as the rationale for these choices, will be useful for your consideration for how VR might be applied in your programs.

A Deep Dive Into the Student VR Experience

The VR experience for our students begins with an introduction tutorial staged within an empty white room, with only a table in front of the virtual user. The initial objective is to get the learners comfortable in the virtual space and familiar with the buttons on their Oculus Touch controllers.

During this tutorial stage, students are provided oral instructions through their headphones on how to switch positions during the procedure. This provides the two-student healthcare team the ability to take turns completing each step of the scripted procedure and allows them to experience both active learning and observation in the virtual space. Our education team decided on a visual cue, a virtual two 'thumbs up' Oculus gesture, to initiate the change in position within the virtual operating space.

As the intro tutorial is completed, a giant red 'Start' button pops into the scene. Students are able to reach out and press this button at their discretion, which then starts a timer to begin the experience.

Once the launch is initiated, learners are transported to the virtual operating room (OR) environment where the procedure will take place. In the virtual OR, learners are presented with a preview of the procedure, along with a description of each of the steps they will be completing.

When the preview is complete, the patient is brought in. In this case, the patient has a laceration on the abdomen from falling on a glass coffee table, and learners must work together to clean, staple, and bandage the wound.

To enhance the realism of the patient in the virtual space, we chose to have a medical actor pose for a 3D scan using an Artec scanner. This system generated a dense 3D textured 'mesh' that was then used to optimize, refine and 'rig' into the final asset used in the scene.

The learning experience itself is a step-by-step guided procedure, where students are directed to pick up highlighted objects from the cart, then align with ghosted objects to initiate each step. We chose this technique in order to manage the time necessary to complete each step of the procedure, and keep the students focused on the broader learning objective by pre-animating various tasks.

As an example, when the students are asked to place a paper drape over the wound, they're instructed to take the drape from the cart and place it over the wound. When they've done this, the drape automatically unwraps and falls into position. This pre-animated technique is a trade-off insofar as it suspends the illusion of immersion by having the drape suddenly fall into place perfectly. This design choice was necessary given the technical limitations and time needed to develop multiple scenarios with each item (i.e. simulating cloth physics, unfolding, and positioning the drape perfectly/imperfectly over the wound). Time and resources here were instead devoted to building out the scene and necessary features to ensure a high-level learning experience from start to finish.

Upon completing each of the steps, the students hear a 'victory' sound and are congratulated for completing the procedure. Altogether, the experience takes about 10 minutes.

Practical Selection of Equipment and Space

As mentioned in our previous paper concerning our VR learnings, selecting VR hardware is an important element of the planning, design, and budgeting process. The hardware one selects can make or break the student experience. From early on in our planning process, the design team debated which platform would work best for the ultimate learning outcome. Oculus Rift with its Oculus Touch hand tracking system was selected as the virtual reality hardware for this project. The platform enables six degrees of freedom, or '6DOF,' meaning that not only is the learner's head movement tracked in virtual space as they look up and down or left and right, but their body and hand movement left and right is also tracked - making for a more realistic and immersive experience. Additionally, the Oculus platform was chosen because of its relative ease of temporary setup on location, where up to ten systems would be installed within a single room, each requiring a PC meeting Oculus' minimum requirements, two tabletop sensors, and approximately 8' x 8' interaction area configured at each station. This hardware choice necessitated a primarily 'front facing' interaction design, where student learners would be primarily standing still and facing forward throughout the experience.

Each Oculus Rift comes with a built-in microphone and headphones, enabling the student learners to talk to and hear each other throughout the learning experience. To help

align positional voice inside the application with their physical location, the recommended configuration consisted of two learners at stations positioned opposite each other.

The option to develop a full 'room scale' experience, enabling free movement within a larger area, could have been achieved with a VR system like HTC Vive, or adding an additional Oculus tracking sensor at each station, but, in our experience, the combination of potential space limitations and the fact that the intended learning interaction didn't require room scale movement, led to the decision to use Oculus Rift and Touch for this application.

In addition to selection of the hardware, during initial design conversations, the team made fundamental decisions on the scene itself that dictated downstream development. Avatars for learners would be represented by simple mannequin torsos with no arms and only virtual hands so as not to distract from the scene. The voice over narration that dictates steps to the student learners would reference pictorial icons on a monitor in the virtual space to enhance the teaching aspects of the scene but to also keep student learners focused on the designed procedure and not their own virtual distractions. Limited/no freeform interaction would be permitted between the student learner avatars and the patient to again limit distractions from the designed procedure. When building complicated scenarios, taking the time to think through downstream implications of early decisions is important.

Setup For a Medical Scenario

Implementing the VR build required careful planning and acquisition of the appropriate facilities. For the remote immersion programming taking place on a university campus, dedicated classroom space was secured and setup with complete VR systems. For optimal results in single or multi-player mode, a 3x6' table was set-up in the middle of classroom space with chairs/tables pushed to the side, providing approximately 50 square feet on both sides of the table. Stations were set-up on opposite sides of the table so the table itself could be used as a barrier preventing both users in multi-player mode from coming into contact physically while immersed in the virtual experience. Additionally, this limited any interaction with cords associated with the second gaming platform; though it did not prevent challenges associated with the headset cord anchoring a student to his/her own setup. Due to the sensitivity of the equipment and demands of the operating room scene, a trained technician was assigned to the equipment setup and to calibrate all sensors to the approximate height of the participants prior to student use. This tech support was also retained to handle any troubleshooting throughout the lesson. Collectively, this proved optimal and ensured the best experience for the students.

Making VR Meaningful

Framing the VR scene prior to learners engaging with the virtual reality environment and discussing their experiences collectively was critical. For the approximately 10 minute VR experience, 75 minutes of curriculum time was earmarked. The primary facilitator spent the first 15 minutes of the lesson discussing the educational merits of virtual reality, then student learners then took turns becoming comfortable with the equipment. Once comfortable, they entered the scene and completed the procedure as described above. After each student team had accomplished their VR procedure, the group convened for the final portion of the period to share their experiences. This dialog

led learners to realize common experiences they'd had in the virtual scene and allowed the collective group to recognize some of the benefits of this technology, like influencing thought through sensory perception.

Student and Facilitator Reactions to VR

The implementation of VR in our *National Youth Leadership Forum: Advanced Medicine & Health Care* program during the summer of 2017 was largely successful from both student and instructor perspectives. However, in the spirit of continuous improvement, we believed there was room to iterate.

As part of the continuous improvement process for all of Envision's programs, we survey our instructors and students on a range of program quality and outcome measures. The survey is a 14 item instrument with free-response questions. We received roughly 750 responses to the survey in 2017. When asked specifically about the VR workshop experience, 84% of students ranked it satisfactory or above on a five-point Likert scale. Out of 11 program elements surveyed, VR ranked fourth in student satisfaction. When asked which components in the program impacted them most, VR made an impression that warranted notation, but not to the degree of some of the more hands-on, skill development components. The following response exemplifies this point best:

> ***"I loved the simulated surgery and the VR, but the biggest impact had to have been patient encounters and doing the physical [exam]."***

Furthermore, when asked which area they would improve, a number cited more depth, freeform play, and engagement with technology through VR. These observations lend credibility

to the argument that student engagement will increase if tools like VR are embedded into core learning. Additionally, engagement will further increase if aspects of virtual environments are improved to allow more freeform exploration. To solidify learning gains, time should be devoted for student learners to share their experiences. Only through the shared discussion during the lesson debrief were some student learners able to synthesize their VR experience.

It became clear throughout longer term testing and observation that certain interactions within the experience were prohibitively difficult for some student learners. For example, aligning the stapler to place stitches required very close alignment with a ghosted 'guide' that most

could achieve without issue but, with which some had a very difficult time. By broadening the target for this interaction and others slightly, we were able to eliminate this issue.

We also found that the timing of instruction to the availability of prop assets for interaction required further refinement in some cases. For example, when the voice instruction would say "pick up the highlighted gauze," there are a few seconds where the gauze isn't highlighted or available for interaction. This would leave some student learners grasping repeatedly for the gauze before the application made it possible.

And, as is the case when implementing any new technology, sometime the technology simply doesn't work.

> ***"We had an epic failure with VR today, the computers went crazy. I was in there for 45 minutes troubleshooting, never seen anything like it. Next three sessions of VR went well once we made some adjustments. ... Overall it went well, a lot of lessons learned, but it went well."***
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> ***- Envision's Director of HS STEM Programming.***

Implementing VR in our 2017 *National Youth Leadership Forum: Advanced Medicine & Health Care* program for high school students was no small feat. As described above, deep subject matter expertise combined with extraordinary attention to detail and technical acumen is required for creating engaging VR-based learning experiences for students.

The following are three points we learned from our initial experiences and seek to build into our future VR endeavors. We hope educators and practitioners can also learn from these points:

1. **Design**: Build VR lessons cohesively into existing curriculum, to allow the total program to tell a learning story – VR should not be just a chapter, but rather an integral component of a whole student learning experience;
2. **Timing**: Ensure sufficient time is dedicated for VR lessons and training is scheduled for facilitators to ensure learners can work through the materials at their own pace and facilitators are able to assist as needed;
3. **Resource allocation**: Earmark dedicated space for the VR experience and make sure that staff are trained to operate the equipment/troubleshoot.

Based on our experience in 2017, we applied these lessons learned to our 2018 program. In part three of our three part VR experience, we will share the changes we made to the 2017 program, as well as the results that we saw.

About Envision

Envision is a nation-wide youth development organization devoted to improving student academic success and career readiness through experiential programming. Envision hosts college-accredited, academic- and career-focused programs for youth. Each Envision program employs a variety of instructional approaches – ranging from distinguished faculty-led lectures, to engaging small group activities, to real-world simulations, and subject-specific field excursions. Programs cater to 21st century skills development which are critical across all current and future careers. With a rich history dating back more than thirty years, Envision takes care in program design, development, and delivery in order to execute its mission – to ensure each student leaves having made progress on their career and life aspirations.