Introduction

Learning Institutions, Universities and medical schools today are increasingly challenged to use innovative technology that delivers transformative anatomy learning experiences while also enhancing the reputation of the school and allowing them to stay competitive with other institutions.

At the same time, these institutions are required to maximize and augment anatomy teaching time with effective teaching methodologies that facilitate heightened learning outside the classroom. This is especially important in many schools where lab time is at a premium, particularly for first year Med students.

In this paper we will explore how virtual reality (VR) tools can help to solve many issues associated with teaching and learning human anatomy in higher education. We will look at how virtual reality can be employed successfully in higher education to engage students with anatomical content. And we will explore what you need to look for when choosing a VR anatomy solution in order to maximize usage, leverage your investment in VR devices, impact retention and contribute to improved student outcomes.

We will also talk about how VR can promote lasting behavior change, and how healthcare providers are using VR to successfully treat a variety of conditions, from anxiety to pain management to PTSD.

Finally, we will introduce you to Primal VR, a VR anatomy experience that combines a uniquely flexible VR platform that is device-agnostic with the world's most accurate anatomy resource.

VR in the Classroom

VR enables anatomy students to learn through practical experience which has been argued as the most effective way to learn, increasing the quality of retention and recall by 70-90%. VR bypasses the process of the brain that will distract the learner from true problem-solving and creative thought, engaging all four learning centers of the brain.

Some of the benefits of experiential learning with VR include:

1. **Accelerates Student Learning**
   Repetitive learning can be dramatically improved by actually performing or visualizing the learning material.

2. **Provides a Safe Learning Environment**
   When medical students make mistakes along the way, the consequences are minimal as they occur in a safe and controlled virtual world.

3. **Bridges the Gap Between Theory and Practice**
   After learning theory about a particular structure or system, students can experience it in an interactive 3D environment, for an even more memorable learning experience.

4. **Increases Engagement Levels**
   The virtual environment lets students collaborate and learn from each other, increasing overall engagement.

Maximizing and Augmenting Lab Time

Cadaver labs are an essential part of medical school training but are not without their challenges. Some schools simply do not have enough physical lab space to accommodate the number of medical students, placing lab time at a premium, particularly for underclassmen. Time constraints are also fueling challenges associated with dissection, with curriculums becoming more crowded with increasing numbers of subject areas such as molecular biology and genetics utilizing the lab space.

Virtual reality enables universities to optimize their use of lab space without compromising the quality of learning. As one professor at Pennsylvania State University puts it, "Repetitive tasks in a physical lab could be done in virtual reality." By providing an immersive tool to practice these types of tasks, instructors gain flexibility in the allocation of lab time while augmenting the experiential learning component for Med students.

In larger classes, students and instructor must gather in a tight group to observe dissection, making it necessary for the instructor to demonstrate structures several times so that everyone can see. With virtual reality, everyone has a clear view.

In embalmed cadavers, organs do not look as they appear in a live patient. The embalmed body has a very flat compressed organ presentation, and the colors are not the vibrant colors of a living human. Having a means to demonstrate an accurate 3D representation of an organ alongside the cadaver allows the instructor to move from one to the other, adding context to what the students are seeing.

Optimizing Lab Prep

Instructors are also using VR tools as an effective precursor to the lab, helping students to prepare for and maximize lab time. For example, Stanford University School of Medicine uses VR for training in its Neurosurgical Simulation and Virtual Reality Center.

After the VR experience, students step across the hall to the neurosurgical anatomy lab, where they can experience the same anatomical structures in a cadaver. The virtual reality warmup prepares students for dissection and instructors say it speeds up learning.

A virtual anatomy tool like Primal VR provides a highly realistic view of living organs, helping students form a foundational understanding of the body structures. By donning VR headsets students can manipulate and examine an organ from multiple angles at their own pace. Students can view structures from the inside out, adding layers and peeling them back again, allowing for independent exploration, reinforcement and mastery of structures and systems.

Engaging Students in Virtual Learning Environments

Accessibility has become an essential component of advanced learning. As the 'flipped classroom' has become an often-necessary method of teaching in larger schools and those trying to maintain costs, faculty are required to maximize anatomy teaching time using the most effective teaching methodologies and facilitate engaging learning experiences outside of class. Many classes have online components or are totally virtual, and class materials must be accessible 24/7 from any connected device.

Virtual reality anatomy tools get students excited about learning and increase student engagement with the subject outside the classroom and in distance-learning settings.

Meeting the Needs of Faculty

While the majority of students have grown up with smartphones and tablets, it's not always the case with instructors. When evaluating VR technology purchases, institutions must take into account the ease by which instructors can learn, use and incorporate the technology into their existing teaching workflows.

In addition to accuracy and accessibility, instructors want anatomical resources that are comprehensive and flexible, catering to the needs of a variety of specialties as well as different learning styles. A good VR anatomy tool provides students with the ability to guide their own learning and go at their own pace and review even the smallest structures and systems until mastery is achieved. Because instructors must work within the university's LMS, it is important that VR anatomy software works with content that instructors can upload easily to share with students 24/7.

Balancing 'Cool' Tech with Compatibility and Effectiveness

Institutions want to offer far more than the latest 'cool' technology for students; they understand the need to ensure the most value from their hardware investment. But universities often find themselves constrained by their VR equipment when they discover the software titles they wanted for their library are not compatible. The technology for which they had such high hopes, inevitably sits on shelves, woefully underutilized.

They purchase VR setups expecting to pair them with highest quality content akin to their more traditional content sources. But many universities invest in the setups only to discover a dearth of quality learning software that is available. According to a recent study, there has been a lack of learning theories incorporated in VR application development to assist and guide toward learning outcomes. Furthermore, the evaluation of educational VR applications has primarily focused on usability of the VR apps instead of learning outcomes.

Thankfully this is changing, as companies known for the quality, accuracy and efficacy of their educational software have entered the virtual reality space. In May 2020, Primal Pictures and Curiious, the Australia-based Immersive Learning Company, announced the creation of Primal VR, a virtual reality anatomy tool that provides the world's most comprehensive and accurate 3D anatomy experience within a fully interactive, device-agnostic VR environment for academic institutions and healthcare environments.

The University of Adelaide became the first institution in the world to provide the product to students when the first module was piloted in 2019. Since then, VR lessons at the university have achieved unprecedented 100 percent engagement levels.

By choosing a VR anatomy solution that can be used with existing equipment, institutions like the University of Adelaide can leverage their existing VR investment to deliver exciting and effective immersive learning experiences – increasing faculty usage and student engagement, increasing comprehension, raising attendance levels and heightening outcomes.

VR has proven effective in a variety of healthcare settings and scenarios, which we will talk about next.

Benefits of VR in Healthcare Settings

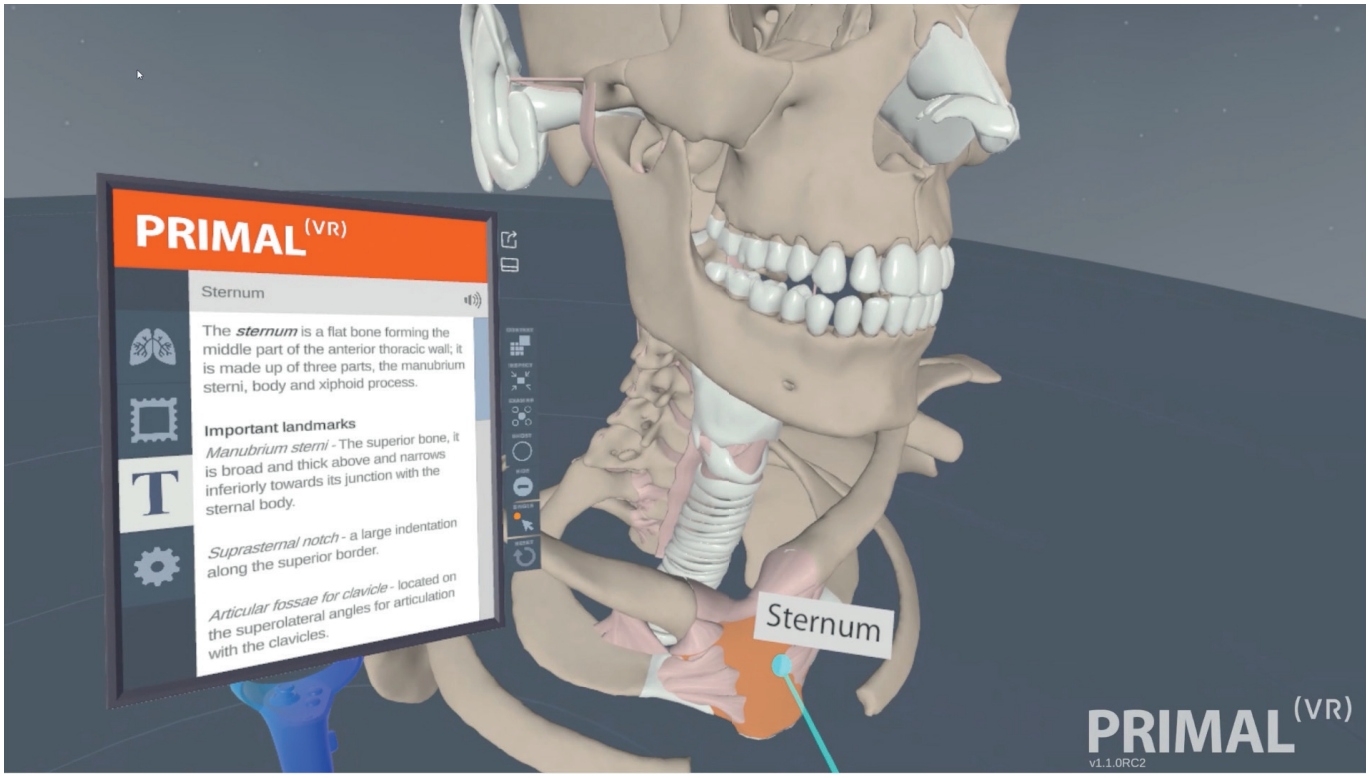
You cannot make someone illicit the feeling of vertigo just by asking them to imagine standing on the edge of a cliff, so it is difficult for a therapist to retrain the brain to reduce the phobia. However, a vertigo-inducing environment in VR makes the brain react in the same way it would in real life because it cannot process the situation differently.

It is believed that virtual reality technology can help reduce the recovery time for patients with vertigo and other phobias. The rehabilitative therapy enables patients to have control over their symptoms by using a digital landscape and virtual reality headsets. Typically, vertigo has a treatment goal of six months with rehabilitative therapy. The new virtual reality system cuts this time to just six to eight weeks.

This is because VR sidesteps interactions from the pre-frontal cortex, the area of the brain involved in conscious thought. That is the part of your brain that is wondering what to have for lunch or worrying about how you look or whether you left the iron on. Supressing this area of the brain allows the other parts of the brain – the limbic cortex and thalamus – to interact more freely to make connections they are not typically allowed to make.

VR exposure floods the visual thalamus and cortex, activating both subcortical threat detection and response pathways as well as cortical conscious pathways. In this way, VR exposure therapy is more effective than imaginal exposure therapy because it activates both exposure and cognitive processes as well as threat extinction processes.

In vivo exposure is inconvenient, expensive and time-consuming (just ask anyone who has undergone 'fear of flying' therapy by taking an actual flight!). VR is proven to interact with the brain in a similar way to psychedelic drugs. When these areas of the brain are allowed to act freely, the patient can give themselves over freely to therapy.



How VR Promotes Behavior Change

VR can facilitate behavior change by taking advantage of the way our brain's learning and reward systems function. VR systems can:

Activate neuroplastic change via reward systems. During such changes, the brain engages in axonal sprouting leading to increased neural connections in the brain, as well as synaptic pruning, deleting the neural connections that are no longer necessary or useful, and strengthening the necessary ones.

Shorten the reward feedback loop so progress is achieved faster. During the virtual reality session, a patient receives an immediate reward for exhibiting the desired response, which trains the brain to replace the old behavior with the preferred one.

Leverage mirror neurons systems to emulate a certain action being performed successfully in the VR setting. When the patient observes a desired action, for example, a calm response to peering over a tall ledge, the mirror neurons representing the performance of that action are activated. The mirror neurons transform visual observation into knowledge so the new behavior can be adopted. Healthcare providers can employ VR successfully to treat a range of conditions involving the brain's reaction to certain stimuli. VR can be used to reduce pain, treat anxiety, phobias and conditions like schizophrenia and psychosis.

Schizophrenia – clinicians are building avatars of their patients as well as the 'demons' that speak to them. The therapist can then take over control of the demon and teach the patient how to interact and eventually control that character.

Pain management – VR is thought to reduce pain by distracting attention away from noxious stimuli. The distraction hypothesis also suggests that when more attention is required to experience the VR environment, the reduction in pain will be greater. VR has shown promising results in reducing pain, anxiety and stress during painful procedures, including during wound dressing changes in burn wound patients and chronic wound patients. Removing the interactions of the prefrontal cortex can permanently reduce pain. This could have tremendous impact on reducing the reliance on and addiction to opioids in patients.

Physical therapy – VR is being used to encourage patients, especially children, to complete tasks such as shooting a bow and arrow and can also track their progress.

Obesity and addiction control – By presenting patients with situations related to the maintain/relapse mechanisms (home, supermarket, restaurant, beach, gym), patients can practice both eating/ emotional/relationship management and general decision-making and problem-solving skills. By rehearsing new skills within the VR environment patients are helped in developing specific strategies for avoiding and/or coping with triggering situations.

PTSD – By allowing the patient to remember the traumatic experience(s) in a safe environment, they are able to extinguish the strong emotional influence on the memory. A preliminary study examining the impact of VR therapy with emergency workers who were at the Twin Towers on September 11th, 2001 found positive outcomes that remained at six months post-treatment.

Psychosis – Putting the patient in everyday regular settings and coaching them through increasing levels of stress allows them to learn how to cope in the real world.

Pre-surgery – Patients are seeing 3D models of their CT scans to fully understand their surgeries, so they worry less. Reducing pre-operative stress is proven to have positive impact on recovery times.

Getting the Most from Your VR Anatomy Solution

Now that we've seen the wide array of uses and benefits of virtual reality anatomy in education and in healthcare, here's what to look for when choosing your VR anatomy solution.

Best-in-Class Content

Look for a VR learning solution that has best-in-class content at its foundation and is proven to engage students and maximize learning outcomes. Primal's embeddable anatomy content has proven effective at learning institutions worldwide. Like all Primal content, Primal VR employs a logical and efficient flow of information for a more controlled and contextual learning experience that suits a variety of teaching and learning styles. And like Primal's standard 3D content, it can be tracked for usage so librarians can assess value and measure levels of usage and engagement.

Device-Agnostic Software

Primal VR utilizes cutting-edge technology that allows instructors and students to interact with Primal's anatomical model in a fully immersive virtual environment for a seamless user experience regardless of the VR device they use. Primal's is the only VR anatomy and physiology solution that is compatible with any tethered VR setup, guaranteeing your students will benefit.

24/7 Accessibility

Students want and expect learning to be something that can be done anywhere, anytime on any internet-connected device. Where devices are available, Primal VR enables learning on the go and supports 'flipped classroom' and distant learning.

Flexible to Accommodate Teaching Workflows

Virtual reality tools are attractive to students, but they must be designed to complement existing teaching workflows so instructors will use them as part of their curriculum. You want a flexible solution that faculty want to use. Primal's flexible content can be used in the classroom, on LMS's and websites, and in study guides and assessments.

Gross anatomy is considered a difficult subject and getting students to engage can be a real challenge. Primal's vibrant and realistic 3D model with the immersive nature of virtual reality overcomes this barrier by creating engagement and enhancing spatial understanding of complex structures. Using Primal VR, students can employ the tools currently available in Primal's Real Time anatomy product to manipulate and explore anatomical structures in a way they never could imagine with a textbook, physical model or in the lab, fulfilling the promise of immersive learning for institutions.

Conclusion

As learning institutions and healthcare providers look for new ways to improve and heighten outcomes while maintaining costs, a virtual reality anatomy solution can deliver effective and lasting benefits. Primal VR combines comprehensive and accurate 3D anatomy within a fully interactive, device-agnostic VR environment, enabling immersive education for improved outcomes.

PRIMAL PICTURES

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