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BRINGING THE CLASSROOM TO YOUR LIVING ROOM- DISTANCE LEARNING THROUGH VIRTUAL REALITY

by

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Biography

Major Joel Oyama is assigned to the 446th Aeromedical Evacuation Squadron, Joint Base Lewis-McChord, WA. Major Oyama directly commissioned in the Air Force Reserve after earning a Bachelor of Science in Nursing from the Oregon Health and Sciences University in 2004. He completed Flight Nurse training at Brooks City-Base, Texas and went on to serve as the Officer in Charge of Aircrew Training at McChord AFB, WA. and Chief of Standardization and Evaluations at the 349th Aeromedical Evacuation Squadron, Travis AFB, CA., and Flight Commander of Operations and Plans for the 349th Air Mobility Operations Squadron, Travis AFB, CA. Prior to his commissioning in the Air Force, Major Oyama served 14 years in the United States Marine Corps in the field of Communications. He has deployed in support of Operations Sea Signal, Enduring Freedom, Iraqi Freedom, New Dawn, and Freedom's Sentinel. Major Oyama's undergraduate, graduate, and professional military education has included synchronous, asynchronous, and blended forms of distance learning.

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PREFACE

I was fortunate enough to have the opportunity to attend Squadron Officer School in-residence. The in-resident experience offered me the invaluable opportunity to interact with members whose experience and perspectives were as diverse as their occupational backgrounds. I also had an outstanding cadre of instructors to access who could help provide guidance or further explanation of the complex concepts presented. Returning to IDE as a distance learning student, it has been more difficult to "connect" with peers and instructors in the asynchronous digital environment. While still in its adolescence, Virtual Reality (VR) technology has now become affordable and ubiquitous enough for the average American to take advantage of its many capabilities. Due to its fully immersive auditory and visual displays, users find themselves transported from their organic environment to the virtual landscape of their choosing. It has the potential to allow students aspects of the "in-residence" experience while remaining at home. While the logistical savings could be profound, the real impetus for this research is to determine if VR can improve the experience of the distance-learner leading to more efficient and effective achievement of learning objectives.

I owe a great debt of gratitude to my advisors Col Tony Millican and Dr. Dennis Armstrong who provided direction, advice, and tremendous encouragement during the research and publication process. I would also like to recognize the sacrifices my wife Amber and son Christian who allowed me to sequester myself away to pour over articles or spend hours in virtual reality.

ABSTRACT

Distance learning has become a mainstay of DOD education. The operational needs of the enterprise require the flexibility it provides. Distance learning, despite its many benefits, has some areas with room for improvement. Students can feel isolated and unsupported in the distance learning environment which leads to a lack of engagement in the content that makes learning difficult and attrition more likely. To make matters worse, the learner is bombarded with distractions while trying to study in the home setting. Many courses simply aren't offered in distance learning format depriving learners who cannot attend. Could VR mitigate many of these barriers to distance learning? As illustrated in a literature review and case study, there is sufficient evidence that VR can enhance distance learning. Virtual reality has the ability to increase engagement through immersion in realistic multi-media displays. It also opens the door for many other courses that were only offered in-residence. By providing the in-residence experience to distance learners, VR will increase the efficiency, satisfaction, and efficacy of training.

Chapter 1

Introduction

"Face to face versus distance modes was the focus of studies with comparative designs, testing the assumption that face to face learning produces better outcomes, which was not in fact supported when knowledge and satisfaction were both measured."

--Berndt, Murray, Kennedy, Stanley, & Gilbert-Hunt, *BMC Medical Education* (2017)

The digital age revolutionized the field of education. It began with large desktop computers that allowed students to learn essential skills, often in a game-like atmosphere that captivated the minds of the users.[1] Years later, the internet tore apart the barriers of distance and time, allowing the proliferation of distance learning (DL), which gave students the ability to access education anywhere and anytime they desired.[2] While DL became an educational force multiplier, its limitations soon became evident in student performance, experience, and attrition.[3] The lack of peer and instructor interaction left questions unanswered, concepts poorly understood, and students disengaged.[4] This often led to student difficulties at best and attrition at worst.[5] Accessing education in non-traditional environments brought non-traditional distractions that tested the learner's concentration and commitment.[6-7] Virtual reality (VR) is poised to be the next game changing technology in education. It offers educators the ability to standardize education and deliver it in a manner that increases engagement, peer and instructor interaction, and minimizes distractions.[8-9] The purpose of this paper is to explore how VR can be used to enhance DL to provide a more effective, efficient, and enjoyable way to achieve learning

objectives. Existing evidence in the literature will be used in conjunction with the author's experiences with distance learning and a recent case study to demonstrate VR's value in DL.

Distance Learning Methods

Instruction is delivered in the DL environment in three ways: asynchronously, synchronously, and in a blended combination of the two.[10] Traditional in-resident courses use the synchronous approach in which the instructor and students meet at regular intervals and the majority of instruction is delivered at these meetings. Homework and additional reading may be assigned but the dissection and analysis of the content is typically done in-class with the instructor guiding the students through enabling learning objectives that allow them to achieve terminal learning objectives. This can be done to a certain extent in the DL setting. Online DL courses can meet synchronously in electronic chat or bulletin board forums to view content or hold discussions of reading they were assigned. While robust discussions can occur in these formats, discussions are often hampered by the student's and instructor's typing ability. The obvious advantage to online discussions is that it provides a perfect transcript that participants can refer back to.[11] The most common form of synchronous DL is when DL students join in-resident students via teleconference or video conferencing.[12] The internet and technological advances have made the merging of DL and traditional classrooms much easier.[13] Distance learning students have the advantage of being able to type in comments and answers or verbally comment if microphone enabled. While this seems the best of both worlds, this approach depends on a moderator who can respond to both the DL students and in-class participants. Distance learning students in one study experienced difficulty gaining the attention of instructors and felt that more attention went to the in-class participants.[14] Problems with internet connections, equipment, or user skill have the potential to derail the learning of both in-resident and DL students. The setup that is conducive to the in-resident classroom might make it difficult

for DL students to view or hear when filtered through the small screen of their computer terminal. Conversely, in-resident students may find it distracting to see DL student screens paused or movement in the backgrounds of their screens if the DL students are visible to the class. Synchronous learning, whether through DL or strictly in-residence, is the most resource-intensive approach as it depends on a physical space to meet and instructors at each meeting to prepare and deliver educational lessons.

The bedrock of DL is asynchronous learning.[15] This style of learning provides the flexibility and convenience that DL students seek out. It is also the cheapest and fastest method of content delivery as it does not depend on a physical space or instructors beyond what is needed in the original production.[16-17] In this design, the learner has full access to the course content and independently pursues the learning objectives at their own pace and location. Deadlines are typically still part of the courses, with essays, exams, or other assignments the principle evaluation means. As the content is accessed at the user's discretion, the content can't easily be individualized or clarified in real time. This works very well for students who are disciplined and are able to learn more independently. Many students need additional clarification or reassurance that they have understood the directions or learning objectives and thus have a difficult time with the lack of this feedback in the asynchronous environment.[18] Even students who are adept at navigating the independent environment of asynchronous learning find themselves needing additional information or clarification from time to time. Despite the barriers associated with asynchronous learning, most DL students in the DOD will depend on asynchronous learning due to operational demands.

Blended environments seek to garner the best qualities of both synchronous and asynchronous methods.[19] The bulk of instruction and assignments are done asynchronously, outside of class, with in-class meetings occurring at a regular basis to present lectures or guided

discussions. Distance learning students join the classroom meetings via telephonic or video conference. The blended style allows for guided discussions, student presentations, and interaction with instructors, speakers, and peers to aid learning. It requires less resources than traditional synchronous learning but its requirement for regular "classroom" meetings strains the flexibility many DL students need.[20] The regular meetings however, do provide the interaction many students feel increases their engagement and learning momentum to guide them through the asynchronous parts of the course.[21] With students learning in a variety of ways (visual, verbal, experience, etc.) and many concepts and skills difficult to comprehend, blended learning is often what is needed for DL students to achieve difficult learning objectives.[22]

What is Virtual Reality?

A Boolean search involving VR will reveal thousands of articles that define the technology in a variety of ways. In the broadest sense, VR is technology that places the user, through auditory and visual cues, in another computer-generated environment.[23] The popular computer game, "Second Life" is commonly referred to in the literature as VR. While its graphics, narrative, and user imagination help to make the experience in the virtual setting feel more engaging, it still depends on the user to tune out their real-world stimuli and use imagination to fill in visual and auditory gaps. The most impressive applications of VR utilize head mounted displays (HMDs). Sensors within the HMD track the user's movement allowing it to project images at locations the user would expect creating the illusion of moving within a 360-degree synthetic reality.[24] Most HMDs completely envelop the wearer's eyes thereby eliminating peripheral distraction increasing the authenticity of the user's experience. This sense of full immersion in the computer-generated virtual environment is referred to as "presence" and increasing it is the goal of every VR designer.[25] Increasing realism and presence depends on the developers to design environments that mimic the physics and behavior of natural life, or at least

behave the way that is believable. The visual and auditory cues presented must also convince the brain that what is being experienced is possible. If all are captured just right, the user is so transformed by their virtual experience that they can literally believe they are flying, falling, fighting, etc. Vince Jordan of Lobaki Inc., one of the pioneers of virtual reality education and design, had to provide safety spotters during his demonstrations of a virtual environment that asked participants to walk off a pirate plank after several users lost their actual balance.[26] While the graphics and accompanying audio are stunning, the biggest factor influencing presence is the user's ability to have freedom over their environment.[27] Users in VR are not bound by where the director decided to focus the camera but rather, they can choose what they want to view and when. With this freedom and the elimination of peripheral stimuli, it is not long before one forgets they are still in the real world. This is increasingly true as technology allows users to untether from the power and system cords that restrict natural movement. Wireless HMDs are now available which allow users to navigate around in the virtual environment beyond where the traditional wired connection would allow. Lobaki Inc. is experimenting with supportive equipment that allows users to perform natural movements like walking and running, as well as unnatural movements like flying.[28] Known as "haptic" technology, wearable sensors allow the user to obtain physical sensations like vibration, positioning, and even air puffs.[29] Matching the visual and auditory information with haptic feedback induces the most powerful feelings of presence. While the academic definition of VR is broad, VR for the purpose of this paper will refer to the fully immersible HMD-generated applications.

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Chapter 2

"There are several ways in which VR technology is expected to assist learning. It allows students to visualize abstract concepts, to observe events at atomic or planetary scales, and to visit environments and interact with events that distance, time, or safety factor make unavailable. The types of activities supported by this technology promote current educational thinking that students are better able to master, retain, and generalize new knowledge when they are actively involved in constructing that knowledge in a hands-on learning environment."

--Marwa Abdelaziz, *International Journal of E-Education, E-Business, E-Management and E-Learning* (2014).

Distance Learning: The Pros

Distance Learning has been game-changing for mass education. It has allowed exponentially more students to receive education then would otherwise have been able due to cost, location, or time. It allows instructors to reach an infinite number of learners. Consequently, all servicemembers can receive the vital professional development education regardless of the limited number of available slots for in-residence programs. This also reduces the cost involved with sending members on temporary duty (TDY) assignments for extended periods of time. The improvement in the quality of life for servicemembers and DOD employees who can remain at home with their families cannot be overlooked as well. Perhaps the most important aspect of distance learning is its ability to be delivered asynchronously. The "on-demand" nature of DL is what allows the deployed pilot the ability to complete their IDE during their downtime or the ammunition technician to increase their occupational acumen in a base far

from the formal training unit. Without DL, the DOD would be hard-pressed to provide the education the force needs while still meeting the demands of the combatant commanders and maintaining a work-life balance conducive to retention.

Distance Learning: The Cons

While this flexibility has allowed vital education to be delivered to more individuals than ever before, the asynchronous nature of DL has also stripped away some of the aspects of education that are important to many students' ability to achieve learning objectives.[1] In the asynchronous environment, questions and feedback are delivered electronically with response times varying with the participation from both sender and receiver. Add a weekend or holiday to the situation and it could be close to a week before a question is answered or clarification received. As most courses deliver content in a manner that builds on the foundation of previously learned skills and information, students often cannot progress until they achieve proficiency in the problem area. At best, the student risks falling behind in the course, but an increasing number of students in DL courses simply give up.[2]

Technology itself can be a barrier in DL. The DL model typically requires internet connection, sufficient software and hardware to store and deliver educational materials, and users adept at using the technology. Some of the austere locations DOD personnel serve in cannot support the basic requirements for DL. A typical IDE lesson plan for example, contains hundreds of pages of instructions and required reading which can result in a file size of 10-15 Megabytes (MB). Courses that depend on video-based instruction can require downloading or streaming files up to 500 MB. Student's trying to download these large files in unstable or slow internet connections are often unable to complete the download. While this problem is slowly resolving as the global community embraces technology, system outages, slow internet speeds

and equipment failure will likely always be a barrier to DL.[3] Participating in DL also requires a basic level of technological proficiency, particularly computer skills. Like the proliferation of the internet, those with the required computer skills will become increasingly more prevalent but user ability will still be a key consideration in DL.

Social isolation is one of the biggest complaints voiced by the DL student.[4] This is due in part to the lack of interaction with other classmates and instructors.[5] Interactions from peers and instructors is an important part of learning. These interactions provide clarification for instructions, encouragement to build confidence in newly acquired knowledge and skills, and most importantly, increases student engagement.[6] Students engaged in their learning acquire knowledge and skills faster and are more apt to successfully complete a course of study.[7] Peer interaction is also a source of education in itself, particularly in the setting of professional military education. The insights gained by experiencing content through the unique and diverse perspectives of peers are invaluable. Student-instructor interaction is equally important in reducing isolation and facilitating learning.[8] Through their interaction, student anxiety is often decreased while their confidence increased by clarifications and reassurances from the instructor. The instructor interacting with their students, is able to identify and correct errors or inefficiencies in learning. In traditional classrooms, this is typically immediate feedback whereas this crucial feedback is often delayed for the asynchronous DL student.

The freedom asynchronous learning provides is a godsend to most, but many others struggle with maintaining self-discipline, motivation, and concentration.[9] The daily or weekly reminders of important dates or announcements are difficult to ignore in the traditional classroom but are just a mouse-click or a failure to login away for the DL student. Many a DL student has put their coursework on the back-burner only to return to an almost unsurmountable amount of content to digest and assignments to complete[10]. Family, work, and personal distractions are much more

prevalent in DL due to its ability to take place virtually anywhere. Unlike the traditional classroom, the DL setting allows for TV, phone, eating, and other distractions to divert the attention of the student. Students may also experience moral conflict when choosing to devote the necessary attention to their studies instead of the family at home with them[11]. Even the content delivery device, the computer, can be a distraction to the DL student. While the traditional student is focused on an instructor in a classroom designed to support the instruction, viewing content on the small screens of laptop and desktop computers allows for visual and auditory distractions in the periphery. Add to this the instant messages and other alerts that are frequently encountered in personal computing and it is easy to see how difficult concentrating in this environment can be.

Virtual Reality Education in Practice

While gamers have been the driving force behind the recent proliferation and advancement of VR, the education industry is beginning to realize its merits and is emerging as a leading consumer. Initial proponents of VR in education sought out the technology to capitalize on its gaming appeal[12]. Gaming and education have been intertwined for decades. Students in the 1980's learned about pioneer life and history while avoiding virtual dysentery in the iconic "Oregon Trail" computer game[13]. People like playing games and most enjoy competition which makes "gamifying" education attractive. Research also supports this type of approach noting interactive multi-media content has been shown to increase learner performance.[14] Researcher George Papanastasiou and colleagues found students using VR had as much as 40% higher recall of information when compared to their traditional-class counterparts.[15]

The benefits of game-based learning have not escaped the DOD. The most recent version of their Information Assurance training incorporates a series of in-course games and tasks that provide virtual "trophies" for flawless completion and keeps a running score. With the added

realism VR brings, gamifying instruction can not only make learning more enjoyable, but more useful. The useful task of encountering and dealing with unexploded ordinance (UXO) for example, could be made more entertaining and effective by allowing learners to perform the required steps in the interactive VR environment. Students must recall knowledge learned in previous lessons and demonstrate it physically in the VR space. Get the step wrong and the UXO explodes allowing the student to see the consequences of their actions. Get it right and the student gains confidence that they could perform these tasks correctly in the operational environment. Combining realistic imagery with performing hands-on tasks like marking the site and cordoning off the area provides visual and tactile reinforcement for the lesson making it more memorable. This type of VR training incorporates all of the methods students learn information: reading, listening, observing, and performing. The ease at which content can be modified in VR can keep content fresh which will help to maintain the accuracy of lessons and increase engagement.

Interaction with the content can also make it more memorable. One VR educational offering uses a series of interactive games and quests as it teaches the learner about life in ancient Greece.[16] The learner is educated about the style of art produced by the ancient inhabitants while restoring a damaged fresco utilizing materials that would have been used in that time period (another lesson in and of itself). The immersive quality of VR provides the perfect venue for interactive educational content delivered in a memorable and enjoyable way.

As the VR space is able to be customized by the designers, additional educational content could be added or existing content modified to reflect new information. The designers of the Greek civilization experience commented that additional content could be available to the user by merely placing characters in the experience who must be contacted in a quest.[17] Additional content could also be added that is not mandatory but could allow a curious or advanced student

to dig deeper into the content. Electronic content customization and updating is much less labor intensive and costly than with print or video-based media.[18] As information or learning objectives change, modifications to the virtual reality space can be made that users will have access to in minutes with just an online update to their application.

Some of the most valuable VR applications in education simulate costly environments. Hands-on training where costly resources are expended typically limits the repetitions available for the learner. In some instances, the resources are so valuable that hands-on training cannot occur outside the operational environment. This may result in student attrition for those who struggle with task proficiency. Many of these students may be able to be successful with more practice in the controlled environment of VR.

Skills that are dangerous to perform or done in a dangerous environment can be done in the risk-free environment of VR. Utilizing VR for this type of education has the advantage of the realism and emotion evoked by the immersive quality of VR. Instead of the artificial and safe environment of a training area, VR simulation can transport the student to a realistic and chaotic environment that introduces sights and sounds that can impart stress and anxiety. As haptic feedback devices become more sophisticated and ubiquitous, the ability to induce the stress and realism of dangerous environments will be even more effective.

While simulating dangerous environments in training is not new, VR can increase the access to this type of invaluable training. Simulating healthcare in the tactical wartime environment is the goal of the Tactical Combat Casualty Care (TCCC) courses offered throughout the DOD.[19] Students in this course must perform life-saving tasks that include applying a tourniquet on a bleeding patient while under simulated enemy fire which is much more stressful than in the controlled hospital environment. While these courses are outstanding in their ability to provide realistic and high-quality training, they are resource-intensive and only offered at a limited

number of locations and dates. Students in these courses are also limited in the number of training scenarios and practice sessions which may not allow a struggling student to gain the experience they need to accomplish the learning objectives. By practicing in VR, the student failing in this environment can reset the scenario in seconds and try again until they feel confident that they have achieved proficiency. A struggling student can also have their performance assisted by an in-vivo instructor or reviewed asynchronously.

Research validating VR as a pedagogue for training that traditionally requires hands-on performance means the breadth of training offered in the DL environment could increase.[20] Currently, DL is limited in its ability to be used in areas where hands-on skills are required. Cardiopulmonary resuscitation (CPR) for example, requires the physical demonstration and evaluation of chest compression and rescue breathing. The didactic portion can be done asynchronously in DL but the learner must complete the skill demonstration and evaluation with an instructor. In contrast to DL, evaluations in VR could be performed asynchronously utilizing session recording technology imbedded in applications. Recording not only increases the accuracy of the evaluation but it also provides a useful tool for instruction. The evaluator and student can meet in VR and review and discuss the recorded examination together to help remediate the student or show areas where improvement could be beneficial. Students could also perform self-critiques and identify areas they are struggling in. The ability to conduct courses requiring hands-on performance asynchronously enables participation by anyone with the equipment that can support the content. Over the past decade, VR's ability to successfully reproduce hands-on experiences has dramatically increased making it increasingly efficient and effective for use in distance learning.

Virtual reality may also increase the quality of instruction offered. Imagine having the foremost subject matter expert in a particular field instructing every student in a DOD career

field. This could be possible using VR technology. Neonatal resuscitation educators are researching this concept in their desire to improve their education by bringing it into VR.[21] Neonatal resuscitation is fortunately a rare occurrence but when it is needed it is stressful and requires great skill. Finding expert instructors for these courses can be challenging given the small community that practice it. Course designers can design virtual reality-based training that incorporates expert instruction from whoever they desire. The ease at which users can join the virtual space increases the flexibility for guest speakers. The CSAF, for instance, could pop into a question and answer session in a leadership block of a military course while at his Pentagon desk.

Documentary filmmakers have recognized the power VR immersion can have on an audience's emotions. An increasing number of these documentaries put the viewer in the midst of another's life experience in an effort to increase empathy. In "Clouds Over Sidra", viewers are taken on a journey of a Syrian refugee camp by a young Syrian refugee girl who relates her experience in the austere camp.[22] The viewer has full reign over their environment and can look around the room and move around as the narrator talks. Sociologists psychologists, and educators are all looking at ways harnessing empathy can teach the important lessons that can help eliminate social, environmental, and economic disparities.[23]

The freedom of movement that is so coveted by VR users can be troubling for its use in education. With content literally in every part of the user's field of view, there are a myriad of distractions that can divert their attention away from the intended focus. Where the traditional director would position the camera toward where the viewer should look, VR directors must make the focus area compelling enough to overlook the details in the background.[24] Narration and tasks built into the VR application were the most common ways directors helped the viewer navigate logically through the content.[25] In "Clouds Over Sidra", the viewer is drawn to focus

on the girl due to her compelling narrative over the added detail in the periphery with the additional imagery helping the viewer identify with the situation. Additional controls can be imbedded in the VR environment to steer the user toward focus items or away from other areas.[26] Programs that allow users to walk along a path often use the virtual imagery to force the user to turn at key points.[27] This ensures the user does not stray out of the sphere of control of the VR hardware and prevents users from walking into walls or other obstacles. While challenging at times, mitigating many of the problems encountered with freedom of movement can be controlled with intelligent environment design.

With VR, learners can travel back or forward in time and be immersed in a life-like environment. In addition to the entertainment value, the immersion reinforces the learning objectives making them more memorable. Alexiou and Tsiatsos (2004) tested the linkage between immersion and retention of learning objectives using a simulated medical laboratory. They designed a course that gave participants the opportunity to train in a functioning medical laboratory without physically being present.[28] This experiment produced some encouraging results. The students commented that being able to practice in a life-like environment helped prepare them for the real environment. The designers also noted that the lab could be used in multi-user mode which allowed students to interact with each other like they would in an actual lab. The individual mode allowed students to practice in isolation and allowed more than one person to practice in a particular duty position which is not possible in the actual setting. Just as designers were able to induce empathy, the immersion of VR can also induce feelings of stress and danger that can be useful when training for difficult or dangerous tasks that would be difficult to replicate in other training formats.[29] The continued partnership between gaming and education will further increase the possibilities and capabilities of VR-based education and training.

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Chapter 3

"By the end of the course, only 3 of the 27 students in the class showed up for the in-person meetings. Mr. Gill, an assistant professor of education, says he was impressed by the level of discussion in the virtual world."

--Jeffrey R. Young, *The Chronicle of Higher Education (2000)*

Case Study: Virtual Reality Research Elective

Methodology

Responding to an open invitation by Air War College and ACSC cadre in the Fall of 2018, the author and a number of students applied and were accepted into an exclusive, one-of-a-kind research opportunity that was designed to explore virtual reality. The ultimate goal of the research was to find ways this burgeoning technology could be used to enhance DOD training, capabilities, or quality of life[1]. The design was simple, a blended learning environment linking in-resident participants at Maxwell AFB to eight distance learning classmates spread throughout the country via Adobe Connect, a popular videoconferencing software, and Virtual Reality equipment and software. Students in as many as seven different time zones participated simultaneously in the course each session. Several of the students traveled on temporary duty assignments or vacations with their VR equipment and were able to successfully participate in the class sessions. Each student was asked to procure or utilize provided VR HMDs and software. The HMDs used were the Oculus Rift and HTC Vive, both commercial off-the-shelf devices affordable to the average consumer. Most DL students who procured their own HMDs required an upgrade of their computer system due to the tremendous graphics and processing demands VR requires. Throughout the term, DL students joined in-resident students and

instructors for three-hour classroom sessions one to two times per week. Readings were assigned along with several group projects. Students were also tasked with formulating a research question and proposal that they would use to produce a report illuminating the area of VR they felt could benefit the DOD enterprise. During the three-hour classroom sessions, students received didactic presentations from instructors and featured guest speakers. The classroom sessions were also geared toward introducing and evaluating various VR applications and educational platforms with an increasing amount of time spent in the VR space. After achieving initial proficiency in multi-user VR space, instructors broke the class up into groups of four to five students. The groups included at least one DL student and were utilized for both group projects and small group discussions. Students took turns as facilitators in their small groups which gave them the chance to design educational forums and introduce content for review. Following the completion of tasks in virtual reality, students and instructors typically met in a shared VR space to discuss their findings and experiences. These sessions were often recorded to allow students who were absent due to operational needs to view them asynchronously. Students were also regularly asked to reflect on their user experience with both the applications introduced and their overall learning experience. At one point in the term, in-residence students were able to bring home VR hardware and participate from home providing them the DL experience. While the groups could utilize videoconferencing, phone conferencing, or other means of communication to collaborate, most of these small groups chose to utilize multi-user VR space. The natural feel of conversation and added visual presence made communication easier and more productive than other methods. The ability for these small groups to meet in real-time within a structured class setting is a novel capability in DL bringing it even closer to the in-resident experience.

Toward the end of the term, a research conference was setup that brought the class to Vince Jordan's Lobaki Inc. research laboratory in Jackson, MS. Billed as one of the largest and most advanced VR labs in the region, it offers both a non-profit VR academy teaching the latest VR design and a commercial VR simulation design business. Its graduates, often coming from low socioeconomic backgrounds, are frequently employed by the commercial business upon graduation. In addition to receiving additional guidance and instruction on VR applications, design, and theory, the class was able to trial a variety of sophisticated VR applications and devices that opened the minds of participants to the increasing capabilities and possibilities that exist in the VR space. This research trip was the first time DL students met their in-residence counterparts in-situ. Toward the end of the semester, a synchronous class session was hosted via webinar and multi-user VR from the Interservice/ Industry Training, Simulation and Education Conference (I/ITSEC). Instructors and several students shared their first-hand perspectives from the conference to the remaining members of the class who attended virtually from locations across the country. This gave the entire class a DL experience as new technologies and applications were introduced to the class. The highlight of this opportunity was the virtual presentation by a leading industry designer from inside multi-user VR where he gave students a glimpse of future applications and features in development for VR. Taking place entirely in the virtual space, this opportunity was a powerful demonstration on how effective and effortless VR meetings can be.

Learning Objectives

Although the ultimate objective of this research elective was to produce a research report, a crucial learning objective was to function effectively in the virtual reality space in a variety of applications. Initially, the mostly VR-naïve students required a great deal of in-class instruction on how to access and setup the VR space. As an emerging technology, the industry has yet to

standardize many of its controls and interfaces which adds to the challenges the early adopter faces. The mismatch of visual and vestibular inputs can induce nausea and headaches in VR and this is more pronounced in the inexperienced VR user.[2] The first classes spent minimal time in VR for these reasons. Time spent in VR increased dramatically throughout the course until a majority of classroom time was spent in the VR space. Instructors provided minimal instructions at times to help the students evaluate the ease, or more appropriately the difficulty, of some of the virtual reality applications. Core educational functions of guided discussion and multi-media presentation were evaluated using a variety of VR applications and environments. This helped students grasp the crucial details and considerations that would be required to use VR in education. In addition to on-campus office hours and phone calls, one instructor regularly extended the invitation to students to join him in several VR spaces to continue discussions or participate in more learning. As students became more comfortable with VR, those joining the after-class groups increased. In an article by Jeffrey Young, a UNC professor teaching a course almost exclusively using VR, experienced a similar result.[3] In the UNC course, the instructor offered traditional and virtual office hours. Many used the traditional, in-person method initially but by the end of the term nearly all of those accessing the instructor did so in VR.

Barriers To VR

Participants had to overcome several obstacles in their use of VR. The first hurdle was to obtain the necessary hardware and software to enter the VR space. At the time of this course, the average home computer used by most consumers would not support the impressive graphics and processing speeds necessary to render a virtual environment. Underpowered computers run the risk of inducing the dreaded "simulator sickness" due to the image lag produced when the frame per second rate does not closely mimic real life.[4] More sophisticated and life-like simulations require higher graphics and processing capabilities.[5] Fortunately, the HMD has become much

more affordable and compatible with most operating systems and virtual reality applications. Based on in-class and informal discussions, students were satisfied with both the Oculus Rift and the HTC Vive HMDs.

Internet connections and computer server limitations did not occur often, but when they did, they essentially shut down the class until they were resolved for those affected. The internet issues occurred most frequently in the DL students who were TDY or away from their home networks and using shared internet connections. In-resident students dealt more frequently with server issues that may have had difficulty handling the glut of students accessing the school network with high bandwidth demands. In several of the VR applications the class used regularly, software updates were a frequent demand. Depending on the speed of the internet connection, these updates typically took less than a minute to install but required restarting applications or even the entire computer which delayed group members at times. To mitigate these time delays, instructors published the locations and applications that would be used in class prior to meeting so students could log in and install the necessary updates to allow for a seamless transition into VR. The industry is also responding to the issue of high internet bandwidth demands by developing new technology. Facebook and Oculus, both led by internet guru Mark Zuckerberg, are using new "pyramid geometry" techniques that have been able to reduce 360-degree video and VR files by in impressive 80 percent.[4] Zuckerberg and other internet elites recognize the value of VR and are committed to bringing improvements in technology to remove current barriers and make it as ubiquitous as social media and other internet-based technologies. [5]

Although the course participants possessed excellent computer skills, navigating in VR was a steep learning curve for most. The 360-degree ability of VR means that content can literally be anywhere in the user's field of view. The login screens the user uses to input their password could very well be behind them. Even entering passwords can be a challenge as it may require

the user to point to keyboards on the wall, use the HMD's handheld wands, or a combination of the two. Applications are also unique in their controls so what is used to navigate and select in one program is likely not the method of control in another program. Over time the students learned how to reorient their views and how to customize their environment, but a significant part of the initial class periods was spent assisting students' orientation in the VR space. As VR matures, similar standardization of controls that are seen in personal computing (double click and right click for example) will likely be adopted that mitigate some of these issues.

The other glaring barriers to using VR for education that were identified during the case study is the lack of notetaking capability and the cumbersome seams between HMD and computer software. While wearing the HMD, it is difficult to access the computer without taking off the HMD. Taking off the HMD disengages the viewer from the content but is the only way to make changes to the computer or take notes. Some applications have a notepad available but without a fingered keyboard, users are forced to hunt and peck on suspended keyboards which is inefficient and impractical. The background noise of many users created microphone feedback that was also problematic. This was most pronounced in the in-resident classroom where microphones picked up the student in close proximity to them. This required students and moderators to control the microphone permissions which created delays in natural conversation at times when users or moderators forgot to take the participant off mute. Due to proprietary software arrangements, some VR applications had to be loaded from the computer first before they could be accessed in the HMD. Most of these issues were successfully mitigated by making changes to the microphone sensitivity and increasing the spacing of in-resident students. Virtual reality designers may also be able to develop voice enabled microphones that mute the speaker when they are not talking or designate one of the buttons on the handheld controller as a "push-to-talk" (PTT) switch similar to aircrew communications systems.

Virtual Reality Enablers

Virtual reality is entertaining. From the first time a user encounters a life-like 360-degree virtual space, they are engaged. The quality of image rendering in applications is astounding. A quick Google Earth "Street View" query can bring up a childhood home in exquisite detail. Thanks to its 360-degree navigation, its possible to stroll the neighborhood as well. The HMD shuts out the distractions of the outside world and its crisp, clear visual and auditory inputs deny their ability to be anywhere other than the virtual space. This immersion helps to invoke emotion in the viewer who becomes part of the narrative. Many of the educational presentations on the market today utilize VR to invoke empathy in viewers in an attempt to change behavior and attitudes.[6]

The visual and auditory stimuli can also invoke the useful emotions of fear and stress in training scenarios where operating in the actual environment would be too dangerous or cost-prohibitive. The ability to add realistic multi-media content to support the instruction assists with imprinting the message on the brain.[7] The fact that the user typically has more control over the media than in traditional formats allows the user to move past the simple receipt of information to become "transformers of knowledge", incorporating it in novel ways.[8]

The VR environment allows for students to view life-like depictions of themselves, known as avatars, complete with body language and in some instances, facial expressions. With controls varying with application, users can craft their digital doppelgänger to appear as their actual likeness or their idealized self. Most users choose features that have a basis in reality, either in the physical sense or in personality but may be enhanced to increase visual appeal.[9] This human likeness coupled with the matching body language, mannerisms, and voice provided an eerie sense of presence that blurred the line between reality and the digital world. This was proven in the first in-situ meeting between DL and in-resident students. By observing conversations, it was

evident most students needed no introduction to their peers and several commented that they felt like they had already met and knew quite a bit about each other. Students also noted that while videoconferencing allowed them to have a visual representation of their peers, VR provided the chance to gain a true sense of their personality through their avatar customization and the ability to have more natural conversations. Another key student observation discussed in class was that interacting online in the VR space felt more natural than speaking though videoconferencing due to the avatar's appearance and ability to have unrestricted movement. Realism matters, and students noted a decrease in engagement and presence in applications where the avatars appeared or behaved differently than normal.

The game-like atmosphere of VR is also an enabler to its use in education due to its ability to increase interest, engagement, and satisfaction. This is increasingly true as today's student has grown up in the digital world with both educational and recreational gaming. They are motivated by progress toward quests, finding hidden objects, or besting adversaries in virtual combat[10]. Education has found this type of learning valuable and its use in modern education is increasing.[11] Competition, either with oneself or others, is an important motivator in the achievement of goals and objectives and game-like formats are an excellent way to foster this.[12]

Results

Of the 18 students who enrolled in the research elective, all were able to complete the didactic term and complete all assignments. While several students had absences during the course, students remained engaged in the course and demonstrated achievement of both research and virtual reality learning objectives. The initial class periods were marked with significant technical issues related to user experience and equipment which was disruptive to both DL and in-resident students. Once these issues were mitigated, there seemed to be little difference between the in-resident and DL experience. In-resident students who took advantage of the

opportunity to bring equipment home and participate in DL echoed this thought in class discussions. When entering the VR space, DL students actually seemed to have a slight advantage over in-class students who had to operate in a small space with other users and deal with their microphone feedback. Until users were able to mute microphones and turn down input gains, work in the virtual space was virtually impossible with in-class participants. With most of the technical issues resolved, the virtual reality space equalized the experience of all participants, whether in-class or at home. It was such an engaging space that participants often lost track of time and instructors or moderators had to maintain a connection with the physical world to signal when the next transition was to take place.

The multi-user virtual space offered by the educational application, "Engage" was cited by most students as the application most conducive to collaboration. This was also one of the first applications introduced and used heavily throughout the course. Several other applications were evaluated but the ease of use and reliability of Engage led most groups to use it after class to collaborate with their DL/in-residence mixed groups. The ability to introduce multi-media content from the internet or computer drive into a virtual meeting made Engage valuable in the production and presentation of several group and individual projects throughout the term. Students could view and provide feedback on collaborative content all in the same space that was free from other distractions making the meetings highly productive.

By using videoconferencing, VR, and the face-to-face TDY lessons, students had the unique opportunity to evaluate what impact VR had on their educational experience. During class sessions, in-resident students had the advantage of the instructor cadre within arms reach of them which was helpful when clarifications and assistance were needed. The DL students had to access instructors through the videoconference moderator which led to some occasional delays. The only time this was problematic was when DL students required troubleshooting to access a

new VR application which was very difficult over videoconference chat. Several researchers have noted that DL students who are isolated from the instructor can feel subservient to in-resident students which can affect their engagement.[13] Berndt and Gilbert-Hunt (2017) interestingly found that in-resident students in blended courses may also feel their ability to communicate hampered by the concern that they will be talking over a distance learning student.[14] Instructors were successful at mitigating this by diligently asking for feedback from DL students and monitoring the chat logs during transitions to and from the VR space. Instructors also regularly emailed and texted students with updates, announcements, and to check the progress of both online and in-resident students. The cadre also had an open-door policy for students to contact them with questions or issues. With these mitigation strategies, both DL and in-resident students had essentially the same resources available to them in pursuit of their learning objectives.

As stated before, the VR space was the great equalizer in class participation. Every participant was essentially a distance learner once the HMDs were donned. Initially, when students were assigned to small groups and broken-out into separate VR rooms, many students forgot who the DL students were in their group. Students and instructors routinely commented in group discussions that they favored the VR space due to its ability to filter out distractions and facilitate natural conversations. In a blended class, it can be difficult for DL students to gain the attention of the instructor or make spontaneous comments. This changes in the VR space where the DL student can raise their hand or behave like any other resident student in class. Microphones in VR can be quite sensitive which required some students to use the mute function when they were not speaking. The controls to mute/unmute were not always simple in every application which created some delays in communication. These delays were an annoyance but did not appear to negatively affect the overall learning experience. These delays should be easily

mitigated with the previously mentioned voice-enabled microphone or PTT upgrades. Without the distractions and handicaps students experienced in the videoconference portion of the class, participants were more engaged and interactive in course activities. This was especially true for the DL students as a higher degree of participation in discussions was noted in VR, likely due to the ease of communication in this space. This engagement and participation aided in the achievement of the learning objectives.

The instructors also stated they preferred operating in VR. This was the first time most students had used VR and HMD's in particular. To allow the participants' vestibular and ocular systems to adapt to the unique imagery VR delivers, an adjustment period was needed. As students gained their "VR legs", or tolerance to VR imagery, time in VR increased. Toward the end of the term, nearly all instruction was done in VR. In VR instructors were able to move from room to room to assess student performance. Although this can be done in real life, the advantage of the VR space is that there is no noise or distraction when the instructor enters the space. An avatar just appears and the instructor can move to a position that allows them to gain the best perspective with minimal distraction. From their unique vantage point, the instructors could see how far students had come in the course and what learning objectives had been met. Instructor affinity for VR extended beyond instruction and evaluation of learning. Colonel Tony Millican, one of the lead instructors, frequently held impromptu office hours or additional learning opportunities in VR at the conclusion of the class session. While this could have been done utilizing videoconferencing for DL students, using VR provided a more focused environment mimicking an instructor's office and eliminated the need for a moderator and camera operator.

Outcomes

Both students and instructors routinely commented on how beneficial their experience in VR was to their learning throughout the course. Setting up a password protected VR meeting space and presenting a 360-degree video initially took the students multiple attempts, instructor assistance, and significant time. This gradually decreased over the course and was seamless and effortless in the end. The foundation in VR skills that the students developed allowed them to access and participate in more elaborate and complex VR experiences throughout the term. The culmination of these learned skills was demonstrated in the 360-degree video project and meeting with VR industry executives in the VR space at the ITSEC conference. Utilizing their newly acquired skills and knowledge, several groups produced amazing 360-degree video presentations. These presentations could easily be made into professional applications with little to no additional effort. Viewing presentations in VR allowed all participants to choose where they wanted to look or focus their attention. By utilizing the Engage software, the users' avatars turn transparent while viewing multi-media content which means there is never any obstructions in the viewer's way. At the end of the course, both students and instructors remarked at how far their VR skills had progressed and the quality of the presentations that were produced. The consensus from DL students was that they preferred operating in the VR space in the blended learning environment due to the equalization of experience.

Judging by interactions between students, instructors, and each other, communication was more enjoyable and easier in the VR space. There was a definite increase in interaction in VR from many students when compared to the videoconference format. This was especially true of the DL students who had a harder time making natural comments in the video conference portion of the course. Depending on the voice tone or location in the class, DL students often had a difficult time hearing student questions or comments over the videoconference. This difficulty

was eliminated with VR and students had the added benefit of visualizing the student and observing their body language which felt more natural. Students were also able to assist each other with VR navigation, settings, and introducing new features or applications while meeting in the VR space. This student interaction was even more effective with the ability to access multi-media content and applications. More interaction likely occurred due to the lack of barriers associated with the VR space. Each student was able to move their position in the room with the click of a button which is obviously not possible in the real world. All students, regardless of physical location, were able to gain the attention of the instructor by voice and visual cues. Students could position themselves closer to the instructor or raise their hands in addition to speaking which mimicked real life behavior. Shy or less confident students had the "protection" of the avatar to make interaction, particularly with instructors, less intimidating. Increasing participation of all students is helpful to instructors as it offers a glimpse at the progress of the class and their readiness to move along in the lesson. Interaction with both instructors and students in DL courses has been found to increase engagement, satisfaction, and completion which all positively influenced learner achievement.[15-16]

In the final course meeting, students and instructors discussed their experiences throughout the course. Participants felt that VR enhanced their satisfaction with both the course content and their ability to achieve the learning objectives. Freedom from outside distractions and technical issues related to videoconferencing made work in VR was more efficient and enjoyable according to one of the small course groups. Being able to meet in a mountainside cabin, metropolitan loft, or the surface of Mars kept many students entertained which increased engagement and satisfaction. Achieving the VR learning objectives allowed students to apply their skills to other VR applications. Each week, students commented on other VR experiences or applications they had outside of class. Several students and instructors even held social events

in VR outside of class. The ability to customize the VR space and become fully immersed in it allowed participants to achieve the learning objectives in a uniquely enjoyable way.

Notes

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[3] Jeffrey R. Young, "Virtual Reality on a Desktop Hailed as New Tool in Distance Education," *The Chronicle of Higher Education*, 47, (October 2000): 6.

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[9] Bailenson, *Experience on Demand*, Chap. 7.

[10] Robert J. Stone, and Frank P. Hannigan. "Applications of Virtual Environments," in *Handbook of Virtual Environments: Design, Implementation, and Applications*, ed. Kelly S. Hale & Kay M. Stanney, Second ed. (Boca Raton, FL: CRC Press, Taylor & Francis Group, 2015), 892.

[11] Papanastasiou, "Virtual and Augmented Reality", 7.

[12] Christo Dichev, and Darina Dicheva, "Gamifying Education: What Is Known, What Is Believed and What Remains Uncertain: A Critical Review." *International Journal of Educational Technology in Higher Education* 14, no. 1 (2017): 2. doi:10.1186/s41239-017-0042-5.

[13] Angela Berndt, Carolyn M. Murray, Kate Kennedy, Mandy J. Stanley, and Susan Gilbert-Hunt, "Effectiveness of Distance Learning Strategies for Continuing Professional Development (CPD) for Rural Allied Health Practitioners: A Systematic Review," *BMC Medical Education* 17, no. 1 (April 2017): 9. doi:10.1186/s12909-017-0949-5.

[14] Ibid.

[15] Bernard, "A Meta-Analysis", 1264-1267.

[16] T. J. Centner, "Structuring a Distance Education Program to Attain Student Engagement." *NACTA Journal* 58, no. 3 (2014): 233.

Chapter 4

"Immersive VR can offer great advantages for learning: it allows a direct feeling of objects and events that are physically out of our reach, it supports training in a safe environment avoiding potential real dangers and, thanks to the game approach, it increases the learner's involvement and motivation while widening the range of learning styles supported."

--Laura Freina & Micheala Ott. *A Literature Review on Immersive VR in Education,* (2015).

Conclusions

The experiences of participants in the case study agree with the current body of evidence that supports the assertion that VR enhances learning. Due to the immersive quality that VR offers, students can benefit from engagement multi-fold: with the content, with other students, and with instructors. The ability to regulate outside distractions and have control over the virtual environment can make lessons more efficient and the instructor better able to gauge the class performance. Students, guest speakers, or even instructors that find public speaking intimidating may have a less stressful experience addressing audiences using VR avatars. The VR avatar allows the user to control their physical appearance which may mitigate issues with negative self-image that can decrease the speaker's confidence. Bringing stunning multi-media content into lessons can make them more memorable and useful, increasing the likelihood the information will be recalled in the operational environment. Students who struggle with a key skill or concepts in training could be able to gain the practice they need to gain proficiency and confidence in the task. Some of these students may have even been individuals who would have been removed from training as resources were unavailable to coach them through difficult concepts or skills. The improved experience of VR simulations will likely increase the quality of

training for fields involving costly, rare, dangerous, or experimental resources or environments. Virtual reality can also invigorate the mundane but essential occupational, readiness, and professional military education courses. Students would appreciate the novelty of the new environments along with the gamified content that makes completing the computer-based-training (CBT) courses more enjoyable. Key points of emphasis can also be reinforced with visual and tactile tasks built into the CBT making them more memorable. With some research demonstrating stronger retention of information, the frequency of CBT assignments could likely be decreased which could save both time and money for the DOD.[1] The ability to induce emotion and empathy that VR possesses could be game-changers in our battle against sexual misconduct and suicide. Helping learners gain a personal connection to these issues can help destigmatize them and increase their awareness of warning signs.

The positive effect VR has on learning is amplified with DL students. Virtual reality gives the DL student a seat in the class with the same rights and privileges as their in-resident counterparts. They no longer have to hope a moderator shifts the camera to the visual presentation, wait for the instructor to notice their question in chat, or strain to hear what a classmate away from the microphone is saying. Distance learning students can now carry on conversations with classmates regardless of physical location. This personal connection pays big dividends when group collaborative exercises or assignments are tasked. Gaining the perspectives and experiences of peers and instructors is also an important part of professional military education. Participating in natural conversations in the VR space with group members of different services, backgrounds, and occupations provides this valuable relationship building. Increasing the use of VR in DOD education will increase the number of offerings available to DL students. The number of students allowed in a course can also increase as instructors can be utilized from any location. Very little physical space is required allowing class enrollment to be

essentially limitless. Perhaps the biggest benefit VR offers the DL student is its immersion. With an HMD in place, it is difficult to be aware of anything other than what is in the VR simulation. Minimizing distractions allows the DL student to concentrate which will make learning more efficient and effective. Removing the DL student from their home environment and into one more conducive to learning helps the student engage with the content as well. Based on the positive experience of the Research Elective course and the available research, DL courses should fully incorporate VR-based learning where appropriate.

Recommendations

Most educators believe VR should not be a replacement for face-to-face or hands-on instruction in all areas.[2] Nearly all researchers agree however, that there are many areas where VR has a clear advantage over traditional methods.[3] The DOD utilizes distance learning for a majority of its recurrent training. These CBT modules are not well received by many participants who simply click through the slides and go straight to the test. Although unethical, a simple search on the internet can provide most if not all of the test answers to many of these CBTs. Virtual reality can increase the effectiveness of these courses at imparting the knowledge users really need to take away in an engaging way that is likely to increase course compliance and information retention.

The capability of VR to induce emotions like empathy through its immersive quality can also improve the quality training of important topics. Sexual harassment and resilience are two areas the DOD recognizes are problematic and desperately trying to improve. Virtual reality has the potential to revolutionize the way we deliver sexual harassment education. The same first-person experience that made the documentary, “Clouds Over Sidra” so effective could be used to put learners in the shoes of a victim of sexual assault. These learners could learn from survivors of assault and identify ways they could protect themselves or others from this devastating

experience. Another advantage to using VR is that it can be customized to role and offered modularly. All learners for example, may be required to participate in the sexual harassment training as victim or bystander but then the learner can access the follow-on role they play. A commander module could be used for commanders to gain the training they need to be more effective at handling the issue. Health care worker modules would handle the medical aspects of sexual assault. Similarly, learning from individuals who have struggled with suicide themselves or had a close friend or family member who have could be equally beneficial. Being able to connect and be engaged in the content has been proven to increase the ability to learn it.[4] For many, the concepts of sexual misconduct and suicide are difficult to grasp due to their lack of exposure to it. Using VR to expose learners in an educational and supportive way that induces empathy may be the way we see real reductions in these devastating incidents.

As the immersive quality of VR has the potential to invoke strong emotions, special consideration will need to be made with any programs involving sensitive subjects such as suicide, PTSD, or physical and sexual violence. Victims could run the risk of being retraumatized by realistic reenactments of previously experienced trauma. The company Vantage Point, who has created an application geared toward using VR in organizational prevention of sexual harassment and violence recognizes this. Their objective is to deliver a "survivor-centric" and "survivor-focused" experience in a safe way.[5] Their training application allows users who find they are being triggered by upsetting imagery to move past these parts of the training without having to exit VR and drawing attention to themselves.[6] While triggering victims of trauma is a valid risk, safeguards like the ones designed by Vantage Point should be sufficient to allow this powerful and invaluable training to be safely delivered to the masses.

While VR can simulate hands-on or face-to-face performance, it should not be a wholesale replacement for these. Public speaking for example, could easily be simulated in the VR

environment. The application "Virtual Speech" allows users to practice their public speaking in front of a variety of virtual audiences. Tracking software imbedded in the program can utilize sensors on the user's HMD that track eye and head movement, amount of hesitation words used, and speaking pace.[7] While this can help prepare someone for public speaking, it may not be able to simulate all of the stress-inducing variables a user may encounter in the often unpredictable environment of real life. People in the virtual audience might not have been talking amongst themselves, snickering, or playing on their phones when the student was giving their speech in VR but they often are in real life. Virtual reality can perform brilliant simulations and induce a wide range of emotions but there is still a comfortable tether with reality that has to be appreciated. The user's mind, no matter how visually or aurally "tricked" they are, will still subconsciously know they are in their living room which will affect the value of the training. For these reasons, pilots will still need to fly training sorties, security police still need to shoot on the range, and nurses still need to insert IVs in training. Practicing in VR beforehand however, will likely make their real-life training more efficient and effective.

Despite any challenges or barriers associated with VR, it is game-changing technology for education and DL in particular. Distance learners have yearned for elements of the in-class experience since its inception. Not having the camaraderie and support of other students makes the DL student feel alone and more apt to quit the course. There is also little replacement for unfettered access to the instructor, particularly when you are struggling to understand a concept or directions. Virtual reality, unlike other forms of distance learning, provides a realistic and natural form of interaction that can enhance learning as it does in the traditional classroom. The virtual "face-to-face conversations" not only make communication more efficient but they often spurn more robust discussion. There is no waiting for another user to type a response as is the

case with discussion boards and no delays when questions have to be repeated for others to hear as is encountered in the webinar format.

The force is littered with students who have started self-paced DL courses only to drop out due to lack of motivation, interest, or frustrations with not being able to grasp concepts independently. Distance learners have also learned to hate the many distractions that bombard them as soon as they start to study. Limitations in the courses offered in DL format have also adversely affected the distance learner. Virtual reality's ability to connect the learner with the content, other students, and the instructor in a uniquely entertaining way has the potential to change this. Being provided the same in-class experience at home without distraction may be the way to provide game-changing results.

Notes

[1] George Papanastasiou, Drigas, Athanasios, Skianis, Charalabos, Lytras, Miltiadis, and Papanastasiou, Effrosyni, "Virtual and Augmented Reality Effects on K-12, Higher and Tertiary Education Students' Twenty-first Century Skills." *Virtual Reality*, 2018: 5.

[2] Rohan Jowallah, Luke Bennett, and Kathleen Bastedo, "Leveraging the Affordances of Virtual Reality Systems within K–12 Education: Responding to Future Innovations." *Distance Learning* 15, no. 2 (2018): 25.

[3] Laura Freina and Micheala Ott, *A Literature Review on Immersive Virtual Reality in Education: State Of The Art and Perspectives*. CNR, Institute for Educational Technology. Genova, IT.

[4] Allen Munro, Jim Patrey, Elizabeth Sheldon Biddle, and Meredith Carroll. "Applications of Virtual Environments," in *Handbook of Virtual Environments: Design, Implementation, and Applications*, ed. Kelly S. Hale & Kay M. Stanney, Second ed. (Boca Raton, FL: CRC Press, Taylor & Francis Group, 2015): Chap. 16.

[5] Allison Hollender, "This Company Is Fighting Sexual Harassment with VR." VRScout. November 09, 2017. Accessed April 07, 2019. https://vrscout.com/news/vr-stop-sexual-harassment/#.

[6] Ibid.

[7] Elliot Hu-Au, "Virtual Reality for Education Posts." Virtual Reality for Education. March 14, 2019. Accessed April 07, 2019. http://virtualrealityforeducation.com/vr-tools-for-public-speaking/.

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