The Benefits of Using VR to Help with the Limitations of Online Learning and its Effects on Student Learning in Higher Education

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1 PROJECT IDEA

With the current usages of Virtual Reality (VR), in what ways can VR affect student learning in higher education in addition to providing a beneficial tool to help with the limitations of online learning?

ABSTRACT

The purpose of this research paper is to present how the unique properties found in VR can improve student learning in higher education and be used as a beneficial tool to help with the limitations of online learning. Virtual Reality can be used for classes that are not suitable for online classes as well as better preparing students for future jobs. The interactive and immersive properties found in VR helps to increase communication, collaboration, and engagement in class. This paper provides a critical analysis of current research studies of VR being used by students in higher education. The effects of virtual reality on students' learning examined include understanding, remembering, motivation, attention, constructivist learning, creative thinking, and decision making. The result indicates improvement in students' overall learning performance. Though there is no significant difference found in the students' understanding, VR is found to be more effective on students' remembering, motivation, attention, constructivist learning, creative thinking, and decision-making compared to traditional methods of teaching such as video, audio, and text.

KEYWORDS

Virtual Reality, VR, students, higher education, learning, COVID-19, online learning, student learning

2 BACKGROUND

2.1 Online learning and face-to-face learning

2.1.1 Shift from face-to-face learning to online learning

The COVID-19 pandemic has caused significant disturbances in our daily life, most notable is the closing of schools. Schools closing for an extended period can result in a loss of learning as it shifts to online learning. To reduce the pandemic's effects, schools will not only need to remodel and reimagine how teaching and learning have been done in the past but also, schools will have to adopt a suitable method of providing quality education through a balanced combination of schooling at home.

Zoom, Google Hangouts, Discord or Skype meet-ups, Google classrooms, Learning Management System (LMS), Information and Communication Technology (ICT), YouTube, are some of the most common teaching and learning tools used for online learning. Several institutions offered online faculty development services to help the faculty during the crisis. Higher education believes that there is no difference between online and face-to-face classes since they can exchange PowerPoint presentations. However, in face-to-face classes, when students attend classes physically in person, there are opportunities to use the board and marker to demonstrate an example in class and follow along with the diagrams in real-time. To adapt to the shift to online learning, the faculty have participated in online role-playing, community presentations, and guest sessions with industry experts, and CEO talks online [16, 20].

2.1.2 Advantages and challenges found in online learning

One of the advantages of online learning through some online learning platforms is encouraging students to participate more actively in class, particularly those who are less comfortable engaging in face-to-face classes. Some students are hesitant to ask questions in face-to-face classes, but they are more willing to participate in online classes and discussion forums. Shi et al. [20] recorded the total number of questions that students have asked related to the course. Results show that during between 1 to 10 weeks, 35 questions were asked in face-to-face classes, and 106 questions were asked in online classes. Between 11 to 15 weeks, 97 questions were asked in face-to-face classes, and 368 questions were asked in online classes. There is a substantial difference in the number of questions asked in traditional face-to-face classes and online classes, implying that using the online learning platform aided student engagement and overall course contact between and among students and teachers [20].

Also, a survey answered by students shows that students were generally happier with the e-learning platform. It is due to the high expectations found in the platform's features, such as automatic homework checking, more online testing, a more user-friendly learning environment, and quick feedback [20]. However, there were some features of online learning that students found that were not satisfactory, such as less contact and guidance from teachers in the classroom, the lack of a variety of

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teaching aids to suit the learning objectives for the course, and the lack of an active learning environment [20].

Since most universities have classes centered on theory, they are not affected by the change in an environment of not attending classrooms physically in person. Therefore, some universities, which have the most representative online teaching system, have been conducting classes by changing all subjects online without any issues of the postponement of opening face-to-face classes [16, 20]. On the other hand, the situation is not easy for universities and colleges that specialize in two to three-year specialized schools. These schools focus on practical teachings and field trips, with such found in engineering, nursing, first aid, and beauty departments, which require machine operation. Except for specialized universities and colleges such as broadcasting and telecommunications universities and some universities that receive generous state funding, it is not practical for general universities to establish and operate an online class system with the school's pure budget [16, 20]. Thus, we introduce the use of Virtual Reality for online learning, which has been previously used in higher education.

2.2 Virtual Reality for online learning

2.2.1 Definition of Virtual Reality

Virtual Reality (VR) allows the user to see and interact with virtual worlds and objects. Modern virtual reality is provided via a headset that enables the user to see and hear in the three-dimensional (3D) world [19]. As the virtual world replaces the real environment around them, the user is fully submerged in it [3].

VR consists of internal (wearables and embedded devices) and external (unintegrated in the human body) electronic devices which are classified according to their degree of embodiment or interaction with the senses (stationary and portable external devices). Higher levels of technical embodiment produce more immersive interactions by creating a sense of closeness between the device and the senses. Education departments must think about how much technical embodiment can be integrated into their students' experiences [7].

Virtual reality (VR) has a range of features that could be beneficial to education: it portrays worlds in 3D, it is immersive, and it can provide audio, visual, and even haptic feedback. Teaching subjects where it is necessary to visualize the learning materials may benefit from presenting learning materials in 3D (e.g., in chemistry or engineering) [7].

2.2.2 Applications of VR

People's perceptions of the physical and virtual worlds are changed as a result of recent technological advancements. VR is expected to play a significant role in a variety of sectors, including retail, travel, education, healthcare, entertainment, and science [20].

Second Life (SL), one of the most well-known online virtual worlds, is an example of a three-dimensional immersive virtual experience that allows for extensive social networking and knowledge interaction. The SL virtual world is accessed through the SL viewer, a free client application. Individuals join Second Life as avatars, which can take on whatever shape the user desires. Residents of SL can explore environments, meet, and socialize with other residents (via voice and text chat), engage in individual and community activities, and learn from built experiences in the Second Life virtual world. A three-dimensional modeling tool based on basic geometric shapes is included in the app, allowing anyone to create virtual objects. These objects can be used to add functionality when combined with a scripting language [22].

There are several advantages of online learning which can be enhanced with the use of VR technology. At the moment, online learning serves convenience to students and teachers, with the ability to log in from any computing machine connected to the Internet 24 hours a day, 7 days a week, accommodating busy schedules and saving time when commuting. Also, enhanced learning is provided with many opportunities for students to apply and practice their skills. As online learning becomes more prominent, teachers find innovative ways of providing information, which can enhance diversity and creativity. Improved administration is needed to review student work more closely to handle the grading online [2].

Since students are not required to be physically present in a classroom, universities may attract a much larger audience. This also allows students to communicate with professors and other students from around the globe. Universities can consider launching programs for various segments of the population that can be conducted at various times [2]. According to Liu et al. [12], the application of VR technology can create realistic learning situations, deepen students' understanding of theoretical knowledge, improve operational skills,

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and help improve the quality of school education. VR enables students to focus on their tasks and mission in front of them, and to engage in more meaningful and active learning [19]. Also, VR can be used in higher education for self-exploration learning, simulation experiment learning, distance open learning, distance group discussions and distance education platforms [12]. Within the last decade, the use of VR headsets and applications has increased in several domains such as in higher education for students in medicine, engineering, language, and law [2, 8, 10, 14, 21, 22].

2.2.3 Unique properties of VR

With VR's ability to engage the human senses, technical embodiment plays a crucial role in producing immersive and interactive experiences. Immersion helps consumers to better focus on what is in front of them and extend their sense of time, potentially improving satisfaction with the experience. Completely interactive VR equipment with a headset for visuals and sound and a controller to interact with objects, for example, provides a sense of embodiment when users see themselves as parts of the virtual world. It is as if the VR devices are part of their own bodies [3, 7, 8, 9].

Users can influence the content through behavioral interactivity. Video Games and virtual worlds/platforms like Second Life is an example of this, where users can freely control the virtual environment and the material. In the virtual environment, it is engaging enough to distract users from their immediate surroundings. Users may create avatars that represent their preferences and expectations in these virtual platforms to build their virtual identities. While certain real-life characteristics are preserved in this phase, others, such as feelings, emotions, or hidden/idealized expectations, seem to be mirrored in their virtual profiles as well [9].

Students in higher education can benefit from the effects and unique properties of VR technology in their studies. As a result, students can overcome the limitations of online learning which often fails to provide the quality of education in face-to-face learning.

3 DISCUSSION OF THE MEDIATION AFFORDED BY THE TECHNOLOGY

3.1 Mediation

There are several limitations to online learning, which impact student learning. VR technology can be used as a beneficial tool to help with student learning. Teachers and students interact with each other, as the learning materials are provided by the teacher through VR. There are also interactions between students and groups as they exchange information. Through research, students in higher education who use VR technology for learning helps with classes not suitable for online learning, helps students to learn and apply skills that would be hard to teach otherwise, better prepares students for future jobs and increases collaboration and engagement in class.

3.1.1 VR for classes not suitable for online learning

With online learning being the current trend, it is hard to have certain classes online. Those classes include labs, training, and other classes that can be improved with active learning.

VR used for education is commonly used in medical fields. Fabris et al. collected studies in bioscience and medical fields that have used VR for higher education. The collection of studies had mixed results in student learning. Specific fields studied include neuroanatomy, cardiac anatomy, simulation of a science lab, embryonic development, maxillofacial surgery, and computer assembly. Positive outcomes from using VR for studying cardiac anatomy are the higher test results found when comparing a pre-quiz and post-quiz answered by the students. When using VR for performing maxillofacial surgery, there was no significant difference in performance, however, there were higher levels of confidence compared to a controlled group who did not use VR [7].

Virtual Reality learning environments used for other fields of studies include humanities. In the VR environment, students learn historical material about Che Guevara and the Cuban Revolution. The final build of this VR environment produced a rich in detail and interactive experience for students. They can walk around, teleport to places if there is no space for them to walk towards, and examine physical objects with quotes provided. This creates learning by doing, hands-on, and active learning experiences for students [11].

Another example of VR being used for higher education is in law studies. Law-established games are used as inspiration to develop a VR game for learning. Students can apply their critical reasoning skills, reading facts and information relevant to a murder case. Students need to be observant as hints are given through text and dialog [14]. The immersive and interactive benefits found in VR

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allow students to practice their observational and attentive skills.

Though it is difficult to come up with a proper design to include the learning outcome goals defined in the course curriculum, the experiments conducted for using VR for student learning have produced a positive difference in their grades and learning experience.

Akbulut et al. [2] conducted a 2-hour lab for a Data Structures course for the software engineering program. It consisted of two groups: one group interacted with a system called "Virtual Reality Enhanced Interactive Teaching Environment" (VR-ENITE) and the other group completed the lab traditionally, reading a textbook. While the two groups are based in a classroom and the lab is not conducted online, it still shows differences in grades and feedback between the two groups. Results show that the group using VR scored slightly better with an average of 72, compared to the other group with an average of 60. The student's feedback is generally positive as they found that the use of VR makes it very engaging, interesting, and motivating as they manipulated objects to understand sorting algorithms [2].

The online learning experience with and without VR technology for students is different. Taking the labs with VR technology and using VR for active learning provides more opportunities for the students to explore their skills.

3.1.2 Better preparation for future jobs

Having confidence helps to better prepare oneself for future jobs. To gain confidence, students can practice their skills using VR technology.

VR is commonly used in the medical field for training in which it has specific benefits. This includes resources saved when training, operation on virtual patients, of which students will not worry about casualties and failures, and immediate responses to their actions [9, 10, 11]. With these benefits, it increases the student's confidence in their training. The use of virtual objects in labs found in VR improves student learning, which cannot be obtained through online learning [17].

In the research by Harrington et al. [10], they examined the practical use of VR in the medical field. Though participants are well above higher education and have experience in different specialty areas, they compare the use of VR of groups of participants who have little experience in the medical field (candidates) and those who have

been in the medical field for many years of course-instructors. The simulation consisted of the participant making correct decisions and diagnosis of a patient, including variables such as the number of patient deaths and the amount of time taken. The candidate group found the use of VR useful and both groups find that VR held beneficial immersive qualities in their training. Most of the participants felt that maintaining trauma management skills was important and therefore can practice that skill whenever they do the VR simulator [10].

Second Life is used as an educational environment in the medical field. Weicha et al. [22] piloted a study to potentially use VR for medical education. They took advantage of the virtual world and avatars that Second Life. The virtual world is used in a lab setting to perform insulin therapy for type 2 diabetes on patients. The avatar is used as a companion of the medical student. The students chat with them, asking questions and interacting as one would in a lab [22]. The students are in a simulation performing tasks, to gain confidence and proper practice for insulin therapy. In other medical training which uses VR technology, students can learn with a serious game for surgical skills training, VR dental simulator, etc. [2, 22].

In a different field of studies, Shih and Yang used VR as a beneficial tool to learn a language. In a virtual world, the use of avatars of themselves played a huge factor in their learning. The avatars formed the anonymity of the user which helps students to gain confidence. From the use of VR as avatar masking, results have shown that it helped students feel more confident to share stories in interviews [21].

3.1.3 Increase in communication, collaboration, and engagement in class

The online VR platform, Second Life, allows users all around the world to join. Students use this platform, with the opportunity to meet people from different parts of the world. Furthermore, users can have conversations and private meetings, for entertainment purposes, such as watching movies or playing games together, or for educational purposes, such as training in an operating room. VR holds immersive properties to make the experience feel like it is just like the real world [22]. Using virtual worlds helps to convert information, which is normally communicated through flat, text-based one-dimension interfaces online, into colourful and immersive 3D environments with many potentials in teaching and learning settings [15]. Likewise, there are differences seen between communication in the VR

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environment and the traditional environment where people can verbally communicate and communicate with actions, with each other in the VR world.

The experiment by Shih and Yang [21] combined 3D graphics and live voice communication when using VR. With the use of avatars created by the students, students can communicate and interact with each other. By doing so, it increases their confidence when learning a language, which cannot normally be found when learning a language online [21].

Not only does VR technology increase communication between people, but it also increases collaboration and engagement. VR is an effective tool used for teaching and learning as it allows students to be challenged, and to explore and carry out missions, with full control of the process [17]. Thus, it increases student collaboration and engagement in the learning process. When students are given missions to do on VR, it can be related to doing a group project, where there are missions and checkpoints throughout the group project. During the process of completing a mission, students must talk and work together as they all have the same goal, which is to complete the mission. Since using VR is a novel method of learning in the education field, it introduces a game-like learning experience, as students collaborate and engage with each other and objects to complete missions. This can then also stimulate students' motivation for learning [17].

In the pilot study conducted by Weicha et al. [22], which uses SL, backchat is enabled, allowing users to communicate with fellow doctors. Due to this feature, it made the interaction immersive due to the real, life-like avatars and environment setting. The use of backchat in the study allowed students to adapt to the environment, asking the doctors questions and guidance when feedback is needed [22].

With VR technology, students can have a better learning experience as VR increases communication, collaboration, and engagement that cannot be obtained through online learning. Using VR will promote students' self-confidence. Once they feel comfortable with using VR for earning, they will be more motivated to participate in tasks, which can lead students to be more motivated to learn [6].

3.2 Signs and Symbol Systems

The use of VR technology consists of signs and symbols for which helps with student learning. VR technology consists of wearing a headset to experience virtual reality. Using the headset, they see objects, found both in two-dimensional and three-dimensional written components, and a world on which they have the freedom to roam. These features, in addition to audio and haptic feedback, helps with immersion and interactivity [3]. Depending on the degree of technical embodiment or interaction with senses found in VR devices, it can help to produce more immersive interactions.

The haptic feedback gives an immersive experience. It is useful when students in the medical field use VR for training, as they are getting a real, hands-on experience [6]. The haptic feedback made students believe that it was a real experience of performing an anatomy dissection, rather than a simulation on VR [6].

The interactivity found when using VR promotes more active learning, as the students obtain feedback in real-time [3]. The ability to roam around in an environment and manipulate objects allowed students to explore their skills and learning. In the research conducted by Izard et al., students are studying a 3D anatomy of the skull in virtual reality [8]. With virtual reality, the students can interact with the 3D model and obtain visual details and explanations according to what they are interacting with [8].

3.3 Power and Agency

Academic administrators and professors have the power of deciding whether it is necessary to use VR for educational purposes. Academic administrators decide the budget for the technology being used and the way that the course should be delivered to students. Professors have the power to agree with the technology that is offered to be used, as well as create a curriculum to support the use of VR technology.

In the experiment conducted by Akbulut et al., the VR-ENITE system used for a data structures course implemented a feature to either use VR headsets (Oculus Rift or HTC Vive), or VR glasses made up of cardboard and a smartphone. Its flexibility between headset devices is an advantage to students since using cardboard glasses is cost-effective and accessible. The professors can also customize their experiments, managing the specific sorting algorithm the students can see, while conducting them, which provides a real-time experience for the students [2]. It is also possible for VR to build virtual labs at a lower cost without

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worrying about casualties or equipment damage caused by experimental failures [5, 12].

However, VR technology holds a lot of power and has some drawbacks when students use VR for learning. For VR to be effective as an educational tool, it needs to meet certain criteria. The criterion includes the ability for students to apply their knowledge and skills, interact and manipulate with the environment to be active in their learning, and self-direct in their learning [3, 9]. There are some design implications and negative feedback of using VR, which include dizziness and an uncomfortable experience due to the VR headset, and poor 3D graphics [8]. Some students also have trouble adjusting to the environment, or there is a need for training to use VR technology [22]. Though academic administrators and professors have the power, VR technology holds a lot of power as it benefits the limitations of online learning and has effects on student learning.

4 APPROACH

The approach of the paper is to evaluate the effects of using Virtual Reality for student learning. The effects on student learning analyzed include student understanding and remembering students' attention and motivation, and constructivist learning, creative thinking, and decision making.

4.1 Understanding and Remembering

One of the approaches of using VR on student learning is to see the effects on student understanding and their remembering skills. A study performed by Allocat and Mühlenen [3] was reviewed to see this effect. The study involved 99 participants who were first-year Psychology students at the University of Warwick. The participants were assigned randomly to one of the three learning conditions: textbook, video, and VR. Those who were a part of the VR learning group used the HTC VIVE headset. The research procedure was the same for all groups of different learning. Participants started with answering a set of pretest questions. The learning phase involved learning materials on a plant cell which was provided as text, video, and 3D model, according to the learning conditions. After the learning phase, students took a post-test which covered the same questions as the pretest. The knowledge questionnaire data was split into two categories based on Bloom's taxonomy which represents learning as a hierarchy of learning involving six stages including remembering, understanding, applying, analyzing, evaluating, and creating. [4]. One group of questions was related to the students'

remembering of information and the other was related to the students' understanding of the information. The research was conducted using VR for studying showed a better performance for remembering compared to traditional ways of teaching such as using video and text.

4.2 Motivation and attention

One of the advantages of using VR for student learning is that it shows improvement in student attention and motivation. Articles by Gonzalez et al. [8], Papanastasiou et al. [15], and Lorenzo et al. [13] were analyzed to examine this effect. Gonzalez et al. explain that student motivation is one of the key elements in the teaching-learning process. According to Gonzalez et al., motivation affects student learning and performance in four ways:

1. Increases the energy level and activity level of the individual.
2. Directs the individual towards certain goals.
3. Encourages certain activities to be initiated, which increases the likelihood that a student will start something on their initiative.
4. Affects the learning strategies and cognitive processes a student deploys on a task [8].

Gonzalez et al. [8] conducted a statistical study on first-year students of Medicine at the University of Salamanca, dividing them into two groups. The first group used traditional teaching materials for learning the anatomy of the human skull while the second group used VR glasses to view a 3D model of the human skull. Students learn by motivation which can be obtained with the use of VR. As students learn materials by doing activities and completing missions, their interests increase.

As the hands-on experience obtained using VR increases their interest, their attention also increases. According to Papanastasiou et al. [15], VR increases attention for students with learning disabilities. Some of which include attention deficit hyperactivity disorder (ADHD), autism spectrum disorder (ASD), and Asperger syndrome. Lorenzo et al. [13] conducted an experimental study on students with Asperger syndrome where they interacted with an Immersive Virtual Reality system (IVR) as a support tool for their study. The procedure involved students using IVR to enter a synthetic world and interact and manipulate the existing objects in the virtual world. A Kinect sensor was used to capture the student's movements in the virtual world.

4.3 Constructivist learning, creative thinking, and decision-making

Virtual reality also has a positive effect on students' constructivist learning, creative thinking, and decision-making. Research papers by Chau et al. [5] and Papanastasiou et al. [15] are reviewed for this effect. Constructivist learning is a learning process in which learners build new ideas and concepts based on their current and prior knowledge [1]. For learners to construct new concepts based on their past knowledge, they need to interact with meaningful activities [18]. With the use of Virtual Reality, students can interact with virtual objects and virtual environments, applying their abstract knowledge from a first-person perspective. This enables students to construct new concepts based on their past knowledge. In comparison, in a traditional learning environment, knowledge and information are presented in third-person to students by teachers, with the use of text, audio, video, and graphics [5].

Chau et al. [5] conducted an experimental study on first-year undergraduate Business students to examine how VR can affect students' constructivist learning. The research developed a virtual office room through the virtual world environment, Second Life. In the virtual world, students could interact with virtual objects such as chairs, computers, desks, etc. for their introductory management information system course. There were seven sections of tutorials for the course which were assigned randomly to 105 students. All students in all tutorial sections were first taught about security by the same teacher. After, students were separated into different tutorial sections and were asked to identify some security vulnerabilities in a virtual office. There were 49 students assigned to an experimental group, and 56 students assigned to a control group. The students in the tutorial sections of the experimental group used Second Life, where it showed a 3D virtual world environment of an office. The students in the tutorial sections of the controlled group watched a video of the office. After the tutorial, each group answered the same set of questions. The test score from the questions of the students was used to determine their learning outcome achievements.

Also, the use of VR in education has a positive effect on students' creative thinking and decision-making. According to Papanastasiou et al. [15], VR enables students to transform knowledge rather than just receiving the information. In a 3D virtual learning environment, students create their objects simulating social reactions which result in creativity, spatial orientation, and facing problems that should be solved with making decisions. Second Life has features in which users wear a headset and the contents in the virtual world are created by the users such as avatars, objects, and lands which users can customize and explore. This allows users to achieve a better understanding of abstract concepts by creating them and become more creative by visiting places that would be hard to visit otherwise due to the distance and time constraints.

5 RESULTS

There is a threshold for online classes that are sometimes not suitable for online classes. When using VR to help with the limitations of online learning, it provides accommodations for classes not suitable for online learning, allows students to better prepare for future jobs, and increases communication, collaboration, and engagement. The use of VR for labs and training in the medical field allows students to apply their skills and knowledge to the mission they are doing. Interaction found between students, and between students and teachers becomes more active. With that, the motivation and attention of students increase. The important outcome of the use of VR for online learning is that it positively affects the learning strategies and cognitive processes of students. Through studying experiments of using VR for student learning in higher education, there have been positive results on student learning.

According to the result of the study performed by Allcoat and Muhlenen [3] evaluating the effect of VR on remembering and understanding of the first-year Psychology students, there was a significant improvement of the students' knowledge by 23.2% when comparing the pre-test to the post-test. The outcome for the students' remembering of information shows that there was a significant difference in students learning. Students who used VR for learning scored higher than those who used traditional ways of learning: textbook and video, which were 53.1%, 40.6%, and 43.6% respectively [3]. The analyses of the students' understanding scores show that there were no significant differences between students who used VR for learning and those who used textbooks. However, students who used video for learning scored lower than students who used VR and textbooks. The results for students who used VR, read textbooks, and watched videos were 60.2%, 62.3%, and 50.2% respectively [3].

Based on the feedback and result of the study conducted by Gonzalez et al. [8] examining the motivation and attention of the first-year students,

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it shows that the interactive and innovative VR system increased their motivation when studying. For the study conducted by Lorenzo et al. [13] on students with Asperger syndrome, the result captured from the Kinect sensor indicates a high degree of attention and improvement in the students' behavior.

According to the experimental study conducted by Chau et al. [5] evaluating the effect of VR on constructivist learning on first-year undergraduate business students, the results showed that students who used VR as the learning tool scored higher, with the mean test score of 5.97 than students who used video achieving mean test scores of 2.49 [5]. Therefore, using VR helps learners in gaining knowledge through constructivist learning.

As per Papanastasiou et al. [15], Virtual Reality has a positive effect on student's creative thinking and decision making. With the use of VR, students are able to interact with virtual objects that would be hard or impossible to present and explore in the real world. This allows students to become more creative, cultivating students' innovative ability, and face new problems that can improve their decision-making.

6 CONCLUSION

With the advances in Virtual Reality, research has shown that learning using VR is possible. As VR is currently being used for learning, it provides a livelier, more immersive, and interactive experience in the 3D world. VR headsets, controllers, and motion sensors provide visual and auditory help to establish situations like reality. It also provides written components found in 2D and haptic feedback. Significant differences in grades are shown between groups of students with and without the use of VR for their learning [2, 3, 8]. It shows that students using VR for learning gain higher grades compared to students not using VR for learning and learning in a traditional way. Through research, students showed a better performance in remembering the course materials compared to traditional ways of teaching using text, video, and audio. However, there was not a significant improvement in students' understanding compared to traditional ways of teaching. The research also shows that the use of VR for teaching has a positive effect on students' motivation, attention, constructivist learning, creative thinking, and decision making.

VR has unique immersive and interactive properties, which can provide a rich and vivid environment for students. It allows students to have classes that are not suitable for online learning, completing labs and training that are better suited in person. VR can help medical students to have a better vision of how to do a detailed surgery and study the anatomy of the human body, organs, and plant cells. Also, the use of VR benefits medical students as resources are saved when training, there is less worry about failures and casualties when operating on patients, and there are immediate responses to their actions.

Using VR for classes aside from the medical field, such as engineering, law, and language is shown possible with significant positive results through the research papers gathered. As VR helps with classes not suitable for online learning, students can also better prepare themselves for future jobs. Students feel more confident as they practice and apply their skills and knowledge. There is also an increase in communication, collaboration, and engagement between students when using VR, which can be easily obtained in real life compared to learning traditionally online. Research papers gathered in this critical analysis show that using VR in the learning process will help students in higher education grasp new knowledge more firmly, as it shows a positive difference in grades on the tests. The unique properties of VR are used to design a course to include the learning outcome goals defined in the course curriculum. While VR is used to provide a more vivid environment, it also creates learning by doing, hands-on, and active learning experiences for students.

Due to the pandemic, the plan on writing an empirical study in which VR technology is used for student learning in higher education could not take place. If done, the students would also be surveyed about their experiences of using VR for learning. In the future, it is also important to test to see the effectiveness of using VR as a beneficial tool for students when studying online. The data collected and analyzed from the empirical study will directly show the difference between the traditional learning style and using VR for online learning, all without losing the learning outcomes provided in the curriculum.

Online classes have many benefits compared to face-to-face classes. These benefits include convenience, enhanced learning, innovative teaching, and improved administration. In the case of higher education, physical presence is not always necessary as the information provided by the teacher is found online. Depending on the professor's teaching style, online learning for students has been possible. With the COVID-19 pandemic, students and teachers are forced to shift

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from face-to-face learning to online learning; thus, students are admitted and taught globally. As face-to-face classes shift to online classes during the pandemic, students and teachers must adapt to the changes to be sure that learning outcome goals are obtained. Remodeling and reimagining how information is produced from professors to students are needed to ensure that the quality of education is

balanced when schooling at home. Greatly seen in the pandemic, learners can access high-quality education online from the best institutions and faculty around the globe. With the benefits found in online learning for students, the use of VR can further improve student learning in higher education.
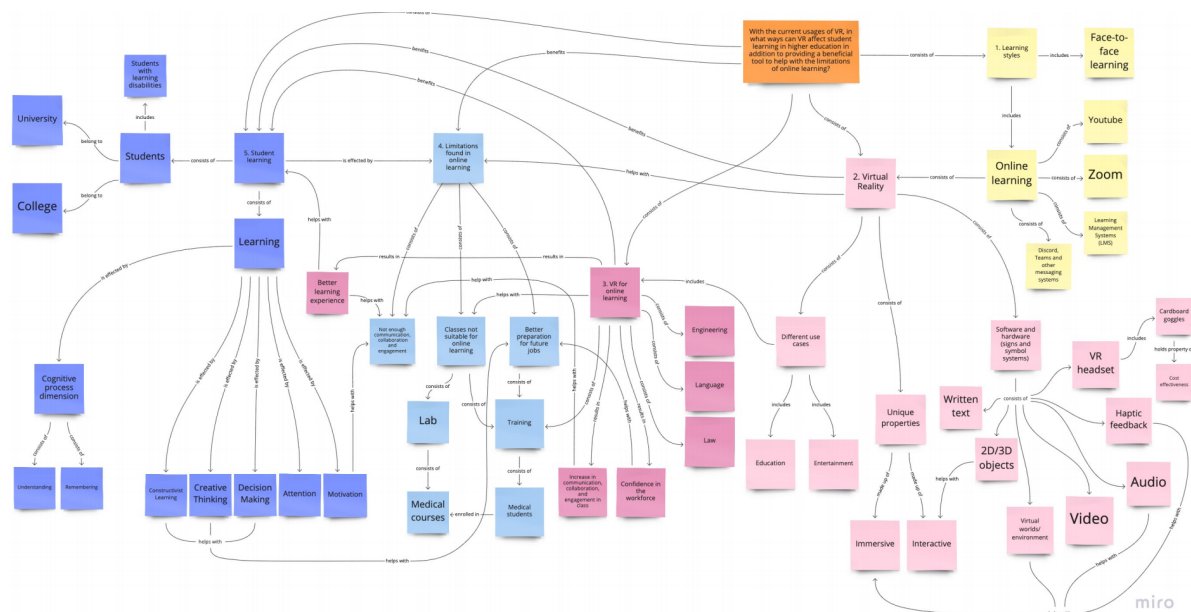
APPENDIX

Figure 1: Concept Map of project idea: With the current usages of Virtual Reality (VR), in what ways can VR affect student learning in higher education in addition to providing a beneficial tool to help with the limitations of online learning?

REFERENCES

[1] Adams, N. B. 2007. Toward a model for knowledge development in virtual environments: strategies for student ownership, *International Journal of Human and Social Sciences* 2 (2007).

[2] Akbulut, A., Catal, C., and Yildiz, B. 2018. On the effectiveness of virtual reality in the education of software engineering. *Computer Applications in Engineering Education* 26, (April 2018). DOI:https://doi.org/10.1002/cae.21935.

[3] Allcoat, D., and von Mühlenen, A. 2018. Learning in virtual reality: Effects on performance, emotion and engagement. Research in Learning Technology. 26, (Nov.

2018). DOI: https://doi.org/10.25304/rlt.v26.2140.

[4] Bloom, B. 1974. *Taxonomy of educational objectives : the classification of educational goals.*

[5] Chau, M., Wong, A., Wang, M., Lai, S., Chan, K., Li, T., Chu, D., Chan, I., and Sung, W. 2013. Using 3D virtual environments to facilitate students in constructivist learning. *Decision Support Systems*, 56 (June 2013), 115–121. DOI: https://doi.org/10.1016/j.dss.2013.05.009

[6] Fabris, C., Rathner, J., Fong, A., and Sevigny, C. 2019. Virtual Reality in Higher Education. *International Journal of Innovation in Science and Mathematics Education.* DOI: http://dx.doi.org/10.30722/IJISME.27.08.006.

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[7] Flavián, C., Ibáñez-Sánchez, S., and Orús, C. The impact of virtual, augmented and mixed reality technologies on the customer experience, *Journal of Business Research*, Volume 100, 2019, Pages 547-560, ISSN 0148-2963, DOI:https://doi.org/10.1016/j.jbusres.2018.10.050.

[8] González Izard, S., Vivo, C., Juanes, J., and Palau, R. 2020. Virtual Reality In Higher Education: An Experience With Medical Students: Research into how Virtual Reality can be used as a powerful training tool for medicine students. 414-421.

[9] Hanson, K. and Shelton, B. 2008. Design and Development of Virtual Reality: Analysis of Challenges Faced by Educators. *ITLS Faculty Publications* 11, (January 2008).

[10] Harrington, C., Kavanagh, D., Quinlan, J., Ryan, D., Dicker, P., O'Keeffe, D., Traynor, O., and Tierney, S. 2017. Development and evaluation of a trauma decision-making simulator in Oculus virtual reality. *The American Journal of Surgery* 215, (February 2017). DOI:https://doi.org/10.1016/j.amjsurg.2017.02.011.

[11] Levy, J., Tanenbaum, K., and Schlieski, T. Experiential Critical Thinking: Prototyping a Humanities Learning Module in VR. DOI: https://doi.org/10.3217/978-3-85125-609-3-36.

[12] Liu, Y., Fan, X., Zhou, X., Liu, M., Wang, J., Liu, T., 2019. Application of Virtual Reality Technology in Distance Higher Education. *In Proceedings of the 2019 4th International Conference on Distance Education and Learning (ICDEL 2019). Association for Computing Machinery*, New York, NY, USA, 35–39. DOI: https://doi.org/10.1145/3338147.3338174.

[13] Lorenzo, G., Pomares, J., and Lledó, A. 2013. Inclusion of immersive virtual learning environments and visual control systems to support the learning of students with Asperger syndrome. Computers and Education, 62 (October 2013), 88–101. DOI: https://doi.org/10.1016/j.compedu.2012.10.028.

[14] Mentzelopoulos, M., Parrish, J., Kathrani, P., and Economou, D.. 2016. REVRLaw: An Immersive Way for Teaching Criminal Law Using Virtual Reality. 73–84. DOI:https://doi.org/10.1007/978-3-319-41769-1_6.

[15] Papanastasiou, G., Drigas, A., Skianis, C. et al., 2018. Virtual and augmented reality effects on K-12, higher and tertiary education students' twenty-first century skills. *Virtual Reality* 23, 425–436 (Dec. 2019). DOI: https://doi.org/10.1007/s10055-018-0363-2.

[16] Rao, V. and Rao, D. 2020. Online learning in education sector revealing the benefits and challenges. *EPRA International Journal of Environmental Economics, Commerce and Educational Management* (2020), 20–23. DOI: http://dx.doi.org/10.36713/epra5218.

[17] Schlemmer, E., Chagas, W., and Lima, C. Games & Gamification In The Pedagogy Degree: An Alternative To Distance Education Models. DOI: https://doi.org/10.3217/978-3-85125-530-0-12.

[18] Schunk, D. H. 1991. *Learning Theories: an Educational Perspective*. Merrill, NewYork.

[19] Shen, C., Ho, J., Kuo, T, and Luong, T. 2017. Behavioral Intention of Using Virtual Reality in Learning. *In Proceedings of the 26th International Conference on World Wide Web Companion (WWW '17 Companion). International World Wide Web Conferences Steering Committee, Republic and Canton of Geneva*, CHE, 129–137. DOI:https://doi.org/10.1145/3041021.3054152.

[20] Shi, X. 2016. A Comparative study of E-learning Platform in Reading and Translating Course for Engineering Students. *Luoyang Institute of Science and Technology, Luoyang*. DOI: http://dx.doi.org/10.3991/ijet.v11i04.5551

[21] Shih, Y. and Yang, M. 2008. A Collaborative Virtual Environment for Situated Language Learning Using VEC3D. Educational Technology & Society, 11(January 2008), 56–68.

[22] Wiecha, J, Heyden, R., Sternthal, E., and Merialdi, M. 2010. Learning in a Virtual World: Experience With Using Second Life for Medical Education. *J Med Internet* Res 12, 1 (January 2010), e1. DOI:https://doi.org/10.2196/jmir.1337.