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Effective Gamification Within Educational Virtual Reality Environments

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By

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Abstract

With the advent and now widespread use of mobile phones and computers in educational settings, exploring effective and new ways of using technology in the classroom is important for educating the next generation of students. Innovative technology, like Virtual Reality, has started being discussed and researched for its potential benefits in educational settings. This paper presents a brief history of VR, game theory, and examines two VR educational games from the University of Nebraska-Lincoln College of Nursing's (UNMC) Senior Design teams. The two games will be used to replace lecture-style classes and to go out and educate the community. We explore how the two teams gamified educational material through different techniques to provide a more enriching learning experience for nurses in training. The VR games have provided UNMC with a more hands-on approach than conventional learning material, but successful educational games can only be achieved through understanding gamification.

Introduction

With every advancement in technology in the past century, educators have found new ways of incorporating it into the classroom. Dating back to the 1920s, radio was used to have on-air classes for any listener within range. Shortly after came the first overhead projector, then headphones, videotapes, and much more, leading us closer to what we see in the modern-day classroom (Purdue University). Inventions like handheld calculators, photocopiers, and the Scantron system seem like necessities now, but are only about 50 years old. The pre-computer years were important for setting a precedent for the wide-spread incorporation of technology in the classroom. So when the first personal computers were introduced in the early 1970s, it was only a matter of time before they were seen in classrooms.

Introducing new technology in the classroom and finding effective ways to use existing technology is important to adapting learning strategies for new generations of students. According to the U.S. Department of Education, only 10% of high-school-aged children were enrolled in high school in 1900, but by 1992, 95% were enrolled. The number of students in college in 1930 was around 1 million, and by 2019, that number had grown to 20 million (Purdue University, Muniz). With an increasing number of children attending high school and moving on to college, there has been more demand for educators and an emphasis on effectively educating the young minds of America. Technology has been one of the main ways we have been able to be more deliberate with and scale our education to provide a positive learning experience to more students. By 2008, the ratio of students in the United States to instructional computers was 3.1 to 1. In 2017, 95% of undergraduate students owned a laptop or smartphone, while 30% owned a laptop, smartphone, and tablet (National Center for Education Statistics, Pomerantz).

There is a constant upward trend of more students gaining access to computers for instructional purposes, which leads educators and researchers to wonder what technology will make its breakthrough in education next. One of the emerging technologies that is starting to be used in educational settings more is virtual reality (VR). Merriam-Webster defines virtual reality as an artificial environment that is experienced through sensory stimuli (such as sights and sounds) provided by a computer and in which one's actions partially determine what happens in the environment. Virtual reality is an environmental experience via a head-mounted display (HMD).

This paper examines how virtual reality is being used to combat current gaps in educational curriculum that other technology has failed to fill. We show how virtual reality is expanding our educational boundary and changing how we approach learning. We provide case

studies of two specific virtual reality educational games sponsored by the University of Nebraska Medical Center's College of Nursing and how we used various gamification techniques to effectively deliver an educational message to the player.

Background

I. Virtual Reality

The first use of virtual reality dates back to Morton Heilig in 1957. His invention called the "Sensorama" became known as the first VR system, although the term "virtual reality" was not coined until 1987 (Poetker). The Sensorama, shown in Figure 1, was a theatre cabinet multimedia device that uses fans for touch, devices that emitted smells, and audio speakers for sound.

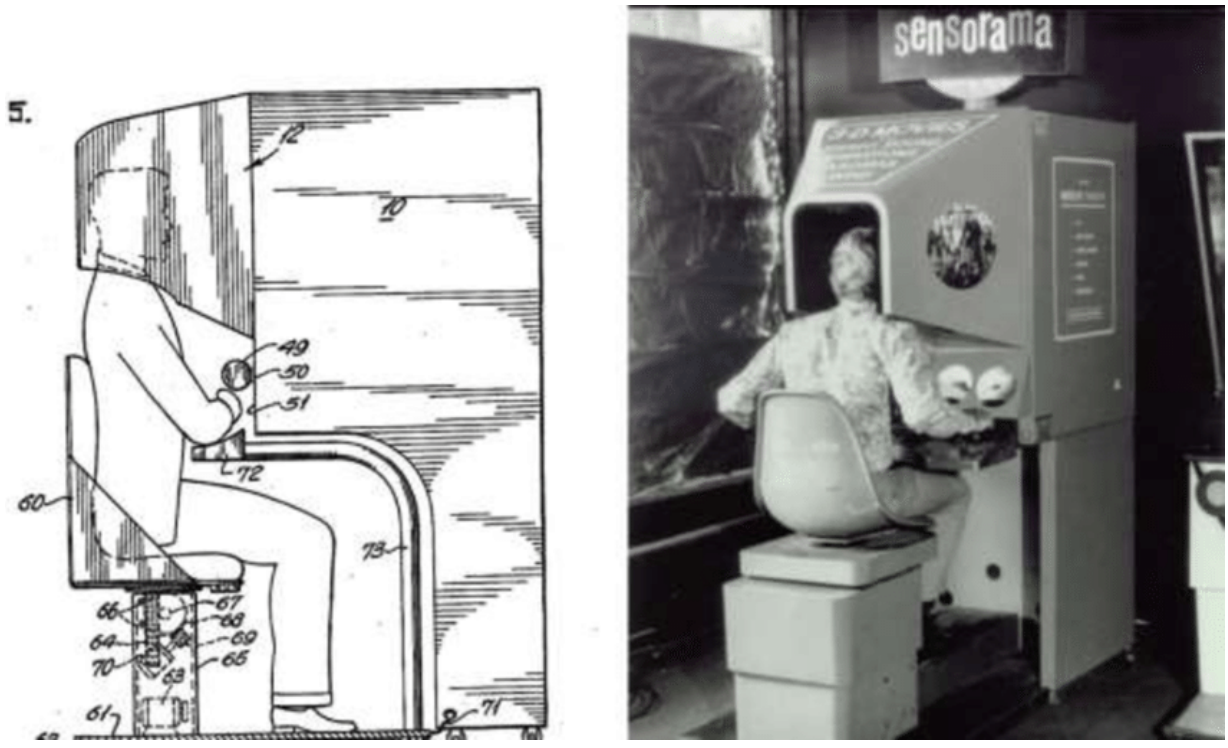

Figure one: The Sensorama was the first known VR machine (Spence).

In 1961, we witnessed the creation of the first head-mounted display (HMD) known as Headsight, shown in Figure 2 (Poetker). Headsight was the first motion-tracking device equipped with an individual video screen for each eye. Headsight allowed the user to look around an environment, a concept that carries on to virtual reality in a modern context. Virtual reality in the 70's and 80's was characterized by massive increases in VR research and breakthroughs in VR hardware, including General Electric's first flight simulator, MIT's Aspen Movie Map, and McDonnell-Douglas Corporation creating VR for military use. In 1982, some of the first wire gloves were created by Sandin and Defanti which "monitored hand movements by using light emitters and photocells in the gloves' fingers" (Barnard). From VR's origins, education was strongly tied to VR use and development. By the 90's, VR started to be brought to the general public in a series of games and arcade machines.

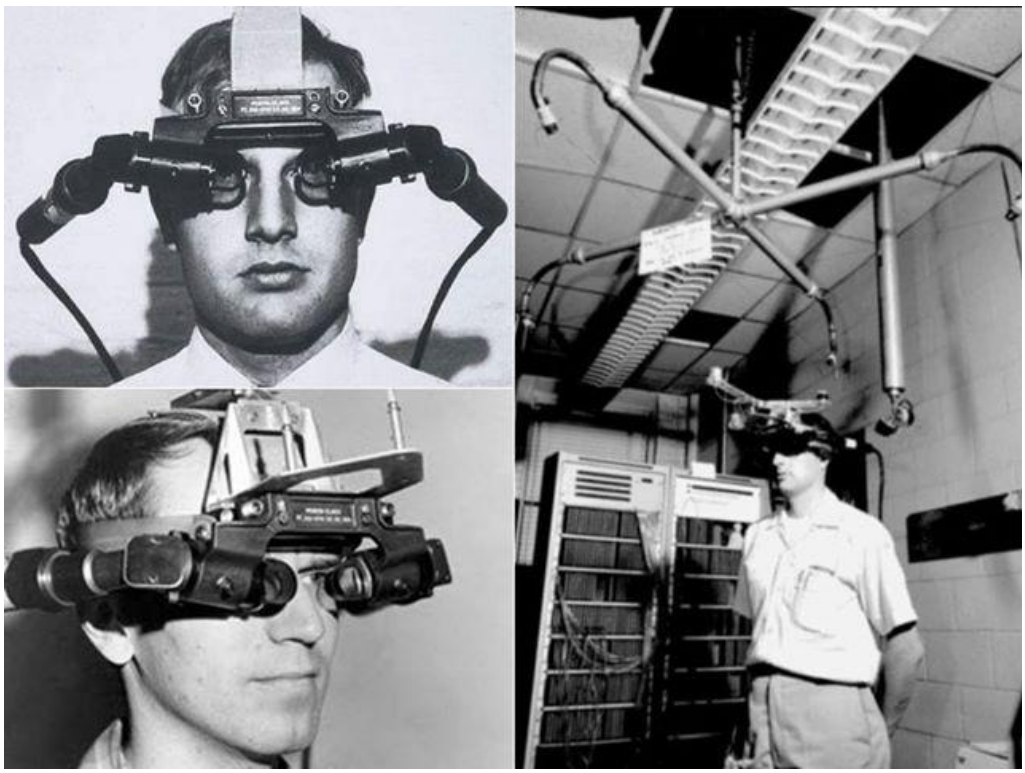

Figure two: Headsight was the first HMD (Immersive).

The first company to sell VR goggles and gloves to consumers was VPL Research in 1985, but it was not till the 2000s when virtual reality was able to reach the public in larger masses (Barnard). In 2014, Google released its Google Cardboard VR (shown in Figure 3), Facebook acquired Oculus VR, and Playstation announced it was working on a VR gaming headset (Watters). A large concern with VR was that it required the user to buy new hardware, often costly hardware. VR has always struggled with accessibility, and Google Cardboard VR provided one of the first solutions where one could use their smartphone. This began as a joke at the Google developer conference, "where a piece of cardboard with optical lenses and an android phone could display VR wirelessly with the Google Cardboard application" (Hussein).

Figure three: The Google Cardboard VR uses one's smartphone to display virtual reality games (Google Cardboard).

While Google Cardboard lacked in terms of head-tracking and caused motion sickness, products like Samsung Gear VR and Oculus Rift used the same concept of a smartphone while not sacrificing motion latency and head tracking.

II. Gamification Theory

Every action within a game comes with real-life physical and neurological responses for the player. Dating all the way back to the 1990s, researchers were finding connections between gaming and the brain. In fact, a study in 1998 found that video games can raise someone's dopamine levels by 100 percent (Koepp). With a strong connection between games and neurological responses, it is important that game scenes and objectives need to be developed with intention. The use of game elements in non-game contexts is known as gamification (Muangsrinoon). What this really is referring to is the necessary components that make a captivating and entertaining game. Successful gamification would entice, challenge, and push the player to continue the game or achieve higher levels.

At the heart of a good game is content that motivates the player. Just like a motivated student is likely to absorb more of the content they are taught, a motivated player is likely to be more engrossed in the game. Inherently, games are motivational because they are usually seen as "fun" or played during peoples' free-time. That is what sets virtual reality games apart from traditional lecture-style education. The student is more likely to view their VR experience as a "game" rather than learning. In the context of learning, gamification is more than just providing a fun gameplay experience, but rather, communicating educational information in a non-traditional format. Motivation itself can be broken down into White Hat motivators and Black Hat motivators, White Hat motivators being positive and Black Hat motivators being negative. We will dive deeper into these different motivators when we examine the two VR games, "but keep in mind that White Hat should predominate in learning...Too much Black Hat may result in game fatigue and frustration and that can lead people to stop playing. In smaller doses it is, however, effective in adding a sense of urgency to engage a learner quickly"

(eLearning Industry Inc.). Furthermore, Zandstra identified the critical elements that most games contain at the basic level: goals, rules and limitations, decision or actions, game mechanics, and feedback system (eLearning Industry Inc).

- Goals: Goals are what are to be achieved by the players to keep them on track, whether that be a destination, solving a mystery or puzzle, or completing a quest.
- Rules and Limitations: Rules should be consistent throughout the game and simple to understand when a user learns the game.
- Decisions or Actions: Players are presented without various choices and must make decisions.
- Game Mechanics: Game mechanics refers to the options the player has to navigate the game environment, such as taking turns, competing against a clock, leaderboards, or player statistics.
- Feedback System: This shows the player how well they are doing in a game compared to the stated objectives.

All five of these elements are critical to include when developing an educational game, otherwise, a player may get frustrated and give up playing or the player does not learn what they were intended to learn from the game. In the case studies, we dive deeper into gamification theory and how each game used gamification elements to convey educational information.

Case Study One: Agricultural Safety

I. Problem Statement

The National Agricultural Tractor Safety Initiative reports that tractors cause about 130 deaths annually, which is 50% of all farmer deaths. Specifically, tractor rollovers make up 44% of farm accidents. The agricultural industry is one of the most injury-prone industries in the

United States. Workers are at risk of a multitude of injuries. And with farming being one of the few industries where family members often help out around the farm, ensuring tractor safety is important to injury prevention (Kanoski Bresney).

Currently, there exists a gap in education about agricultural safety. In 2018, Kilanowski surveyed 315 members of the National Association of Pediatric Nurse Practitioners and reported that while they were interested in continuing their education on agricultural safety, many of them were not knowledgeable about existing agricultural injury resources. Of the nurses, 95% remembered their education included preventative safety guidance, but only 8% of that 95% said agricultural safety was included. Currently, UNMC's College of Nursing includes agricultural safety in their curriculum, but in lecture format. UNMC has the unique position of being located within an agriculture-heavy state, meaning that tractor accidents are not uncommon. While a lecture format is better than nursing programs that do not include agricultural safety at all, it is UNMC's goal to improve the current education using virtual reality to provide a more hands-on experience. They also want the student nurses to be conduits of change and educate farmers and future farmers utilizing virtual reality at schools and agricultural gatherings.

II. Solution

Five students from the University of Nebraska-Lincoln's Computer Science & Engineering Senior Design program were tasked with creating a virtual reality game simulating a tractor rollover for nurses to better educate agricultural workers and enhance agricultural safety curriculum. The game was developed for Oculus Quests using Unity and free-to-use models.

The object of the game is to place the player in an open-world concept farm where they can explore, learn about items on the farm, and drive a tractor. The tractor needs to be realistic in

the sense that it will roll over when the player drives irresponsibly. The game needs to keep track of what the player did while driving; so that when they crash, it tells them what they did wrong.

III. Game and Motivation Theory

Figure four: Bird's eye view of the farm.

As discussed earlier, a game has five fundamentals: a goal, rules, decision points, mechanics, and feedback. Next, we will examine how the Agricultural Safety VR game meets those fundamentals and how learning and game theory act together to create quality educational material for nurses and agricultural workers. The goal was to create a VR environment that simulated driving a tractor throughout a farm, but would flip over if driven incorrectly. The VR game must be realistic enough to be comparable to driving a real tractor, and the environment must be enough like the farm so that we create an immersive learning experience. First, let us discuss what a rough play-through would look like:

1. Participants spawn onto a VR farm. By looking around in the headset, they can see both of their hands and move around via teleportation[1]. Wandering around the open-world farm allows the user to get comfortable with the VR headset, its controls, and the environment in which they will be driving.

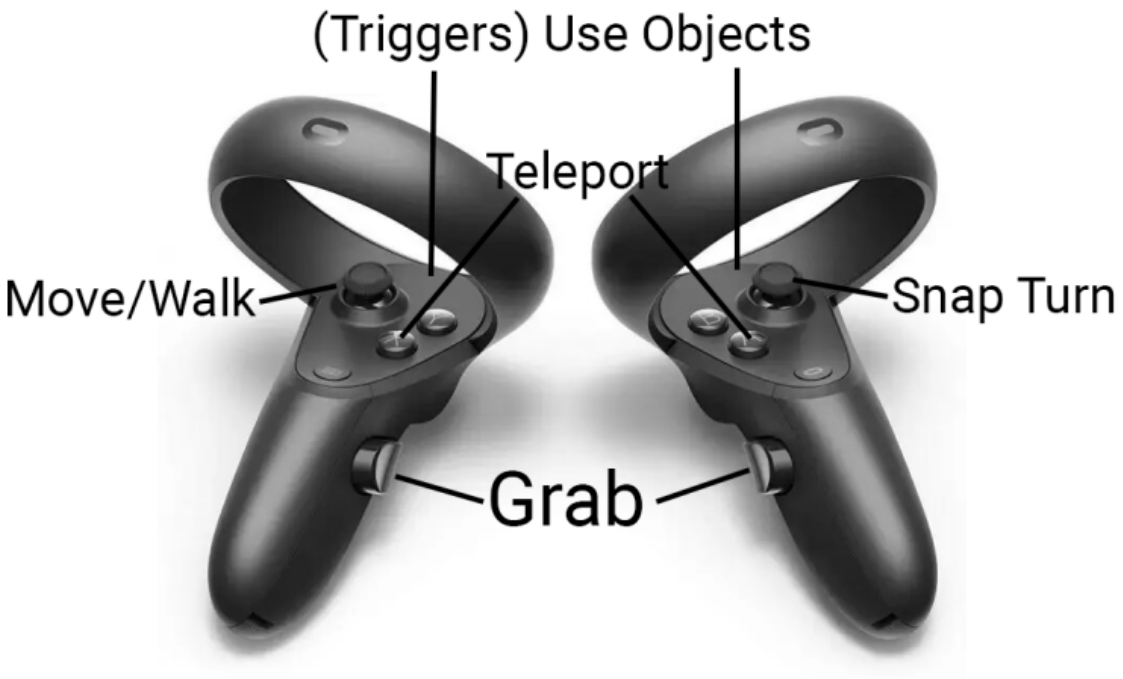

Figure five: Diagram of VR controls on hand controllers

2. The spawn point is located directly in front of the shed containing the tractor. By teleporting to the tractor they will see a gray button labeled “mount.” There is also a “Lift ROPS”[2] button that will reduce the likelihood of injury in the event of a crash, but it is not required to select to mount the tractor (shown in Figure six).

[1] Oftentimes moving around in a virtual reality game is difficult because users need to stay stationary or have limited space to move, so VR games use teleportation to move around the game’s map. This is achieved via different controls on the HMD’s hand controllers.
[2] Tractor ROPS stands for Rollover Protection Structures which are roll bars or roll cages designed for tractors to provide safety in the event of a rollover.

Figure six: ROPS is located on the back of the tractor and the user can flip it up or down. They are also able to click the mount button to mount the tractor.

3. When the user mounts the tractor, they will see controls to the left and right. This includes a shifter that has different gears, reverse, and neutral. On the right are the power controls, which include low, medium, and high options. The controls are changed by grabbing and moving the levers. As the player mounts the tractor, a visual pop-up will appear giving them a task to complete around the farm. The player must complete the five tasks, all while driving safely around the farm.

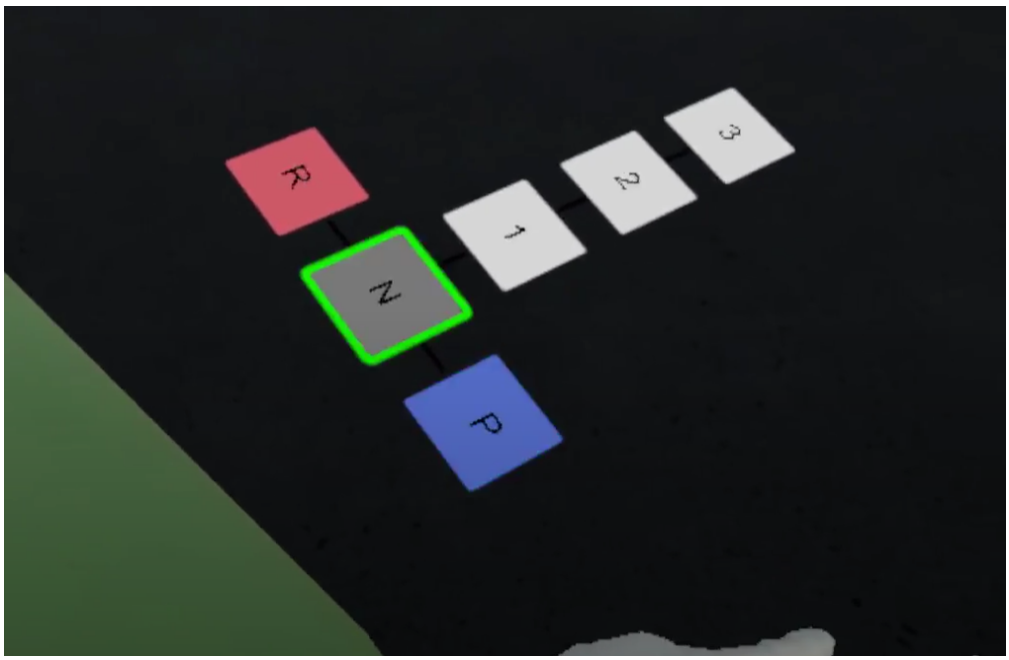

Figure seven: The left side of the tractor has the shifting options including a neutral, park, and reverse.

4. If at any point the tractor crashes or rolls over, the player is shown an end screen that displays why they crashed and how to better prevent a crash in the future.

A. Development and Accomplishment

A "game driver promotes the feeling of pride as the learners overcome successive difficulties and advance through levels, facing challenges, or achieving mastery" (eLearning Industry Inc). The tasks that the player must complete provide a motivating narrative throughout the gameplay. The player is compelled to drive carefully so that they are able to complete all the tasks. The tasks also keep the player focused on the game and, subsequently, their driving.

We chose the following tasks for the user:

- Collect mower from shed

- Mow field with pond
- Drop off mower, get front loader from other shed
- Get hay from barn
- Drop off hay in animal pen
- Return front loader
- Return to barn

By choosing tasks that are commonly performed on farms and may already be familiar to the player, it creates a more realistic and immersive game. The White Hat motivators are the tasks that accomplish things on the farm (i.e. mowing a field, dropping off hay for the animals). The Black Hat motivator, which is key to educating the player, is the chance for rolling the tractor over, motivating them to drive responsibly.

B. Unpredictability and Curiosity

"People are motivated to learn more and do more when something falls outside what is expected or predicted. The distraction or unpredictability in this approach can grab the learner's attention because they do not know what might come next and they want to discover it. It attracts people who thrive on variety, taking chances, or the unknown" (eLearning Industry Inc.). The unpredictability in the Agricultural Safety game comes from the user not being familiar with the layout of the farm. They do not know they are about to drive down a steep hill until they actually see the hill. This helps keep the player on alert while driving, which is what we want them to take away from the game. Another point of unpredictability is the player does not know the next task until they complete their current task. This compels them to continue playing the game and avoid rolling over so that they can find out what the next task is.

C. Loss and Avoidance

"This motivator involves learning by trying to avoid pain. The fear of losing something is powerful as is the desire to escape from undesirable results" (eLearning Industry Inc.). For the Agricultural Safety game, if the player rolls over, their time driving the tractor is over. They are motivated to avoid this loss because if they roll over, they do not get to discover what the remaining tasks are nor do they get to complete them.

The game also shows the player reasons that they rolled over. This feature serves to educate about the common reasons tractors roll over, but also provides a kind of "shame" for the user as they read everything they did wrong. This motivates them to avoid those hazards and drive more responsibly when they play again. Seeing everything they did wrong will help them pay closer attention to areas or actions that cause rollovers.

IV. Conclusion

The Ag Safety game will be used in UNMC's curriculum, but also will be taken around the midwest to conferences to educate agricultural workers and school children. The game uses an open-world concept to encourage exploration and curiosity, while also providing a realistic farm experience. It helps players learn about how to drive a tractor safely with no actual real-life risks. The game is currently still in development, but you can view a demo here: https://www.youtube.com/watch?v=q9H4SiFWYkU

Case Study Two: Sepsis Escape Room

I. Problem Statement

According to the CDC, “each year, at least 1.7 million adults in America develop sepsis,” and “nearly 270,000 Americans die as a result.” Before COVID-19, 1 in 3 patients who died in hospitals died of sepsis. In 2013, sepsis accounted for more than $24 billion in hospital expenses.

“The average length of stay for sepsis patients in U.S. hospitals is approximately 75% greater than for most other conditions” (Paoli). Sepsis is a critical healthcare issue, and better education could potentially save millions of lives and dollars. As stated by the Sepsis Alliance and the Society of Critical Care Medicine, with early recognition, rapid diagnosis, and treatment, 80% of sepsis deaths could be prevented.

Currently, sepsis patients are not being diagnosed early enough and, thus, UNMC’s College of Nursing aims to better educate nurses on how to detect and treat sepsis in a timely manner. Nurses at UNMC and across America are being taught about sepsis via lecture format, but this current format is failing the hundreds of thousands dying from sepsis each year. They wish to put nurses in a more realistic situation where they have to deal with sepsis hands-on virtually before they ever have to deal with it in real life.

II. Solution

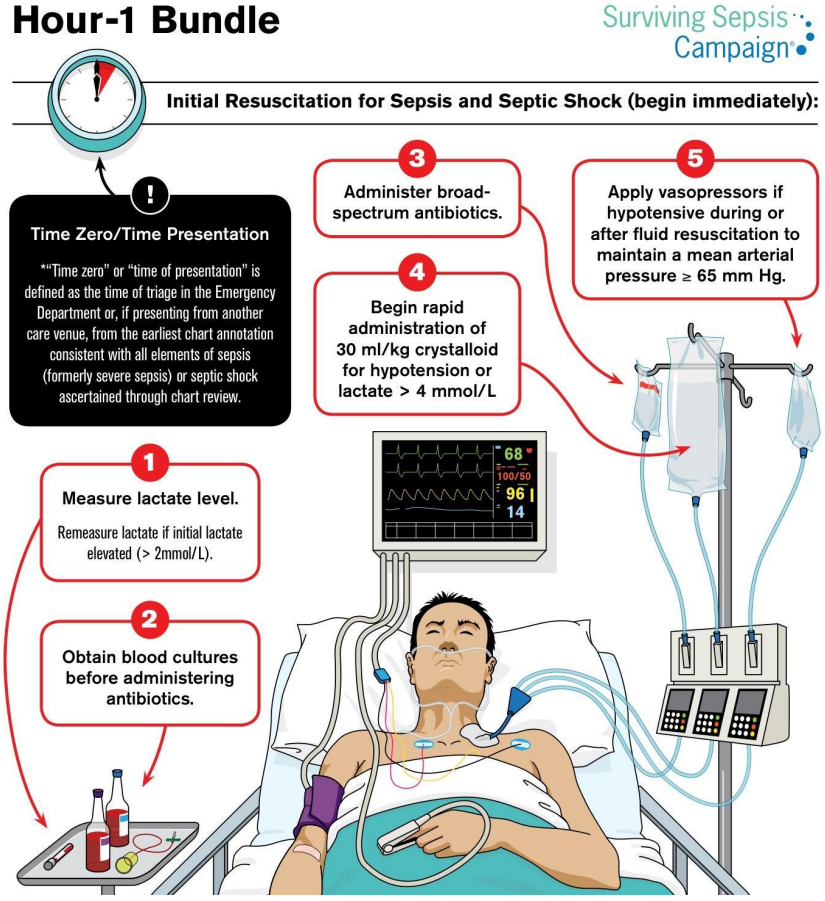

Figure eight: Diagram of sepsis bundle steps (Society of Critical Medicine).

Six students from the University of Nebraska-Lincoln's Computer Science & Engineering Senior Design program were tasked with creating a virtual reality game simulating an escape room for nurses to test their knowledge of Sepsis. To understand the game, there are some basic concepts that the user must be familiar with. A large part of treating sepsis is knowing the "Sepsis Bundle". A different version called the "Sepsis Six" originated in 2006, and was linked to a 50% reduction in mortality, a decreased length of stay in hospital, and fewer intensive care days. The modified sepsis treatment, Sepsis Bundle, came about in 2016, and consists of five

stages instead of six which should all be delivered within one hour of the initial diagnosis of sepsis. The Sepsis Bundle includes the following (Society of Critical Care Medicine):

1. Measure lactate level.
2. Obtain blood cultures before administering antibiotics.
3. Administer broad-spectrum antibiotics.
4. Begin rapid administration of 30 mL/kg crystalloid for hypotension or lactate ≥ 4 mmol/L.
5. Apply vasopressors if hypotensive during or after fluid resuscitation to maintain a mean arterial pressure ≥ 65 mm Hg.

The idea was to place the player in a room where they must first identify that the disease they are dealing with is sepsis, and then must solve five puzzles relating to the five steps of the Sepsis Bundle, respectively. As sepsis is a time-sensitive disease, the game itself is limited to 20 minutes, otherwise, the patient dies. The game was developed for Oculus Quests using Unity, Blender, and free-to-use models. Below is a brief recap of each room's puzzle:

1. In the "Measure Lactate" room, the user finds cards with numbers and words hidden inside the books on the bookshelves. There is a table with a matching system, and the user must match the numbers to the words to unlock the keycard. All the cards are related to a sepsis number/medical term.
2. In the "Obtain Blood Cultures" room, there is a radio playing Morse code and a puzzle. The user has to put together the puzzle to decipher the Morse code playing on the radio.
3. In the "Administer Antibiotics" room, there is a large poster that shows different antibiotic "recipes." The user must know the antibiotics related to treating sepsis and make them before moving on to the next room.

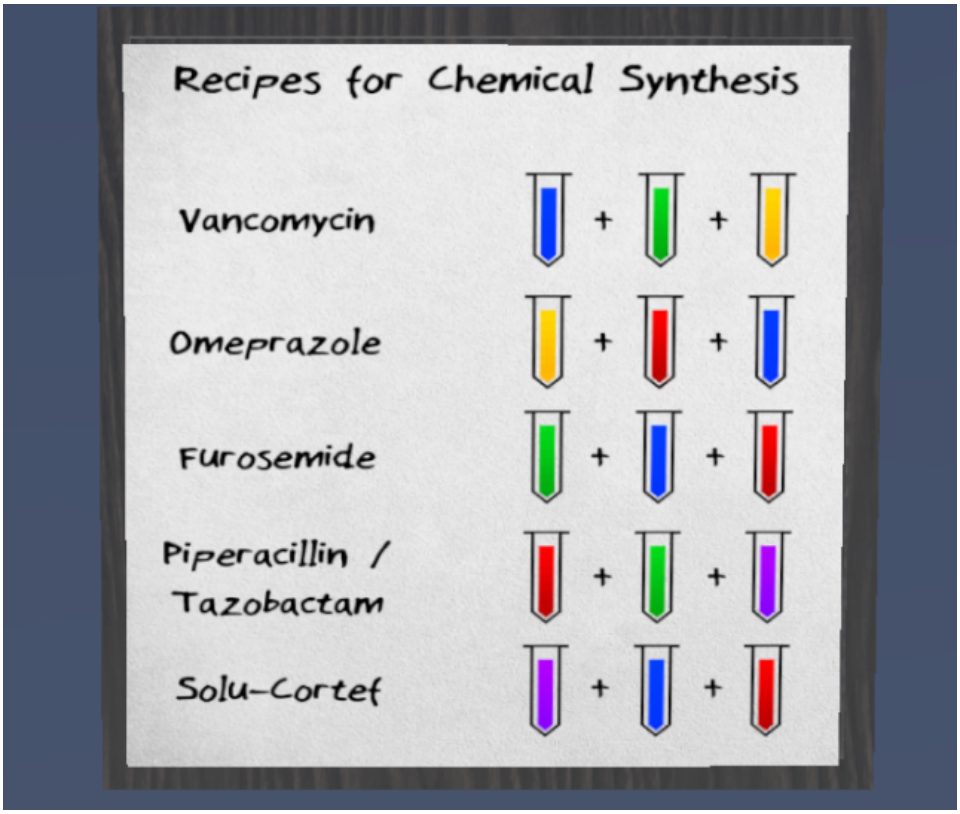

Figure nine: Recipe picture in the third room. User has to create the correct antibiotic to administer.

4. In the "Administer IV Crystalloid" room, there is a weight rack representing a patient's weight, and the user must use the calculator to add up the weights and know to multiply the weight by 30[3].
5. In the "Apply Vasopressors" room, there is a map on the wall with cities labeled. Some cities are puns based on terms specific to this step of the Sepsis Bundle, and other cities have nothing to do with this step of the Sepsis Bundle. The user should click the correct cities to move on.

[3] To determine how much crystalloid to administer to a patient, you take the patient's weight multiplied by 30.

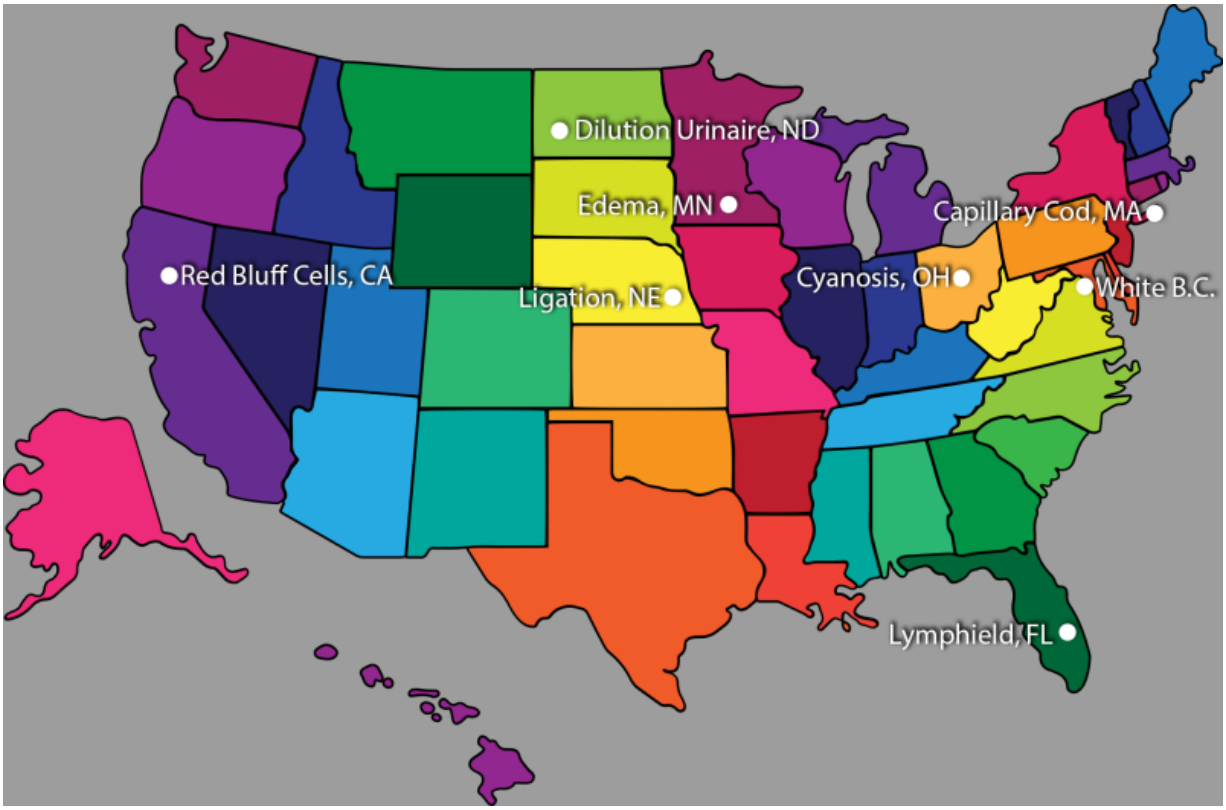

Figure ten: The map with labeled cities. The user has to click the correct cities (Dilution Urinaire, Cyanosis, White B.C, and Capillary Cod).

III. Game and Motivation Theory

A. Epic Meaning and Purpose

A game that has epic meaning gives the player a chance to participate in something larger than themselves. In the case of the Sepsis Escape Room game, the players need to solve all the sepsis-related puzzles in order to save the patient. Someone dies in real life from sepsis every two minutes, so the longer nurses take in the game to administer the Sepsis Bundle, the more people die. We wanted to replicate that within the game to show how treating sepsis is a fight against time.

We did this by including two-minute penalties when the player does something wrong, further honing the nurse's skills and knowledge.

B. Loss and Avoidance

Similar to why the game gives nurses a purpose and epic meaning, the potential for a patient death motivates them to avoid it. It motivates them to solve puzzles faster, get better acclimated with working in time sensitive, high-pressure situations, and recall information about sepsis on the spot. The purpose of the game is to test their knowledge and improve their recall speed. Putting the pressure of a loss of a patient adds the necessary stress to ingrain information about sepsis in their minds, and that pressure is the same pressure they will be facing when they work with real-life patients.

C. Unpredictability and Curiosity

Play begins the game with a player in a room where they first have to identify that they are dealing with sepsis, and then they are surrounded with five different doors, each with a different puzzle testing sepsis knowledge. People are more motivated to learn when there is an aspect of the unknown or mystery. The player does not know the puzzle until they enter the room. For them to continue the game and find out what the other puzzles are, they must first finish the puzzle they are on, as this is a game with a time limit. If they want to complete all the puzzles before time runs out, they must work efficiently.

Each puzzle is also vastly different from the last. The game's unpredictability reflects how dealing with patients in real life is always

unpredictable and each patient is different. The game helps nurses be more adaptable to different situations.

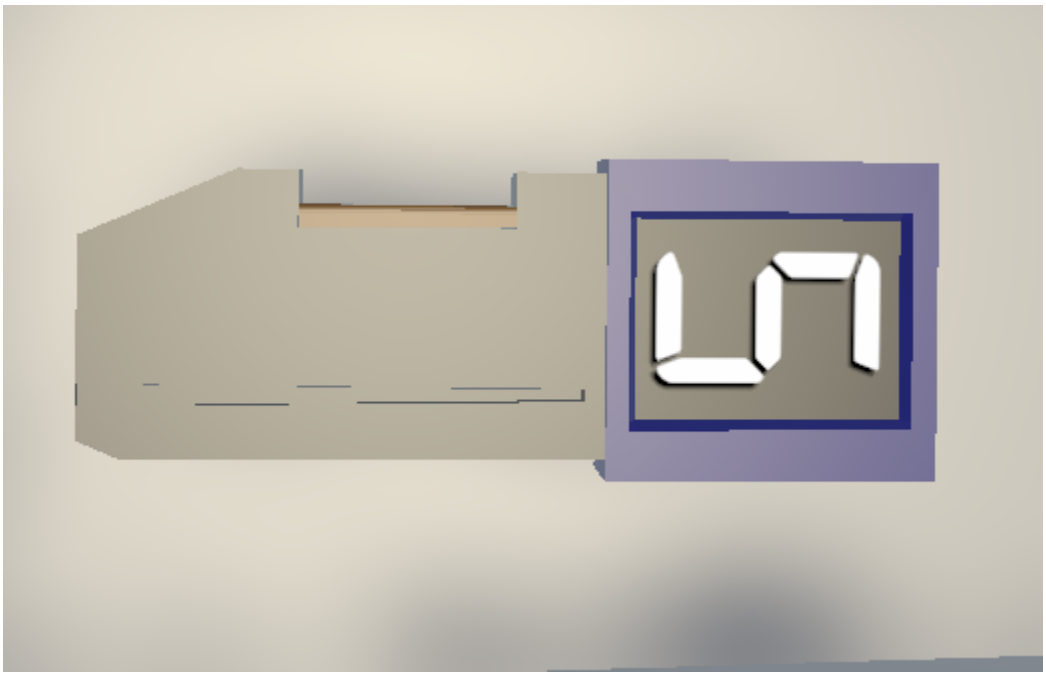

Figure eleven: Keycard that is used to unlock the next room. A new keycard is unlocked after each puzzle.

V. Conclusion

The Sepsis Escape Room game will be used in UNMC's curriculum to test nurses' knowledge of treating patients. The game has five rooms that the user has to navigate through and solve the corresponding puzzles. It helps give nurses a hands-on, no-risk learning experience. The game is currently still in development, but you can view demos of the game here: https://www.youtube.com/playlist?list=PLjWDZoKqSP8mwsERcaTQbW8zN87y-xuos.

Conclusion

Development by the students at the University of Nebraska-Lincoln will end in May 2021, and then it is up to UNMC's College of Nursing whether they consider the game complete or would rather continue development. Eventually, the two games will be integrated into the nursing curriculum. The Sepsis Escape Room game will be more of an exam to test the nurses' knowledge of sepsis treatment. The Agricultural Safety Game is going to be used to travel around the midwest to different conferences and educate farmers and children.

While virtual reality technology has been around for many years, we continue to develop and make use of it more effectively in different situations. Virtual reality is only going to continue to evolve and become more accessible, and will increasingly be used in education. "The virtual reality market is projected to grow from USD 6.1 billion in 2020 to USD 20.9 billion by 2025" (Cision PR Newswire). UNMC, itself, is furthering its development in VR through using full-body VR systems. The goal is to transform how we educate the future generation of caregivers.

Using game theory and techniques, one can produce engaging educational material to better teach the masses. Understanding what makes a game captivating and educational can help developers and educators make better virtual reality games to replace conventional educational material. The two case studies presented are examples of how gamification techniques effectively integrated in a virtual reality game can enhance previous curriculum.

Bibliography

Barnard, Dom. “History of VR - Timeline of Events and Tech Development.” *VirtualSpeech*, VirtualSpeech, 6 Aug. 2019, virtualspeech.com/blog/history-of-vr.

Cision PR Newswire. “Augmented Reality and Virtual Reality Market Worth $77.0 Billion and $20.9 Billion by 2025 Respectively - Exclusive Report by MarketsandMarkets™.” *Cision PR Newswire*, 19 Nov. 2020, www.prnewswire.com/news-releases/augmented-reality-and-virtual-reality-market-worth-77-0-billion-and-20-9-billion-by-2025-respectively--exclusive-report-by-marketsandmarkets-301176866.html#:%7E:text=The%20virtual%20reality%20(VR)%20market,27.9%25%20from%202020%20to%202025.

“Clinical Resources.” *Centers for Disease Control and Prevention*, 7 Dec. 2020, www.cdc.gov/sepsis/clinicaltools/index.html#:%7E:text=Each%20year%2C%20at%20least%201.7,in%20a%20hospital%20has%20sepsis.

Daniels, Ron; Nutbeam, Tim; McNamara, Georgina; Galvin, Clare (2011). "The sepsis six and the severe sepsis resuscitation bundle: a prospective observational cohort study". Emergency Medicine Journal. 28 (6): 507–512. doi:10.1136/emj.2010.095067. ISSN 1472-0213. PMID 21036796.

eLearning Industry Inc. “What Is ELearning Gamification And Why Is It Vital For L&D Professionals?” *ELearning Industry*, 23 June 2020, elearningindustry.com/free-ebooks/what-is-elearning-gamification-why-vital-for-ld-learning-and-development?action=download.

Google Cardboard. “Google Cardboard.” arvr.google.com/cardboard/

“Home | Nursing | University of Nebraska Medical Center.” *University of Nebraska Medical Center*, www.unmc.edu/nursing. Accessed 15 Feb. 2021.

Hussein, Mustafa, and Carl Nätterdal. “The Benefits of Virtual Reality in Education- A Comparision Study.” *Göteborg Universitet*, 2015, gupea.ub.gu.se/handle/2077/39977.

Immersive, Lens. “A Short History of Virtual Reality, For Busy People.” *Medium*, 24 Aug. 2018, arvrjourney.com/a-short-history-of-virtual-reality-for-busy-people-9b088722f3a9.

Kanoski Bresney. “What are the Most Common Types of Tractor Accidents?” *Kanoski Bresney,* 9 April 2019, kanoski.com/personal-injury-attorneys/what-are-the-most-common-types-of-tractor-accidents#:~:text=The%20National%20Agricultural%20Tractor%20Safety,common%20type%20of%20tractor%20accident

Koepp, M., Gunn, R., Lawrence, A. et al. Evidence for striatal dopamine release during a video game. Nature 393, 266–268 (1998). https://doi.org/10.1038/30498

Merriam-Webster. “Virtual Reality.” *The Merriam-Webster.Com Dictionary*, 2021, www.merriam-webster.com/dictionary/virtual%20reality.

Muangsrinoon, Sakchai & Boonbrahm, Poonpong. (2019). Game elements from literature review of gamification in healthcare context. Journal of Technology and Science Education. 9. 20. 10.3926/jotse.556.

Muniz, Hannah. “How Many College Students Are in the U.S.? | BestColleges.” *BestColleges*, 23 June 2020, www.bestcolleges.com/blog/how-many-college-students-in-the-us/#:%7E:text=According%20to%20the%20National%20Center,the%20U.S.%20has%20grown%20significantly.

National Center for Education Statistics. “Number and Internet Access of Instructional Computers and Rooms in Public Schools, by Selected School Characteristics: Selected Years, 1995 through 2008.” *National Center for Education Statistics*, 2018, nces.ed.gov/programs/digest/d18/tables/dt18_218.10.asp?current=yes.

Paoli, Carly J et al. “Epidemiology and Costs of Sepsis in the United States-An Analysis Based on Timing of Diagnosis and Severity Level.” Critical care medicine vol. 46,12 (2018): 1889-1897. doi:10.1097/CCM.0000000000003342

Poetker, Bridget. “The Very Real History of Virtual Reality (+A Look Ahead).” *Learning Hub*, Sept. 2019, learn.g2.com/history-of-virtual-reality#:%7E:text=Virtual%20reality%20technology%20was%20invented,1987%20by%20researcher%20Jaron%20Lanier.

Pomerantz, Jeffrey, and D. Chistopher Brooks. “ECAR Study of Undergraduate Students and Information Technology, 2017.” *EDUCAUSE Research*, 18 Oct. 2017, library.educause.edu/resources/2017/10/ecar-study-of-undergraduate-students-and-information-technology-2017.

Purdue University. “The Evolution Of Technology In The Classroom | Purdue Online.” *Purdue University Online*, online.purdue.edu/blog/education/evolution-technology-classroom. Accessed 15 Feb. 2021.

Sepsis Alliance. (2016). Sepsis 2016 fact sheet. Taken from http://www.sepsisalliance.org/downloads/2016_sepsis_facts_media.pdf

Society of Critical Care Medicine & the European Society of Intensive Care Medicine. “Surviving Sepsis Campaign Hour-1 Bundle.” 2019.

Spence, Charles & Obrist, Marianna & Velasco, Carlos & Ranasinghe, Nimesha. (2017). Digitizing the chemical senses: Possibilities & pitfalls. International Journal of Human-Computer Studies. 107. 10.1016/j.ijhcs.2017.06.003.

“Tractor Accidents.” *Farm Injury Resource Center*, 3 Jan. 2019, farminjuryresource.com/farming-equipment-accidents/tractor-accidents.

U.S. Department of Education. “120 Years of American Education: A Statistical Portrait.” *U.S. Department of Education,* nces.ed.gov/pubs93/93442.pdf?_ga=2.262374031.2061263112.1609277860-1493342243.1609277860. Jan. 1993. Accessed 15 Feb. 2021.

Watters, Audrey. “(Marketing) Virtual Reality in Education: A History.” *Hack Education*, 2 July 2016, hackeducation.com/2016/07/02/virtual-reality.