Virtual Reality for Cancer Patients: A Design Thinking Approach for a Sensory Experience to Reduce Stress and Pain

By Diana Scates

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ABSTRACT

Cancer is an illness devastating individuals' lives all over the world. One in two men and one in three women are diagnosed with cancer in the United States per year. Individuals with cancer often face stressful events that may affect the cure process, including some cancer patients experiencing different levels of pain. While many cancer centers suggest treating pain with medication and non-drug treatment, none of them includes the usage of Virtual Reality (VR) as an alternative for stress and pain relief therapy. The purpose of this research is to determine if VR simulation reduces stress and pain levels among patients (n = 50) in a cancer treatment center. Design Thinking strategies are implemented in this study with the purpose of collecting and analyzing data to configure the best VR application used during the research process.

This research study consists of two parts: Part One involved Design Thinking strategies and Part Two used an experimental design format. During Part One, the researcher implemented the following Design Thinking sessions: Interviewing, Schematic Diagramming, Storyboarding, and Think-Aloud Testing. The results from these strategies determined the content information (video) for the VR experience in Part Two. The researcher designed a VR simulation consisting of relaxing, peaceful, and tranquil nature scenes based on feedback received from former cancer patients, oncology nurses, oncologists, and caregivers (Part One of the study). The researcher assessed the designed VR simulation with a sample of cancer patients assigned to the IV station at Florida Cancer Affiliates (FCA) (Part Two of the study). At the IV station, the oncology nurses access the individual's port or execute an IV procedure.

For Part Two, participants received their typical port or IV access procedure and at the end of the procedure, they filled out a questionnaire that focused on the dependent variables of

pain and stress. On the patient's next visit to the FCA, he or she wore the VR headset glasses as well as headphones during their port or IV access procedure. The VR simulation was a sequence of 7-minute video loops. Once the 7 minutes was up and the IV procedure was complete, the participants completed the questionnaire again about their perceptions of the designed nature simulation along with open-ended questions geared toward stress and pain levels.

Quantitative data revealed that cancer patients who watched the VR simulation content of nature scenes while assigned to the IV procedure were statistically more distracted, felt less frustration, and were more relaxed than those who did not wear the VR glasses. In the quantitative data analysis, the words *relaxed, distracted,* and similar phrases were used 53 times. The body language and the facial expressions of the patients were observed before, during, and after the VR experience, concluding the subject's visible improvement. The findings revealed that VR simulation can be used as a key that has the potential to unlock good memories in cancer patients' brain and trigger a process of relaxation capable of reducing stress through sensory stimuli.

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DEDICATION

I dedicate this work to God. Without His love and mercy, I would not be alive today to publish this research. I consider this opportunity of writing this narrative as part of my destiny.

To my husband, Lance. For his love and support from the first days when I was diagnosed with cancer until the end of this project have left me without words to express my gratitude. Your encouragement and your devotion to God lifted me up during some difficult days of my life. I love you so much.

To my close family: Geraldo, Selma, Rosanna, Rubens, Ruben, Jessica, Núria, and Edna. You chose to enter into this battle against this horrible disease (cancer) so unknown to us all without hesitation and with wholeheartedness. Your prayers and emotional support were very important for my recovery.

To all prayer warriors who stood with us in the gap.

To all cancer patients who are currently undergoing such diagnosis. May this research be a catalyst of hope bringing you a better quality of life. Be healed!

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CHAPTER 1: INTRODUCTION

According to medical history research, as soon as a person is diagnosed with cancer, this individual embarks on a journey of constant stress, and such stress levels may rise over time during the entire treatment. The purpose of this research study was to determine if Virtual Reality (VR) simulation reduces stress and pain levels among patients in a cancer treatment center.

Stress is a physical and mental reaction experienced by all patients, but it is not usually discussed during a patient-healthcare professional interaction (Chandwani, 2012). Generally, after an individual is diagnosed with cancer, oncologists provide a binder of information to the patient, including phone numbers and web links to support groups at different cancer center locations. In addition, in some cancer centers, a list of painkiller relief is included in the binder instructing the patient to make the right use of the drugs when necessary. This research will suggest an alternative approach to reduce a person's stress and pain during the treatment process.

According to MD Anderson Cancer Center (The University of Texas, MD Anderson Cancer Center, n.d.), half of all cancer patients experience some level of pain. The center classifies three causes of pain: pain from the tumor, treatment-related, and post-operative. MD Anderson suggested treating pain with medication and non-drug treatment. However, none of the suggestions include the usage of VR as an alternative pain relief therapy.

Virtual Reality is not a new concept. Seeking to distinguish between the immersive digital worlds and traditional computer simulation, Jaron Lanier of VPL became the first researcher to use the term Virtual Reality (Pimentel, 1994; Paranandi & Sarawgi, 2002). Thus, as technology quickly advanced, VR might be at its greatest momentum now. In 2001, Rory McCloy stated that VR and robotics would have a major impact on health care in the following

decade (McCloy & Stone, 2001). Indeed, it has been thriving since. Today, VR and simulation are increasingly used in clinical validation, surgery, neurosurgery, orthopedics, and cardiology, as well as in mental health, anesthetics, and emergency medicine (see Figure 1).

Figure 1 – Patient wearing VR One glasses

The VR simulation content (video) can be designed in a variety of themes. However, according to Berman (2008), visual access to natural environments facilitates attention restoration, improves mood, and can enhance physiological stress recovery and health. Natural sound can also facilitate mood recovery (Benfield, Taff, Newman, & Smyth, 2014). VR simulation provides both visual exposures to a sequence of images and sounds that have the capability of activating visual memories in subjects. Once visual memories are recalled or formed, they have the potential of activating positive feelings in patients, consequently reducing the level of cortisol and producing happiness (Suthana, 2018).

This study has helped to determine if cancer patients have a better way of coping with the consequences of such diagnosis by reducing their stress and pain levels. In addition, the Virtual Reality interaction experience might improve patients' quality of life and ease their treatment session while at the cancer center. Weber-Fechner Law states that "as we get 'used to' a level of stimuli, we need a greater intensity of that stimulus in order for us to notice a change" (Kopec, 2012, p. 23). Therefore, by studying the level of sensory stimuli an individual achieves by

experiencing the virtual world, it might help us, as design thinkers, to better understand a patient's behavior and recovery. The experience analysis of an ill person immersed in a virtual environment most likely ought to bring valuable data for further research.

Definition of Terms:

Cancer Center – In this study, the term *Cancer Center* is used to mean any clinic or hospital where a patient receives chemotherapy treatment.

Design Thinking (DT) – The process of creative strategies to solve wicked problems. DT can reduce the risks associated with a new idea and generate innovative solutions to a problem.

FCA – Florida Cancer Affiliates, Ocala, Florida.

fMRI – Functional magnetic resonance imaging is a technique for measuring and mapping brain activity that is noninvasive and safe (UCSD.edu).

IV – The abbreviation for *Intravenous*. IV allows healthcare professionals to administer fluids, blood products, and medications directly into a patient's bloodstream via a small tube.

Pain – An unpleasant sensory and emotional experience associated with an actual or potential tissue damage or described in terms of such damage (Merskey & Bogduk, 1994).

Port Access – A port is a small disc made of plastic or metal about the size of a quarter that sits just under the skin. A soft thin tube called a catheter connects the port to a large vein. Fluids, medication, and chemotherapy infusion are given through a special (thick) needle that fits right into the port.

Schematic Diagramming – A DT process that will allow the researcher to build a systematic step-by-step guide on how an idea is going to work.

Sensory Stimuli – Sensory conveys nerve impulses from the sense organs to the nerve centers (Merriam-Webster, 2016). Stimulation is to excite (a nerve, gland, etc.) its functional activity (Merriam-Webster, 2016). In short, *Sensory Stimuli* is a sensory conductor response as a form of stimulus (Psychologydictionary.com, 2016).

Stress – Stress is a physical and mental reaction experienced by all patients (Chandwani, 2012). Also, it is a state of body or mental tension resulted from factors that tend to alter an existent equilibrium (Merriam-Webster, 2016).

Think-aloud testing – A Design Thinking process where the participants narrate their experience while performing a given task.

Virtual Reality – A computer simulation technique in which human sensory stimuli (as sight and sound) are affected by visual images as well as sounds. Such immersive experience can be achieved by head-mounted glasses as Google Glass or Oculus Rift with a sequence of images accompanied by sounds.

CHAPTER 2: LITERATURE REVIEW

According to the American Cancer Society (2016), cancer is the second most common cause of death in the U.S., exceeded only by heart disease, and accounts for nearly one of every four deaths (see Figure 2). Although there has been some progress made in the fight against cancer, the total cancer death rate rose for most of the 20th century because of the tobacco epidemic, peaking in 1991 to 2015 cancer deaths per 100,000 persons.

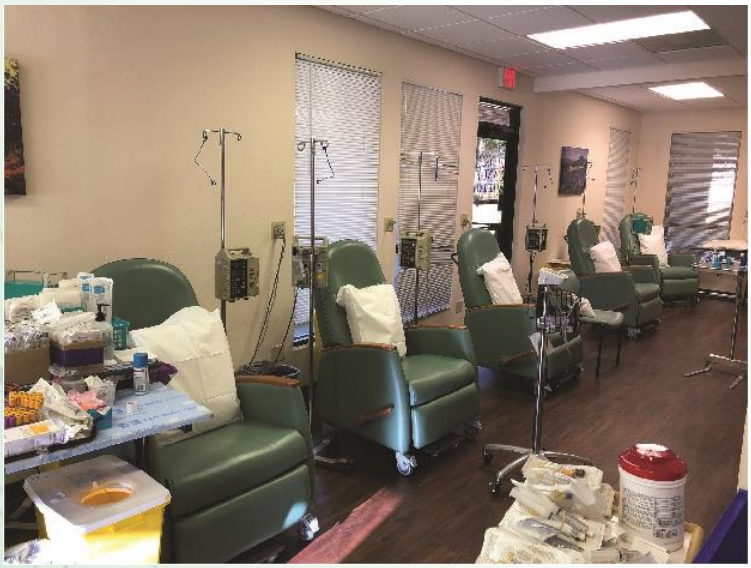


Figure 2 – Chemotherapy infusion room

However, from 1991 to 2012, the rate dropped 23% due to smoking reduction and less propaganda, as well as improvements in early detection and treatment. This decline translates into the avoidance of more than 1.7 million cancer deaths. Nowadays, death rates are declining for all four of the most common cancer types: lung, colorectal, breast, and prostate. Nevertheless, "there are approximately 1,685,210 people diagnosed with cancer today in the US" (ACS, 2016, p. 1-3). The focus of this study is intended to bring a new alternative treatment for patients who are currently facing cancer. An innovative drug-free prescription, such as the usage of the Virtual Reality headset experience, has the potential of reducing stress and pain levels by activating the patient's sensory stimuli in his or her brain.

In a search for stimuli activation research, Yoram Barak (2006) mentioned in his studies that emotions are intimately involved in the initiation or progression of cancer, among other diseases (Barak, 2006). Physiological studies with the inclusion of pleasant stimuli have been recently investigated along with the immune and endocrine systems. The research monitored such chemical systems as they were being released in the brain while pleasant stimuli such as emotional pictures were presented to individuals. The astonishing results revealed an increase in the secretory immunoglobulin A (SIgA) and a decrease in salivary cortisol while the brain was induced by pleasant emotions (Barak et al., 2006; Ulrich, 1984). SIgA is an antibody that plays a critical role in mucosal immunity. It responds to physical and psychological levels of stress through interactions with the autonomic nervous system (Salimetrics, n.d.). As an outside positive stimulus is introduced into the human body, the levels of SIgA are increased, decreasing the salivary cortisol levels caused by the stressor factor involved. In other words, as an individual experiences enjoyable emotion, stress factors are affected, resulting in the increase of the levels of SIgA as well as the decrease of salivary cortisol levels.

"The contact with nature is vital to human intellectual development because the natural world is the most information-rich and sensory-stimulating environment people can ever encounter" (Kellert, 2012).

In a recent interview by Open Voices Blog, the architect Dr. Roger Ulrich (2013) stated:

> *"There is a pattern of evidence that suggests that well-designed gardens can reduce stress, lower blood pressure, and relax people. Also, there is research that shows experiencing nature and looking at gardens reduces pain. Nature seems to reduce pain*

by blocking stress and reducing the extent to which patients focus on themselves and their discomfort."

We are biologically programmed to respond to a wide variety of environmental cues and natural stimuli (Barton, Bragg, Wood, & Pretty, 2016). According to Kellert (2012, p. 21) "the contact with nature is vital to human intellectual development because the natural world is the most information-rich and sensory-stimulating environment people can ever encounter." Unfortunately, modern society has increasingly separated itself from experiencing nature. Consequently, people might have been suffering from sensory deprivation of an environment that could most likely relieve them from stress and anxiety (Kellert, 2012). Visual exposure to natural scenes can aid in reducing stress, high blood pressure, and fatigue. At the same time, natural sound can also facilitate mood recovery (Benfield, Taff, Newman, & Smyth, 2014). Individuals who listened to recordings of natural soundscape showed greater mood recovery after a disturbing event than those who listened to the same soundscape, but with human-made sounds, such as voices and urban noises (Scutti, 2014). Attention Restoration Theory (ART) provides an analysis of experiences that lead to recovery from such stressors (Kaplan, 2004). Natural sounds can provide relief from mental fatigue and promote cognitive performance (Abbott, 2015; Berman, Jonides, & Kaplan, 2008). According to Abbott (2015), individuals exposed to natural sounds, specifically bird sound and wind, had a significant recovery of metal fatigue. In Abbott's study, both the control and experimental group were exposed to a visual stimulus such as watching the Yosemite National Park movie. Participants exposed to natural sounds were able to recover from their mental fatigue when compared to

Natural sounds can provide relief from mental fatigue and promote cognitive performance.

those who were exposed to silence. Therefore, images of nature in combination with natural sounds have resulted in stimuli restoration properties for individuals who have interacted with such features.

It is important to recognize that experiencing nature can occur in multiple ways. One of the most distinct forms is the direct contact with the natural world in outdoor settings. People have experienced "indirect" contact with nature through various interactions involving continuous human input and control such as potted plants, aquariums, pet animals, and more. Moreover, people have also experienced nature representationally through pictures, symbols, video, the computer, and more. According to Barton et al. (2016), all forms of contact with the natural world – direct, indirect and representational – are vital for human health and well-being. Yet few studies have been conducted in search of new ways of reducing stress by using representational forms of nature with VR technology. This research has increased in recent years with the intention of revealing insights of the potential benefits that the virtual environment can bring, as well as to try to fill this gap.

The objective of this study was to use the VR headset immersion experience with the purpose of refocusing cancer patients' mindsets by enhancing their sensory vision and hearing into pleasant environmental views and sounds that ultimately helped the patients to alleviate pain and stress. For instance, a 3D video, which allows an individual to interact in a virtual forest, ocean, or outside space, might stimulate levels of serotonin and promote happiness as well as increase the immune system of a patient (Chandwani et al., 2012; Oyama, 1997; Zachariae, 2009). Psychological stimulation activates the endocrine and the immune system. Both systems may be able to rapidly repair tissues damaged by cancer cells and change the characteristics of cancer itself (Oyama et al.,1997). Although VR treatment might be used as palliative care, the

technique still has the potential to provide patients with emotional support and encouragement into an active lifestyle against cancer. In addition, studies show many more patients with an active lifestyle have survived longer than those with a passive lifestyle (Chandwani et al., 2012; Oyama et al.,1997).

Jonathan Block (2014), a British journalist, described in his article the VR headset immersion experience on a terminally ill woman with cancer. Roberta Firstenberg, the cancer patient, was thrilled as she captured butterflies in a virtual environment outside scenery, something she was not able to accomplish in a real-world setting. She mentioned that such experience was very therapeutic for her as she had always enjoyed this kind of activity. After being surrounded by a dying and painful atmosphere, she felt happy and alive again by being able to be transported and "see" nature and to "walk normally" through the virtual world.

Virtual Reality is a psychological tool that can "calm the nervous system, and that dampens the pain processing" (Dr. Beth Darnall).

Lieutenant Sam Brown had a similar experience by using VR to relieve him from excruciating pain after suffering from third-degree burns on over 30% of his body (Frank & Carter, 2012). The psychologists Dr. Hunter Hoffman and David Patterson (2012) from the University of Washington have been studying immersive Virtual Reality pain distraction since 1983. According to Dr. Hoffman, "the fact that you are getting such huge reductions in pain using something that is not a drug is a paradigm shift" (para. 22). Dr. Patterson has been conducting studies on pain control after burn injuries and trauma since the 1980s. He states:

> *"Our logic for why VR will reduce pain is as follows. Pain perception has a strong psychological component. The same incoming pain signal can be interpreted as painful*

or not, depending on what the patient is thinking. Pain requires conscious attention. The essence of VR is the illusion users have of going inside the computer-generated environment. Being drawn into another world drains a lot of attentional resources, leaving less attention available to process pain signals. Conscious attention is like a spotlight. Usually, it is focused on the pain and wound care. We are luring that spotlight into the virtual world. Rather than having pain as the focus of their attention, for many patients in VR, the wound care becomes more of an annoyance, distracting them from their primary goal of exploring the virtual world." (para. 8)

The idea is that the worst pain can be alleviated by manipulating the way the human mind works; the more you focus on pain, the worse it feels. When the brain is flooded by an overload of pleasant sensory inputs – such as within a virtual world immersion experience – its capacity for processing pain is reduced. According to Dr. Beth Darnall (2016), a clinical associate professor at Stanford Health Care's division of pain medicine, "pain is our harm alarm and it does a really good job of getting our attention" (para. 6). She said Virtual Reality is a psychological tool that can "calm the nervous system, and that dampens the pain processing" (King & Chen, 2016, para. 6)." This notion is based on the hypothesis that treating a cancer patient with the use of the VR headset has great potential of reducing stress as well as pain levels among patients in a cancer treatment center session.

In a recent study, Dr. Brennan Spiegel (2016), who directs health services research at Cedars-Sinai hospital, discovered that 20 minutes with the use of the VR headset software reduced patients' pain by 24% on average. Before using the VR headset device, patients had a mean pain score of roughly 5.5 on a 0 to 10 scale. Afterward, it dropped to 4. This result showed that "there was a dramatic reduction in acute pain that was not too different from what we see

from giving narcotics" (Metz, 2016, para. 9). The VR experience might be better than opioids (morphine and morphine-related chemicals) as it has the potential to be prescribed as a painkiller in the near future. Dr. Spiegel expressed that he is cautiously optimistic about the VR headset prospects of helping reduce patient's discomfort. He stated that he believes as the technology evolves, it could be very beneficial for people who are in pain or stress, both at the hospital or after they have been discharged. However, he has suggested that there is still more additional data needed in order to validate the proper use of the VR headset devices for these types of treatment. In 2016, Dr. Spiegel was responsible for a clinical trial of *Virtual Reality in Inpatients* at Cedars-Sinai Medical Center.

The Virtual Reality experience might be better than opioids (morphine and morphine-related chemicals) as it has the potential to be used to prescribe as a painkiller in the near future.

The use of the VR headset as a distraction to ease cancer patients' experiences has been a subject of study for over a decade. Schneider, Prince-Paul, Allen, Silverman, and Talaba (2004) published research titled *Virtual Reality as a distraction intervention for women receiving chemotherapy* at the Oncology Nursing Forum. The purpose of their research was to explore the use of VR as a distraction intervention tool with the purpose of reducing distress symptoms in women receiving chemotherapy for breast cancer. They sampled 20 women from 18-55 years of age and they used a crossover design method in which 20 subjects served as their own controls. The variables of the research were distress, fatigue, and anxiety. The researchers found that the distraction intervention tool decreased distress symptoms, and it was well received by the patients. In addition, the findings showed a significant decrease in distress and fatigue immediately after chemotherapy treatments while

using the VR headset intervention. The group of researchers concluded that chemotherapy-related distress symptom management can improve patient quality of life. It can also increase chances of survival by reducing treatment-related distress and enhance patients' ability to adhere to treatment regimens as well as cope with their disease.

While there is not much research about the usage of the VR headset devices during chemotherapy treatment, Dr. Antonio Giordano and his team from Temple University are the most current prolific group with published papers on this topic. In the *Journal of Cellular Physiology*, Dr. Giordano (2016) stated:

> *"Virtual Reality improved patients' emotional well-being and diminished their cancer-related psychological symptoms. Cancer patients have psychological issues that are often overlooked. They are scared about side effects and discomfort and are sometimes depressed, and that can interfere with their ability to successfully follow a course of therapy."* (Abstract, para. 1)

Giordano (2016) has shown that immersing patients into VR scenarios has helped patients reduce their stress during cancer treatment. The paper concluded that in all the reviewed research, VR experience has improved patients' emotional well-being as well as diminished their cancer-related psychological symptoms.

Because VR technology has evolved greatly in recent years, Giordano explored the efficacy of VR in reducing the perception of time during chemotherapy treatment. The patients' retrospective estimates of elapsed time during this treatment were evaluated versus chemo patients treated with Music-Therapy (MT). Forty-seven breast cancer patients were randomly assigned either to 20 minutes of VR treatment or 20 minutes of MT during chemotherapy infusion. The results revealed that the VR group underestimated the time spent in the virtual

environment. On the other hand, the MT treatment group overestimated it. In other words, the VR group had a greater beneficial impact than the MT group based on the same period. It is important to point out that Dr. Giordano's studies were among patients diagnosed with breast cancer. There is surely room for future research within many other cancer types.

VR simulation has the capability of activating visual memories in subjects. Visual memories are the ability to visually recall images that have been formerly observed (Nugent, 2013). Memory is essential to all lives. Without a memory of the past, a person cannot operate in the present or think about the future. The ability to remember what people have done yesterday, what they have been doing today, or what they plan to do tomorrow demonstrates their capacity to encode, store, and retrieve information in their brains (McLeod, 2013).

"Memory is essential to all lives. Without a memory of the past, a person cannot operate in the present or think about the future" (McLeod, 2013).

Neuroscientist Dr. Nanthia Suthana and her team have been using VR to help her patients fight memory loss. According to Dr. Suthana (Schmidt, 2017), if we can understand what is happening in the brain when these memories are recalled or formed, then potentially we can develop therapies for patients who have memory disorders. They are one of the first labs in the world to blend VR with a surgically implanted prosthesis to reveal what happens inside of the brain when a person creates memories. The idea is to have a subject using VR glasses where yellow lights signal the locations for them to walk towards and to remember them. Then the research team tests the subject's ability to remember the route without the light cues. After the VR experience, the electrical brain data is collected from the subject and analyzed in forms of deep brain waves to measure the strength of the learning and recall. Dr. Suthana's goal is to develop therapeutic

tools that could restore memories to people suffering from memory disease, traumatic brain injury, and other disorders.

What does happen when the subject's brain is flooded with good memories? Studies from Rutgers University have shown that recalling happy memories elicits positive feelings and enhances one's well-being, suggesting a potential adaptive function in using this strategy for coping with stress (Speer & Delgado, 2017). Megan Speer and Mauricio Delgado made 134 volunteers feel stressed by observing and filming them while plunging their hands into icy water. Some of the participants spent 14 seconds remembering good personal experiences (walking in nature), while others reflected on neutral events (cleaning their house). Later, the group who would recall happy memories felt better and it was found that their levels of the stress hormone cortisol were only 15%, on average, of the surge observed in the group who had neutral memories. The researchers scanned the subjects' brains using fMRI to collect their data. They concluded that although there is plenty of research finding that people who tend to control themselves physiologically soon after stressful events are generally healthier (physically and psychologically), the simple act of recalling happy memories can combat acute stress at a physical level. Thus, thinking about positive past events could help to improve mood and resilience against stress.

"When doctors stop and listening to the patient, they are showing how important they are" (Koniver, 2011).

Body language and facial expression are good indicators of stress and pain. Dr. Mehrabian's (2017) studies revealed that 7% of communication comes from the words we say, 38% comes from our tone of voice, and 55% comes from our body language. Nonverbal communication establishes trust between people and could help patients feel validated. Listening

is a form of body language. When doctors stop and listen to the patient, they are showing how important they are (Koniver, 2011). Signs of stress can be verbally or nonverbally communicated. When a person is feeling stress, one's heart rate increases, breath speeds up, the body's muscles tighten, and blood pressure increases. A person under stress can have a tendency to bounce his or her legs or tap fingers, bite fingernails, slow down, or talk too much. Doctors or caregivers are able to observe some of these behaviors. In addition, facial expression can be attributed to specific emotions such as happiness, sadness, fear or stress. A happy person has lips and cheeks raised, the eyelids narrowing to produce crow's feet in the corners. On the contrary, a stressful person has the eyebrow inner corners drawn up, tense facial muscles and lips closed. According to Dr. Gendeh (2016), healthcare professionals should be attentive and sensitive to nonverbal cues from patients, which may provide information about the patient's emotional state and severity of illness.

In summary, the literature review showed:

- Cancer is the second most common cause of death in the U.S. (ACS, 2016).
- There are scientific studies proving that people who have contact with nature can improve their health physically and psychologically (Ulrich, 2013).
- Few studies showed the usage of VR as a distraction to control pain in patients after burn injuries and trauma, but not in cancer patients.
- Due to the number of cancer patients diagnosed in the U.S., there is a huge gap of research regarding VR as a stress relieving intervention for cancer patients.
- With the current advancement of technology, there are few clinical trials analyzing the capability of VR simulations to activate visual memories in patients with varied diagnoses.

- The study of nonverbal communication in healthcare is improving.

There are many gaps in scientific research today that are failing to show how a person diagnosed with cancer, can improve his or her life physically and psychologically. There are still unknown evidences that need investigation, such as:

- How cancer patients' brains react to VR simulation.
- The best usage of VR simulation in cancer centers for inpatients and outpatients.
- What type of stimuli the brain of a cancer patient needs to overcome negative feelings like fear, stress, and depression.
- How far non-drug therapy technology like VR can help cancer patients overcome the disease.

In this study, the researcher proposed filling some gaps from the literature review by offering the following hypotheses:

- H_1 – Patients will feel less stress when watching the VR simulation during their IV procedure or port access.
- H_2 – Patients will feel less pain when watching the VR simulation during their IV procedure or port access.
- H_3 – Patients will feel more relaxed when watching the VR simulation during their IV procedure or port access.
- H_4 – Patients will feel more distracted when watching the VR simulation during their IV procedure or port access.

Therefore, the literature review suggests that this study is valid, and it has the potential of improving the well-being of many cancer patients who are currently undergoing chemotherapy treatment in order to bring them hope and give them a better quality of life.

CHAPTER 3: METHODOLOGY

Research Design:

This research study consisted of two parts: Part One involved Design Thinking strategies and Part Two used an experimental design format selecting a posttest-only comparison group. During Part One, the researcher implemented the following Design Thinking strategies: Interviewing, Schematic Diagramming, Storyboarding, and Think-Aloud Testing. The objective of this session was to determine which content information (video) was most suitable for the VR experience in this study.

In Part Two, both the student researcher and the oncologist doctor from Florida Cancer Affiliates purposely selected the participants who were assigned to the IV station at FCA. The goal was to recruit 50 cancer patients who were over the age of 18. The same selected patients participated in both experimental and control groups. The experimental group received the VR headset device glasses with video images of nature content (determined via Part One of the study) and the control group did not. Both groups were posttested on the dependent variables (stress and pain). This way the researcher had the advantage of manipulating the independent variable (VR glasses).

The diagram of this design is as follow (Figure 3):

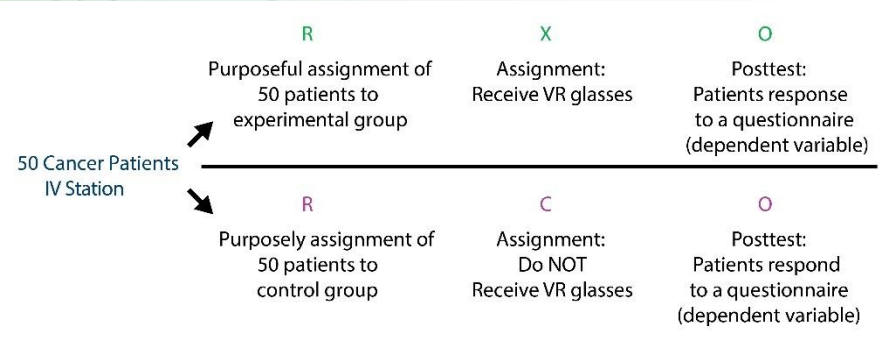


Figure 3 – Research design diagram

The symbol *R* at the beginning of each line indicates the groups purposely assigned. One group received the VR headset glasses (*X*) and the other group (*C*) in comparison did not receive the headset device. The *O* refers to the measurement of the dependent variable. The researcher used a qualitative and quantitative survey questionnaire to collect the data.

Sample:

The researcher used two kinds of nonrandom sampling methods for this investigation: convenience and purposive. First, a convenience sample was used to choose eight people (two of each professional skills) for the interviewing Design Thinking (DT) process of this study (Part One). Doctors, nurses, caregivers, and former patients acquainted with the researcher were invited to participate in the study. Three people were conveniently invited to participate in the DT process: Think-Aloud Testing. Two of the volunteers participated in the interviewing portion of the study. For Part Two, Florida Cancer Affiliates in Ocala, Florida was the facility chosen for this study since it is located close to the researcher. In addition, the cancer center has an IV station that supports patients who come for their chemotherapy treatment, a research department, and provides clinical trials.

For Part Two of the study, the researcher and the oncologist doctor from FCA purposively selected patients at the Florida Cancer Affiliates who were assigned to the IV station. The first 50 individuals, who freely agreed to participate and signed the consent letter, were recruited during 30 consecutive days of the research. All participants over the age of 18, who signed the consent letter, assigned to the IV station on the same day the researcher would be at FCA, were eligible to participate in the study. The same selected patients participated in both experimental and control groups. This was the best approach for this inquiry combining

convenience and purposive nonrandom sampling. The mix of these two methods narrowed down the exact numbers of patients who daily checked-in for the IV station at the FCA. In addition, this study ensured enough data collection to compare with the posttest at the end of the experiment.

There was no distinction between age, race, sex, or ethnicity. The participants needed to know how to read in order to fill out a questionnaire form at the end of the experiment. According to Simone and Lyons (n.d.) from the Huntsman Cancer Institute, adults are being selected because there are more cancer incidents among adults than among children.

Part One of the Study:

For Part One of this study, the student researcher implemented the following design-thinking strategies:

Interviewing: Oncologists, oncology nurses, family caregivers, and former cancer patients (cancer survivors) were recruited and invited to participate in this DT session. Recruitment occurred in a face-to-face manner. The student researcher is a former cancer patient and has access to oncologists, oncology nurses, family members, and former cancer patients. Two people of each professional skill were selected in order to get a variety of feedback (total of 8 people). The student researcher contacted each volunteer and asked them to meet at a mutually agreed upon public location such as a coffee shop to conduct individual interviewing sessions. An informed consent letter was given to interviewees who agreed to participate in the study (see Appendix A). Interviews lasted approximately 20 minutes (see Appendices B-C). The time of each interview was scheduled by the student researcher and participant. Prior to the interview, the student researcher explained the purpose of the session and research study, went over the

consent form, asked for any questions, and had participants sign the form once they were thoroughly informed. Once consent forms were signed, the interview session began. The data collected during the interview provided information that helped determine which virtual scenes the student researcher selected/designed for the VR simulation. At the end of the interview, participants chose from a series of printed nature scenes (see Appendix D) presented by the researcher and selected the ones they thought most relaxed them.

The purpose of interviewing this group of individuals was to identify the gaps missed from the literature review. At the same time, it built credibility within stakeholders. The objective of the interview sessions with oncologists, oncology nurses, and caregivers were to:

- understand the perception of this group of professionals, who work directly with cancer patients, regarding non-drug therapies.
- learn, from their perspective when, how, and why a cancer patient might feel stress and pain during the treatment.
- find out which nature scenes they could suggest that might bring relaxation and tranquil feelings to patients.

There were nine questions asked for former cancer patients. The questions focused on:

- learning about their personal experience while receiving treatment at a cancer center (side effects, type of treatment, etc.).
- understanding which factors triggered their stress and/or pain during and after the treatment.
- hearing their opinions about alternative and non-drug therapies (like music, pet, or stress management therapies).

- finding out, if they were still undergoing cancer treatment, what type of nature scenes they would rather watch to feel more peaceful, tranquil, or relaxing.

Schematic Diagramming: Once the interviews were completed, the student researcher analyzed the results and used a schematic diagram to outline the structure of the components for the VR simulation. In other words, the results from the interviews informed the content designed for the VR video. The interview data showed if nature scenes such as underwater images, or walking through the forest or mountains, for instance, would help produce a pleasant sensory experience that might reduce stress and pain levels in cancer patients while going through treatment at the IV station. A step-by-step diagram was created showing how the content was displayed for the patient (see Appendix E).

Storyboarding: After the research team approved the Schematic Diagramming, a Storyboard was outlined by the researcher in order to establish time, locations, and scenes of the simulation video pilot. The objective of the Storyboard was to show concept images in action, determine the duration of the video and the type of nature scenes that would help people imagine the final product, build a shared understanding, and gain support from decision makers. The Storyboard helped visualize the final product and facilitated revisions at this phase of the project. It captured more than 1 hour of video to produce 7 minutes of VR simulation. It was determined during this process the right equipment (like 360 camera, software, etc.) would be used to capture and produce the simulation (see Appendix F).

Think-Aloud Testing: Once the student researcher's committee members approved the Schematic Diagram and Storyboard, a scheduled session took place with three former chemotherapy patients to implement the Think-Aloud Testing strategy. The recruitment of participants for this session occurred in a face-to-face manner. The Think-Aloud Testing took

place at the CGW Virtual Reality office during business hours. CGW Virtual Reality is the company for which the student researcher is a consultant in Orlando, Florida. Prior to this strategy, the student researcher explained the Think-Aloud Testing for participants and reviewed the consent form with them (see Appendix G). Once all questions were answered, consent forms were signed, and the student researcher provided the CGW Virtual Reality address, date, and time for the testing. During this strategy, the participants "tested" the VR simulation and commented out-loud on the video scenes displayed. Only the student researcher and the think-aloud testing participants were present during the session. Each participant experienced the glasses for 7 minutes and gave their impressions of the VR experience. The researcher recorded all the verbal suggestions in order to analyze them later. The equipment used during the Think-Aloud Testing included the VR One Virtual Reality headset glasses (see Figure 4), headphones, and a similar video content simulation (see Figure 5) based on the Interviewing, Schematic Diagramming, and Storyboard DT strategies data analysis. The verbal description of the VR simulation during the Think-Aloud Testing was recorded. Once the compiled data was collected during this design process, the storyboard was revised, and the research team was able to re-edit the video, adding new nature scenes and sounds per data analysis.

Figure 4 – VR One - Zeiss

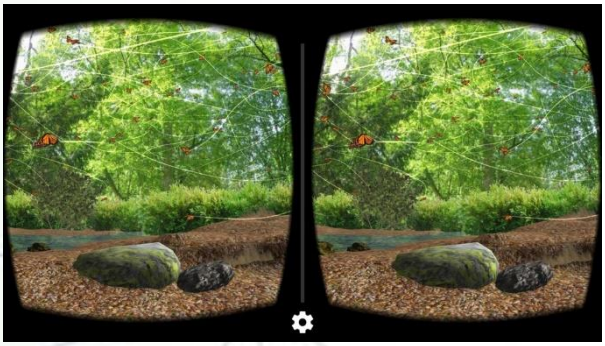


Figure 5 – VR Simulation

Part Two of the Study:

Part Two of this study consisted of visiting Florida Cancer Affiliates (FCA) in Ocala, Florida as well as sending a support letter explaining the purpose of the research and asking permission to conduct the investigation (see Appendix H). In addition, an informed consent letter was given to everyone who volunteered to participate in the research before the study started (see Appendix I). Once the oncology doctor from FCA agreed to participate in this study, and the researcher's committee approved the results from the Design Thinking strategies (Part One), Part Two of the study became a reality. A letter of support from FCA was sent to the researcher (see Appendix J), making the agreement official. Both the student researcher and the oncologist doctor from FCA purposively selected the participants at FCA assigned to the IV station. The goal was to recruit 50 cancer patients over the age of 18. The same selected patients participated in both experimental and control groups. It is important to note that at FCA, it takes an average of 3 to 18 minutes for each patient to go through procedures accessing the port and/or receiving the IV. There are two stages of this study.

Stage 1 - Control Group:

At the IV station, the oncologist nurse assigned to the patient and the student researcher would meet each patient individually to review the consent form, explain the study in detail, and provide time for questions. The oncologist nurses vary from one patient to another. They accompanied the student researcher in order to respond to any question regarding the IV procedure and to administer the IV. The student researcher was responsible for explaining the consent and the HIPPA form to the patient, getting his or her signature, and providing a copy of the consent form after it was signed. The patient was free to choose not to participate in the

study. In this case, there was no penalty involved and he or she continued with his or her procedure as scheduled at the IV station. The same patient willing to participate in the study was recruited to go through both the experimental and control groups. As for the control group procedure, the oncologist nurse executed the IV and port procedure as usual and at the end of the procedure, the patient was posttested on the dependent variables (stress and pain) through the completion of a Likert scale questionnaire (see Appendix K). The questionnaire took an average of 10 minutes to complete. The patient was seated during the IV and port procedure and completed the questionnaire in the same position. At the end of the control group questionnaire, the oncologist nurse informed the student researcher of the patient's next scheduled visit where he or she would participate as part of the experimental group.

Stage 2 - Experimental Group:

During the experimental group procedure, the participants received the VR headset glasses and headphones (as part of the experimental group) to wear during their IV or port procedure. The student researcher was able to work with two patients at the same time, whenever necessary. Two VR headset glasses were available to be used in this experiment. The content of the VR simulation was a sequence of tranquil nature scene views with soft music as illustrated on the final Storyboard from the Design Thinking process described in Part One of this study. It was a sequence of 7 minutes of video loop. Participants could wear the VR headset glasses at their own pace for a maximum of 7 minutes, if necessary. Due to the portability of the VR One glasses, patients were able to stop the VR experience at any time removing the VR headset off of their faces. The content designed for the VR simulation was meant to be a positive distraction with the sole purpose of relaxing and diminishing stress. In a normal setting, as soon as the VR

simulation ended, the patients had already finished with their IV procedure. As a result, patients were posttested on the dependent variables (stress and pain) through the completion of a Likert scale questionnaire (see Appendix L). This time, the questionnaire had not only the demographic and patient's perception regarding the IV procedure (see Table 1), but open-ended questions asking patients their impressions of the VR simulation experience (see Table 2). An oncologist resident physician and the oncologist nurse assisted the student researcher during the study. All nurse staff was present exercising his or her duties at the IV station, providing the best experience possible for the patient during the study, as described previously (see Figure 6).

Table 1 – Pretest Questions 2, 5, 6-13

Demographic Questions:

2. What is your age (please circle your response)?

18-24 years old | 25-34 years old | 35-44 years old | 45-54 years old | 55-64 years old | 65+ years or older

5. What kind of procedure did you have today (please circle your response)?

IV procedure | Chemotherapy Port Access

Perceptions Regarding Your Procedure Today:

For the questions below, please circle your response.

6. Today, I had a good experience during my procedure:

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

7. Today, my experience at the Cancer Center was different:

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

8. My procedure was not stressful:

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

9. My procedure was not frustrating:

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

10. I was distracted during my procedure:

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

11. I was relaxed during my procedure:

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

12. I felt as peace during my procedure:

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

13. I felt no pain during my procedure:

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

Table 2 – Posttest Open-ended Questions 14-18

Virtual Reality Simulation Perceptions:

Please only answer the questions below, if you experienced the Virtual Reality glasses today.
Please write your response in the blanks provided.

14. What did you like about the VR simulation? _____

15. What did you dislike about the VR simulation? _____

16. How did the VR simulation make you feel? _____

17. Was there any particular scene you wish you could have looked at that was missing from the simulation? _____

18. If you could change something about the VR simulation, what would it be? _____

Once the VR experience was concluded and the IV procedure was completed, the researcher also went through an informal interview with the patient. During this conversation, the student researcher asked the subject about his or her impressions regarding the VR simulation and the effectiveness of the procedure. Stage Two of the study took a total of 30 to 35 minutes from start to finish, including an informal interview after the VR simulation.

Data from the study were analyzed using descriptive statistics in the form of means and standard deviations. A paired (dependent) t-test comparison was used to determine if a significant difference existed between the control versus experimental groups. The researcher used the following identifier at the top of the questionnaire: control group responses were keyed at the top with the number 1; experimental group responses were keyed at the top with the

Figure 6 – IV Procedure

number 2. The data analysis of the Likert scale results determined if the purpose of this study was reached or not. During 30 consecutive days, both processes of the data collection were conducted.

Internal Validity:

The researcher selected cancer patients assigned to the IV station to perform IV procedure (take fluids) or to have their port accessed. On this scenario, there were two possible threats to internal validity: (a) subject characteristics and (b) subject attitude.

On subject characteristics, the group included patients at the beginning, middle, or at the end of the treatment. This variable determined the person's strength. Patients at the beginning of chemotherapy treatment felt their body and mind differently from patients who were ending the therapy. Subject characteristics were handled by obtaining more information on the subjects of the study through the demographic questions and informal interview with the patients. Participation in this research was completely voluntary. The subject had the choice of wearing or not wearing the VR headset glasses.

Another threat was the subject attitude. Some patients:

- were afraid of wearing the VR headset glasses because of pre-conceived ideas about it even if the individual had never used the device before.
- did not want their sight covered during the IV procedure.
- preferred to interact with the oncologist nurse and see the IV procedure.

The subject attitude was controlled by providing more information about the VR headset device and video simulation towards the subject. In the same token, the patient had the option of declining or accepting to participate in the research. Their decision was documented by the researcher.

Reliability:

In this study, the researcher used qualitative and quantitative data analysis. The descriptive statistic method was used in the form of means, standard deviations, and a paired (dependent) t-test comparison to determine if a significant difference existed between the control versus experimental groups. The researcher was the only person with permission to access the

collected data. The researcher's assistant independently reviewed the qualitative data and coding to increase the reliability of the results.

Data Analysis:

The quantitative data were analyzed using descriptive statistics in the form of means and sample standard deviations. A paired (dependent) one-tailed t-test comparison was used to determine if a significant difference existed between the control versus experimental groups. The one-tailed t-test was used instead of the two-tailed t-test in order to predict the direction. The p-value score result proved the statistical significance of the hypothesis in Table 3.

Table 3 – Hypothesis 1-4

H_1 – Patients will feel less stress when watching the VR simulation during their IV procedure or port access.
H_2 – Patients will feel less pain when watching the VR simulation during their IV procedure or port access.
H_3 – Patients will feel more relaxed when watching the VR simulation during their IV procedure or port access.
H_4 – Patients will feel more distracted when watching the VR simulation during their IV procedure or port access.

CHAPTER 4: RESULTS

Results - Participation:

A total of 91 patients were invited to participate in the research (see Figure 7). Thus, 55% accepted to participate (n = 50), 30% declined, 9% did not show up at the clinic, and 6% canceled the survey. The most common responses given from the 27 (30%) patients who declined to participate in the research study were:

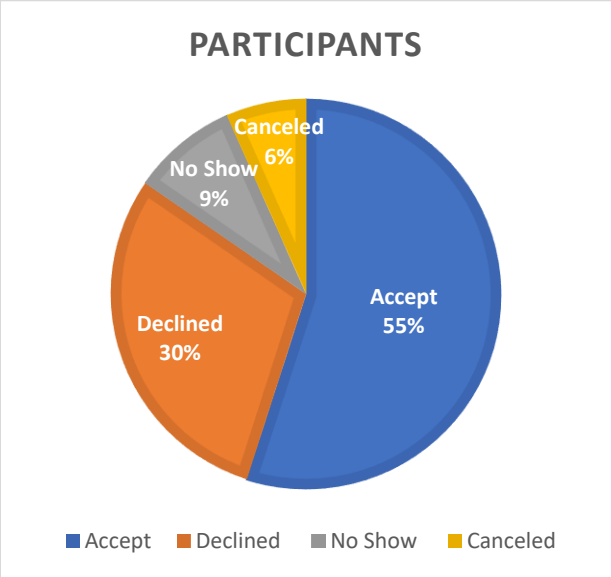


Figure 7 – Demographics

- they preferred to speak with the nurse during the procedure.
- they did not want to use the VR glasses device on their faces that would cover their sight at that moment of the IV procedure or port access.
- they did not want to try the VR experience (even if they had never experienced it before). They had a pre-conceived idea from what they had seen or heard on the TV or internet.
- they would rather see what the nurses were doing during the procedure.
- they were not feeling well at that moment (weak or nauseated).
- they had oxygen tubes on their faces.

The eight (9%) patients from the "No Show" group represented subjects who:

- frequently postponed their treatment.
- showed-up on a different date and time not scheduled with the researcher at the clinic.

- had to check-in at the hospital due to an emergency situation.

The six (6%) patients from the "Canceled" group represented subjects who agreed to participate in the research study, filling out the questionnaire for the Control Group, but who never experienced the VR and did not complete the Experimental Group survey due to:

- their health situation got worst, and he or she was admitted to the hospital.
- they were too weak at the second visit to meet with the researcher.
- others decided not to participate in the Experimental group and did not share the reason why with the researcher.

Results for Part One of the Study:

Interviewing: The interviews were audio recorded and transcribed. The researcher read it three times and concluded that on Question 1 (Q.1), *"During the timeline of the patient's treatment, when do you think the patient would experience more pain and stress? Would it be at the beginning, middle or towards the end of the chemotherapy? Please explain your answer,"* 100% of the oncologists and oncology nurses responded that the patient more likely would feel more stress at the beginning of the treatment. But pain could be felt at any moment:

"Definitely in the beginning. In terms of pain, you know, it can happen any point along the continuing (of the treatment), but especially if they develop advanced diseases." (Oncologist 1)

"I would say during the very first treatment is where they are the most stressed for sure." (Oncology nurse 1)

On the contrary, all former cancer patients and caregivers responded on Q.1, *"During the timeline of your treatment, when did you experience more pain and stress? Would it be at the*

beginning, middle or towards the end of the chemotherapy? Please explain your answer," that based on the report of their own experience (former cancer patient), the stress came more towards at the end of the treatment. The pain would vary from each person's experience.

"It was towards the end of her treatment." (Caregiver 1)

"The last part. The end because the chemo was so strong and very painful. I was stressed because I was still working." (Former Cancer Patient 2)

The data collected showed that the healthcare professionals have a misperception of the level of stress that cancer patients feel during the treatment. Clearly, the feedback from the patients or former cancer patients needs to be taken into consideration.

The questions 2, 3, 4, 5, and 6 on the interview questions related to patient side effects, alternative therapies, and ways to manage stress as well as pain. The perception and personal reports about side effects have demonstrated that 100% of cancer patients deal with some type of reaction from the treatment. The most common words used to describe the subject's side effects are stress, pain, fatigue, discomfort, nausea, weakness, sleepiness, restless legs, depression, and lack of appetite. When analyzing alternative therapies, oncologists and oncology nurses responded based on their own observations that patients like pet, art, and music therapies at the cancer center. Meditation, yoga, and Pilates were on the list of non-drug therapies as well. They have encouraged patients to seek local support groups.

At the same time, most caregivers and former cancer patients expressed one of the main reasons they did not seek cancer support groups was because they felt overwhelmed with the idea of listening to other cancer patients' problems. They would rather have a good time with their families, be close to friends they trust, seek God, and do exercise at their own pace. These results uncovered again that regarding seeking alternative therapies for cancer patients, most

healthcare professionals have a different perception than the caregivers and former cancer patients. Cancer patients prefer to be distracted by activities that take their mind away from anything and everything that relates to their treatment.

"I played a lot with my granddaughter." (Former Patient 1)

"I would be going to my daughter's volleyball games, so that kept me busy and would not have to think about it." (Former Patient 2)

Subsequently, responses related to ways of managing stress and pain show healthcare professionals, caregivers, and former patients using painkiller drugs to manage pain. However, 50% of the healthcare professionals interviewed in this study have never recommended patients to observe or walk through any kind of nature (garden, parks, forest, beach, etc.) in order to reduce their stress. The other half of the same group of experts has encouraged their patients to take a sunbath, leave the house for a walk, go to church, enjoy family, and have contact with nature:

"I try to encourage them (patients) to go outside, open the windows, see the sunlight. Even if they don't feel well, don't stay in bed… go for a walk, go to the park, around the neighborhood. They are in contact with nature. I think that the sunlight is important. If you are in the dark room all day long, you are going to get depressed. If you open the window, I think somehow it will stimulate something in your brain that will help you." (Oncologist 1)

On the same token, caregivers and former cancer patients have expressed that spending time with family, enjoying contact with nature, and praying have kept their mind distracted:

"The best thing for her was playing as much as she could with our great-granddaughter." (Caregiver 1)

"She was able to manage her pain and stress very well during the treatment through a lot of prayers, rest, love, and support (from family)." (Caregiver 2)

"During the treatment, I would go outside of my house to see nature. I would plant something." (Cancer Patient 2)

The questions 8 and 9 from both questionnaires asked the volunteers to choose the printed nature scene that they found more peaceful or relaxing. The researcher observed that all the subjects expressed a good attitude towards these questions. They spent more time trying to decide between scenes and happily enjoyed pointing out their suggestions. Their responses demonstrated that they picked the nature scenes that produced in them positive feelings, most likely those good experiences/memories from the past:

"They are all beautiful. To be honest, I'm most comfortable in the forest. I grew up playing in the woods, climbing trees and so forth. I would climb a tree and fall asleep there. So, if there is anything to do with forest, waterfalls, and mountains. There is where I'm most comfortable. If I have to choose the Virtual Reality scene, I would choose forest and be there most of the time. Beach is nice, but the forest is better." (Former Cancer Patient 1).

"Yes, I love the sound of water. It relaxes me big time. I will be honest. If I was near the ocean when I was going through, I wish I was. That would've put me out…it would relax me big time. Just the sound of the ocean or creek...big time." (Former Cancer Patient 2)

"I love the green… I love that… because there is a combination of water and green. Waterfalls are beautiful. I'm really into nature… I love the sounds… even birds the sounds of birds. I think it is really, really, beautiful." (Oncologist 2)

"I like the waterfall. The calmness of the waterfall... underwater too… I kind of like that. I like most the rainforest" (Oncologist nurse 2)

"I'm not good at swimming, so underwater no….I like the mountains... it calms me… the stillness… the forest is not bad, the flower too, but I like most the mountains." (Caregivers 1)

"I like the scenes at the beach with the sound of the ocean, but the mountains are the one that gives me peace." (Caregiver 2)

Schematic Diagramming:

The researcher designed a step-by-step Schematic Diagramming that helped lay out the results of the interviews. It was composed of forests, creeks, flowers, birds, and kids. Although from the beginning, the plan was to focus only on nature scenes, the data analysis of the first DT strategy (interviews) showed that the volunteers mentioned the importance of family during their recovery time as a point of distraction. Therefore, the research committee members approved adding family or kids at the end of the video, to meet the results of the previous design strategy.

Storyboarding:

Once the Schematic Diagramming was approved, a Storyboard was outlined to establish a timeline of the scenes. The researcher conveniently chose Florida parks and surrounding areas to capture images that include nature, Florida birds, creeks, and kids playing on the water. A 360-video camera was used to capture the images. Thus, a post-video editing software was used to produce the final video pilot to be presented during the Think-Aloud Testing strategy. The

total length of the video was 7 minutes. Nature sound and background music were added to the video.

Think-Aloud Testing:

The Think-Aloud Testing was audio recorded. Thus, the researcher transcribed the main points of the data collected. Three former cancer patients volunteered to participate in the DT strategy. The subjects used the VR One glasses and headphones while watching the 360-video simulation. At the same time, they informally dialogued with the researcher expressing their likes and dislikes and providing suggestions to improve the experience. The video was based on the Storyboard layout from the previous DT strategy. The first former cancer patients liked the nature sound, background music, and bubbling water creek. She disliked the lack of action in the scenery right in the beginning of the video. Also, she suggested to add more colorful nature scenes and flowers. In addition, she thought that the VR simulation would help her relax during her treatment.

The second former cancer patients liked the sound of birds, nature, background music, the kids playing in the water, flowers, waterfalls, and sound of water. She disliked the butterflies because the scenery was dark, traffic, and city buildings in the background of some scenes. She mentioned that buildings reminded her of work and stress. Moreover, she would have liked to see more flowers, hills, nature like mountains, beaches, kids playing with puppies, and baby laughing. She said, “It doesn’t matter if there are kids or people, but just watching someone playing with pets or doing something fun is relaxing.” The second subject approved the concept of VR simulations used for cancer patients. She thought that it would help her distract and maybe transport her to places she enjoys (like the beach), where she could not go during her treatment.

The third subject liked the sound of water, birds, nature, the background music, kids playing with water, the possibility to see 360-degree video, and the concept of Virtual Reality

He disliked roads, traffic, and buildings in the background of some scenes. Also, he suggested to add underwater scenes because he loves swimming, building a story out of the scenes, so it could have a nice sequence, more action, having more kids playing sports or anything that puts a smile on one's face, and add baby animals or puppies.

The third former cancer patient, despite his suggestions, expressed that the concept and video were very well done and thought-out. He mentioned that the videos relaxed him and took his mind away from things around him, allowing him to view all angles possible (360 degrees).

Results for Part Two of the Study:

The demographic data analysis from the survey questionnaire questions 1, 2, and 5 (see Figure 8) showed that from the total group sample (n = 50) of this study, 30% were male and 70% were female (see Figure 9).

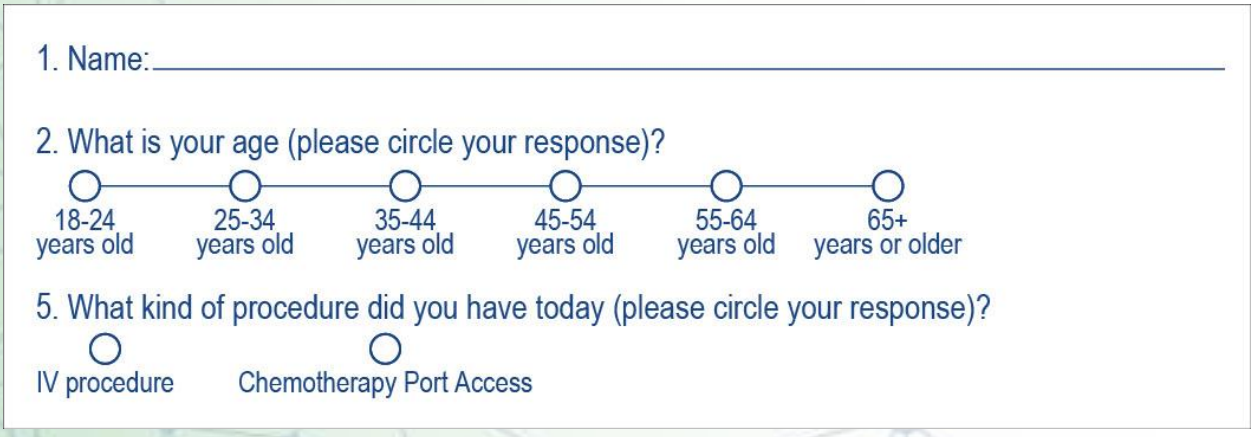


Figure 8 – Pretest and Posttest Questions 1, 2, & 5

The majority of the patients who agreed to do the survey were 65 years of age or older (see Figure 10). The reason was that Florida Cancer Affiliates is located in Ocala, Florida, where

according to U.S. Census Bureau (American FactFinder, 2017), 18.4% fit under this category. The number is close to the average of the state of Florida that has approximately 19.1% of the same population range. The data collected from question 5, "What kind of procedure did you have today? IV Procedure or Chemotherapy Port Access," revealed that 52% of the patients had IV Procedure and 48% had port access (see Figure 11). When analyzing questions regarding the perception of the patient's procedure in the Pretest questionnaire (see Table 4), the researcher found that 46 subjects agreed with "Today, I had a good experience during my procedure," while 3 subjects disagreed (M = 4.34; SD = 0.87). "Today, my experience at the Cancer Center was different," found 9 subjects in agreement, 34 who disagreed, and 7 were uncertain (M = 2.4; SD = 1.14). "My procedure was not stressful" found 39 subjects who agreed with the statement, while 7 disagreed (M = 4.04; SD = 0.87). In addition, "My procedure was not frustrating" had 46 subjects in agreement in contrast with 2 who disagreed (M = 4.2; SD = 0.78). "I was distracted during my procedure" showed 38 subjects who disagreed with the statement, while 9 subjects agreed (M = 2.2; SD = 1.04). "I was relaxed during my procedure" saw 42 in agreement, while 6 were in disagreement (M

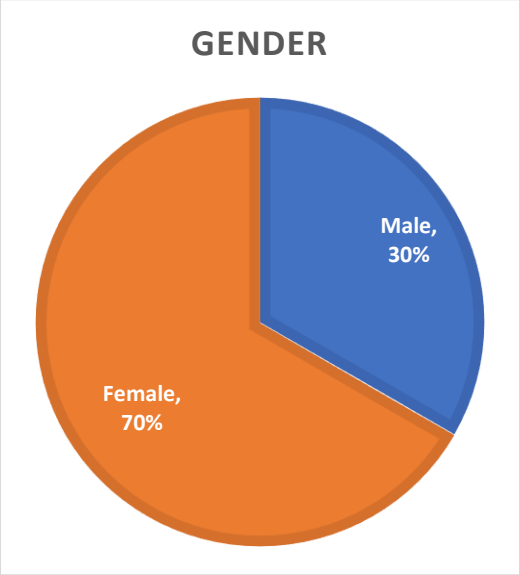


Figure 9 – Graphic Gender

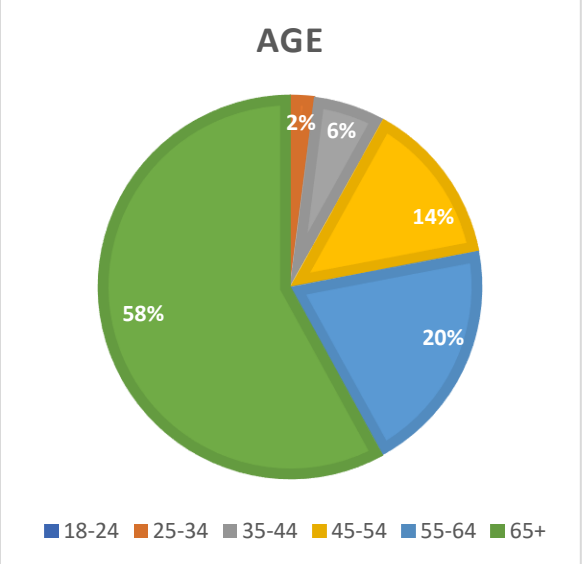


Figure 10 – Graphic Age

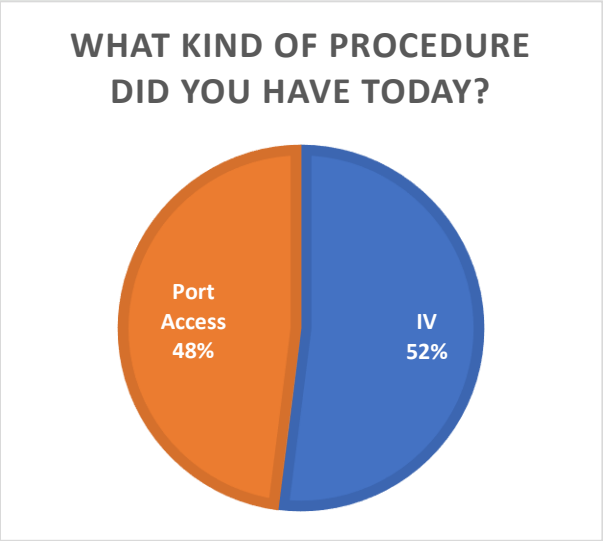


Figure 11 – IV vs Port Access

= 4.04; *SD* = 0.98). "I felt at peace during my procedure" saw 37 subjects in agreement with the statement, while 7 disagreed and 6 were uncertain (*M* = 3.98; *SD* = 1.03). "I felt no pain during my procedure" found 38 subjects in agreement in contrast with 10 who disagreed (*M* = 3.96; *SD* = 1.17) (see Figures 12 & 13). Subsequently, in the Posttest questionnaire (see Table 5), the researcher discovered that 49 subjects agreed with "Today, I had a good experience during my procedure," while 1 subject disagreed (*M* = 4.44; *SD* = 0.69). "Today, my experience at the Cancer Center was different" showed 28 subjects in agreement, 16 who disagreed, and 6 were uncertain (*M* = 3.32; *SD* =

Table 4 – Pretest 6-13

PRETEST	Strong Disagree	Disagree	Uncertain	Agree	Strong Agree	Mean
Question 6: Today, I had a good experience during my procedure:	1	2	1	21	25	4.34
Question 7: Today, my experience at the Cancer Center was different:	9	25	7	5	4	2.4
Question 8: My procedure was not stressful:	2	5	4	17	22	4.04
Question 9: My procedure was not frustrating:	1	1	2	29	17	4.2
Question 10: I was distracted during my procedure:	12	26	3	8	1	2.2
Question 11: I was relaxed during my procedure:	1	5	2	25	17	4.04
Question 12: I felt at peace during my procedure:	0	7	6	18	19	3.98
Question 13: I felt no pain during my procedure:	1	9	2	17	21	3.96

1.33). “My procedure was not stressful” revealed 47 subjects who agreed with the statement, while 3 disagreed (*M* = 4.28; *SD* = 0.83) and “My procedure was not frustrating” found 48 subjects in agreement in contrast with 2 who felt uncertain (*M* = 4.38; *SD* = 0.56). “I was distracted during my procedure” showed 26 subjects who agreed with the statement, while 20 subjects disagreed (*M* = 3.22; *SD* = 1.38). “I was relaxed during my procedure” found 45 in

Table 5 – Posttest 6-13

POSTTEST	Strong Disagree	Disagree	Uncertain	Agree	Strong Agree	Mean
Question 6: Today, I had a good experience during my procedure:	1	0	0	26	23	4.4
Question 7: Today, my experience at the Cancer Center was different:	6	10	6	18	10	3.32
Question 8: My procedure was not stressful:	1	2	0	26	21	4.28
Question 9: My procedure was not frustrating:	0	0	2	27	21	4.38
Question 10: I was distracted during my procedure:	6	14	4	15	11	3.22
Question 11: I was relaxed during my procedure:	0	1	4	24	21	4.3
Question 12: I felt at peace during my procedure:	0	0	5	22	23	4.36
Question 13: I felt no pain during my procedure:	0	4	7	21	18	4.06

agreement, while 4 subjects were uncertain (*M* = 4.3; *SD* = 0.70). “I felt at peace during my procedure” had 45 subjects in agreement with the statement, while 5 subjects were uncertain (*M* = 4.36; *SD* = 0.66). “I felt

no pain during my procedure” showed 39 subjects in agreement in contrast with 4 who disagreed (*M* = 4.06; *SD* = 0.91) (see Figures 14 & 15).

In analyzing the patients’ experiences at the IV station while using the VR glasses (see Table 6), the paired one-tailed t-test comparison indicated that H_1=*Patients will feel less stress*

when watching the VR simulation during their IV procedure or port access was not statistically significant (Q.8/P = 0.11). The patients' perception during the IV procedure at the Cancer Center did not show a significant improvement either (Q.6/P = 0.34). After an informal interview with patients regarding these questions, the researcher concluded that the subjects' responses were based on their IV procedure per se instead of the VR experience. In addition, the P-value of the questions that gave support to H_1, (Q.7/P = 0.00014 and Q.9/P = 0.04), were statistically significant. It is recommended, for future research, to re-write and include the word VR on the sentences and have the patient wear the VR glasses in the Pretest first other than in the Posttest. This way, it might reduce the margins of misinterpretation.

The results showed that H_2=*Patients will feel less pain when watching the VR simulation during their IV procedure or port access* was not statistically significant (Q.13/P = 0.28) However, Dr. Hunter Hoffman and David Patterson's (2011) studies showed that VR is a distraction that plays an important role in a patient who is suffering from pain. According to Dr. Patterson (2011), VR distraction appears to be most effective for patients with the highest pain intensity levels. Thus, when the subject was asked in Q.10, "I was distracted during my procedure," 52% of the patients responded that they agreed with the statement. Therefore, the subjects who were feeling pain might not have expressed it. Instead, they might have felt distracted by the VR experience during the IV procedure. Moreover, H_3=*Patients will feel more relaxed when watching the VR simulation during their IV procedure or port access* was statistically significant (Q.11/P = 0.05 and Q.12/P = 0.01). Lastly, H_4=*Patients will feel more distracted when watching the VR simulation during their IV procedure or port access* was statistically significant (Q.10/P = 0.000006).

In sum, the quantitative data revealed that patients who had the VR experience were statistically more distracted, felt less frustration, and were more relaxed than those who did not wear the VR glasses.

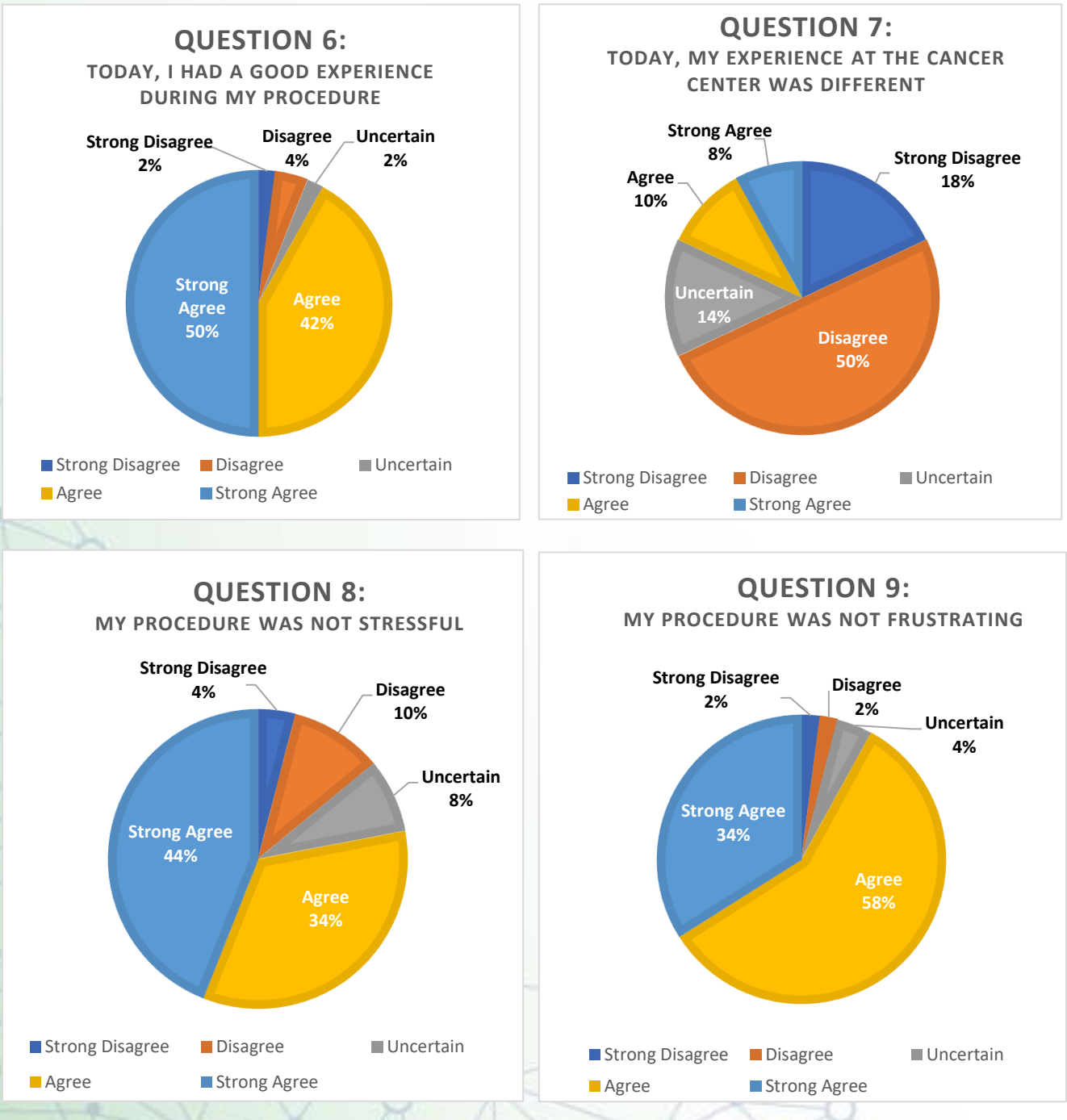
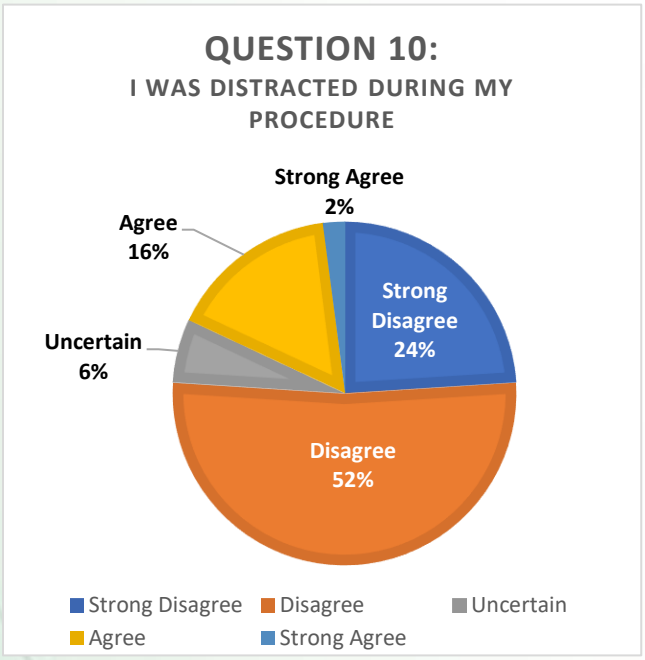
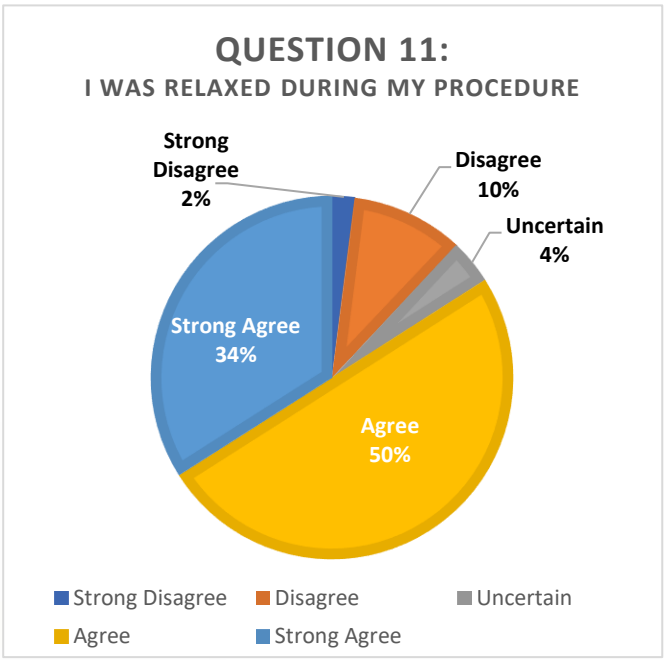
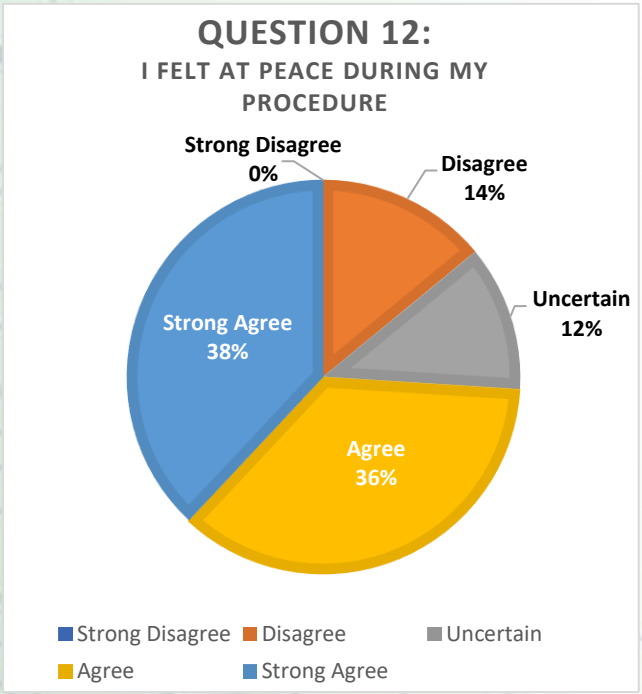


Figure 12 – Pretest Graphic Questions 6-9







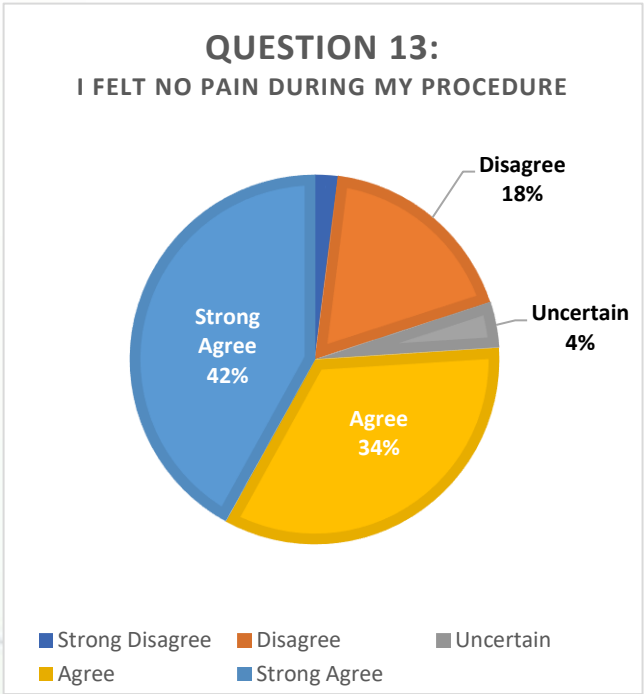
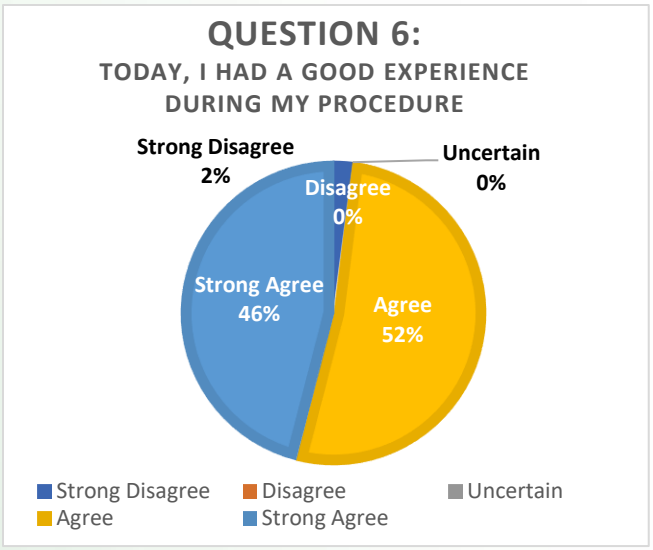
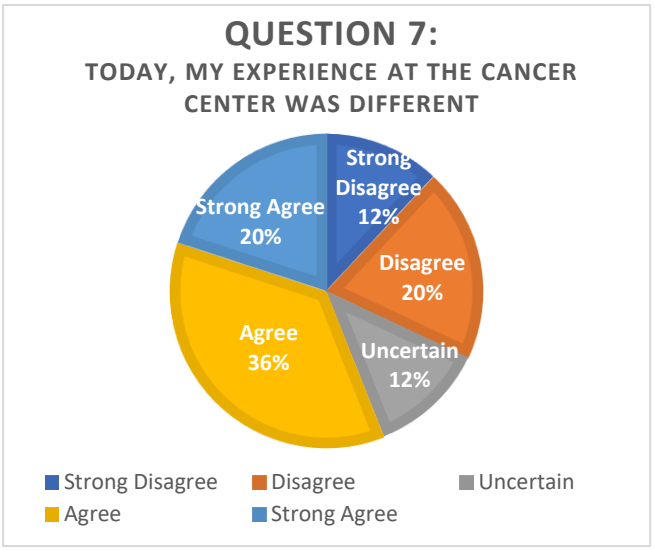
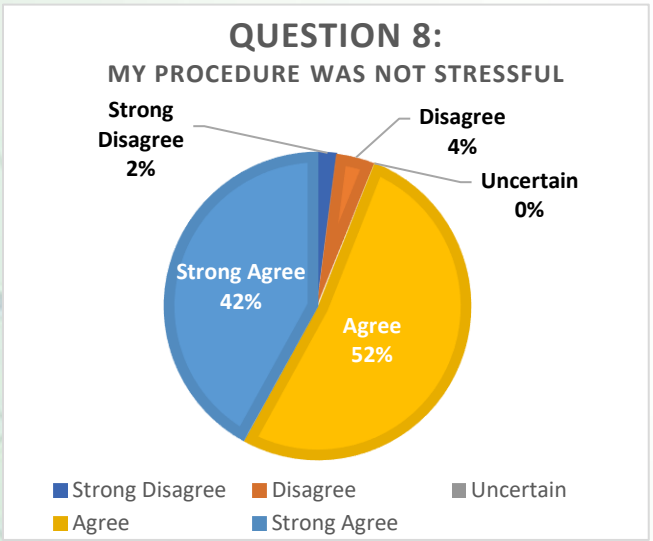
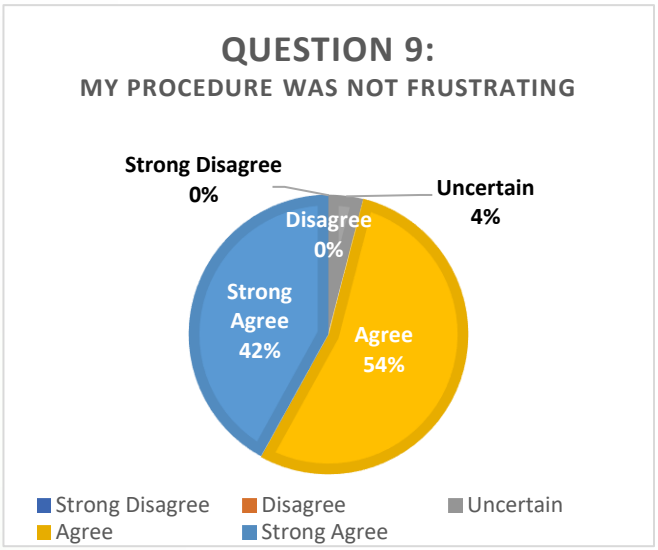


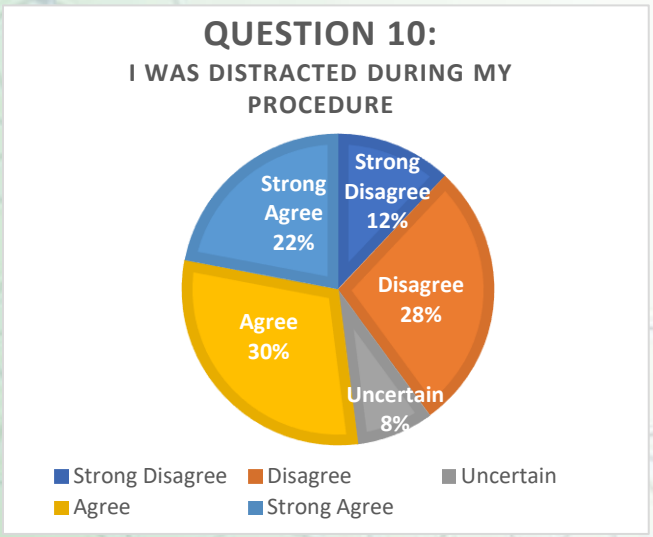
Figure 13 – Pretest Graphic Questions 10-13











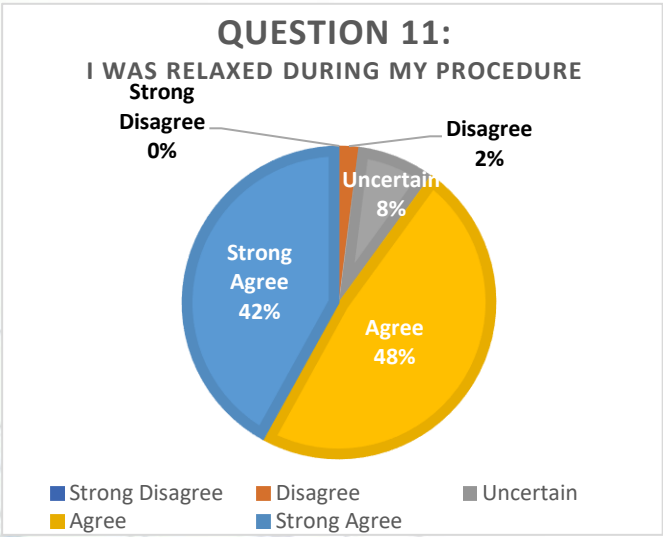
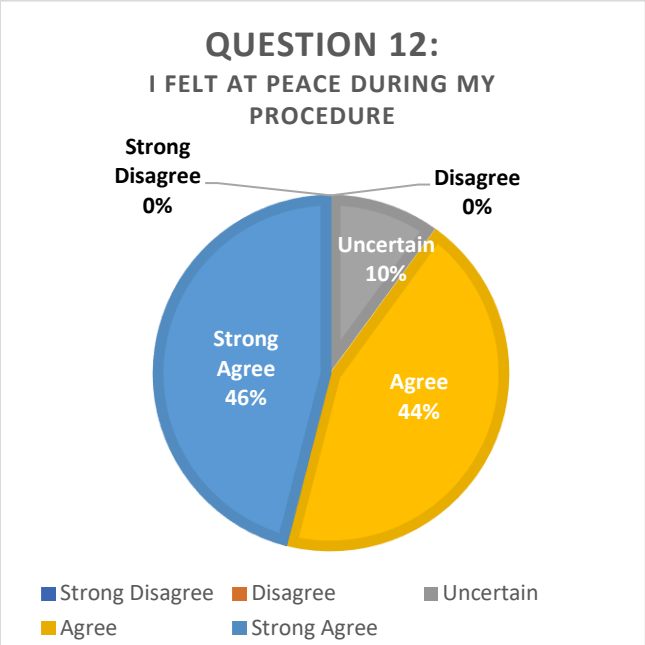


Figure 14 – Posttest Graphic Questions 6-11



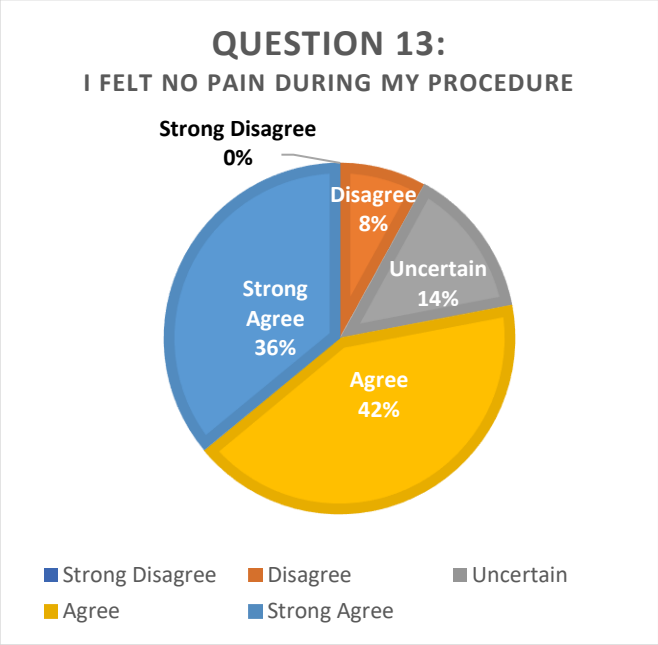


Figure 15 – Posttest Graphic Questions 12-13

Table 6 – T-Test and P-Value
Note: * p less than .05; ** p less than .01

PRE/POST TEST- df and Paired t-Test	df	One-Tailed P-Value	One-Tailed t-Test
Question 6: Today, I had a good experience during my procedure:	48	0.34	-0.39
Question 7: Today, my experience at the Cancer Center was different:	48	0.00014**	-3.92
Question 8: My procedure was not stressful:	48	0.11	-1.34
Question 9: My procedure was not frustrating:	48	0.04**	-1.70
Question 10: I was distracted during my procedure:	48	0.0000067**	-4.85
Question 11: I was relaxed during my procedure:	48	0.05*	-1.64
Question 12: I felt at peace during my procedure:	48	0.01**	-2.27
Question 13: I felt no pain during my procedure:	48	0.28	-0.5

Results – Qualitative Data:

In the Posttest questionnaire, the researcher added five open-ended questions about the perception of the VR simulation video (see Table 7). When analyzing these questions, the researcher independently read and coded through the responses three times. The following themes emerged from the qualitative data:

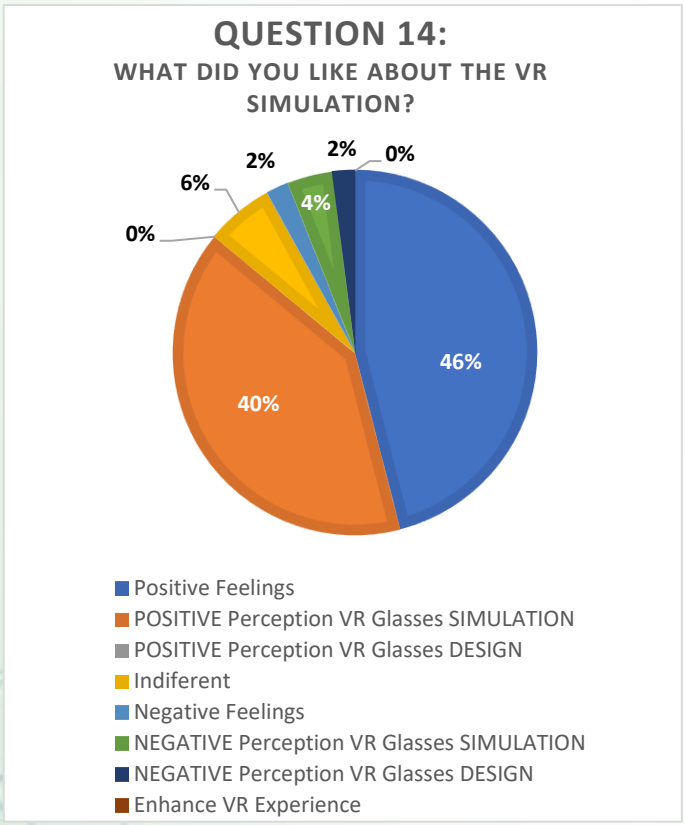
- positive feelings
- negative feelings
- positive perception of the VR glasses design (shape, weight, dimensions, etc.)
- negative perception of the VR glasses design (shape, weight, dimensions, etc.)
- positive perception of the VR simulation
- negative perception of the VR simulation
- suggestions to enhance the VR experience
- indifference

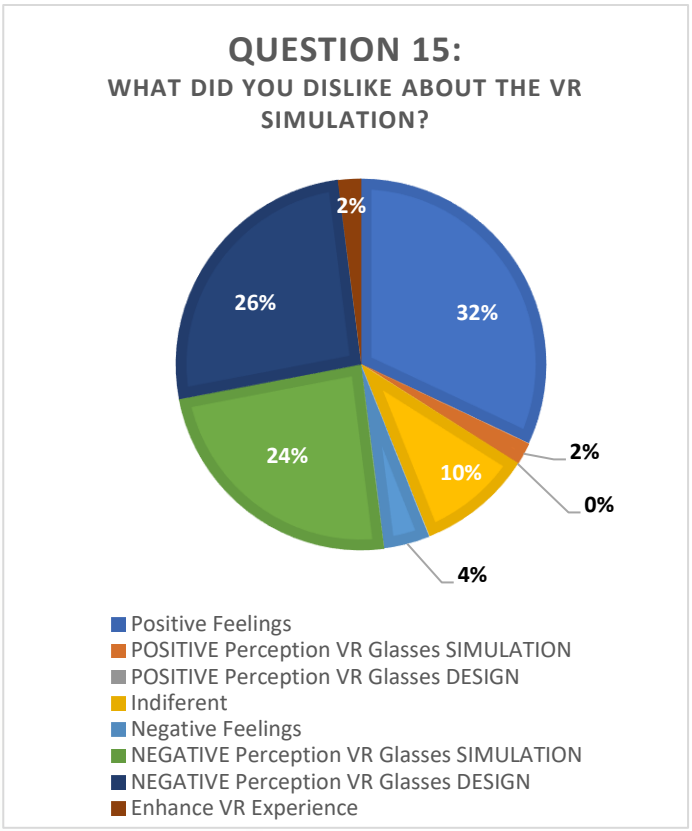
Questions 14, 15, and 16 referred to how the subject felt about the VR simulation. Questions 17 and 18 inquired about the subject's opinion on how the researcher could improve the VR experience in the future. When asked "What did you like about the VR simulation?" the results revealed that 86% of the patients had positive feelings about the experience and a positive perception of the VR simulation (see Figures 16 & 17). Quotes from patients include:

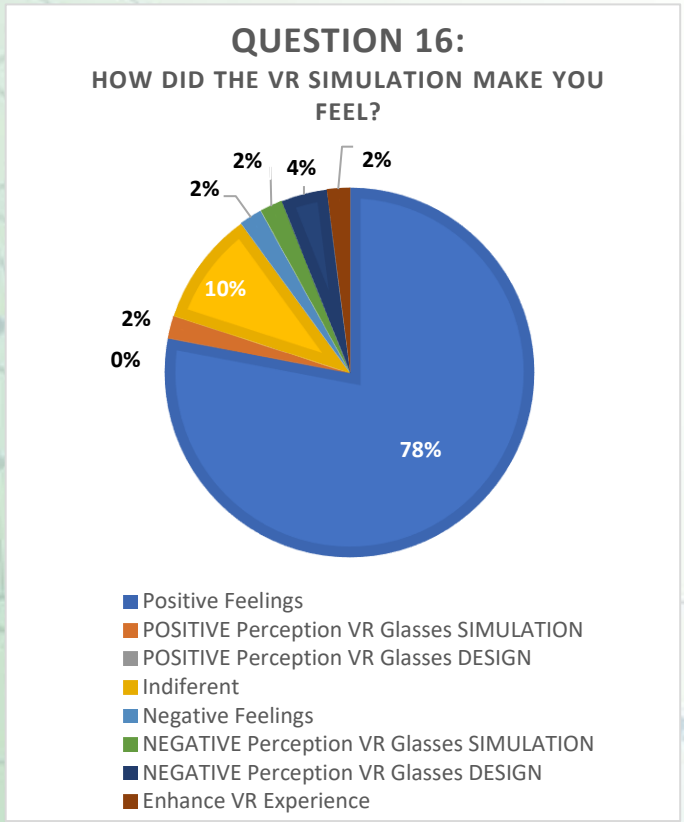
"Extremely beautiful. Awesome outdoors, the beautiful foliage, the very happy people and the serene flowering and water." (Subject 11)

Table 7 – Open-ended Questions 14-18

POSTTEST	Question 14: What did you like about the VR simulation?	Question 15: What did you dislike about the VR simulation?	Question 16: How did the VR simulation make you feel?	Question 17: Was there any particular scene you wish you could have looked at that was missing from the simulation?	Question 18: If you could change something about the VR simulation, what would it be?
Positive Feelings	23	16	39	1	2
POSITIVE Perception VR SIMULATION	20	1	1	1	2
POSITIVE Perception VR Glasses DESIGN	0	0	0	0	0
Indifferent	3	5	5	23	15
Negative Feelings	1	2	1	0	1
NEGATIVE Perception VR SIMULATION	2	12	1	0	2
NEGATIVE Perception VR Glasses DESIGN	1	13	2	0	7
Enhance VR Experience	0	1	1	25	21







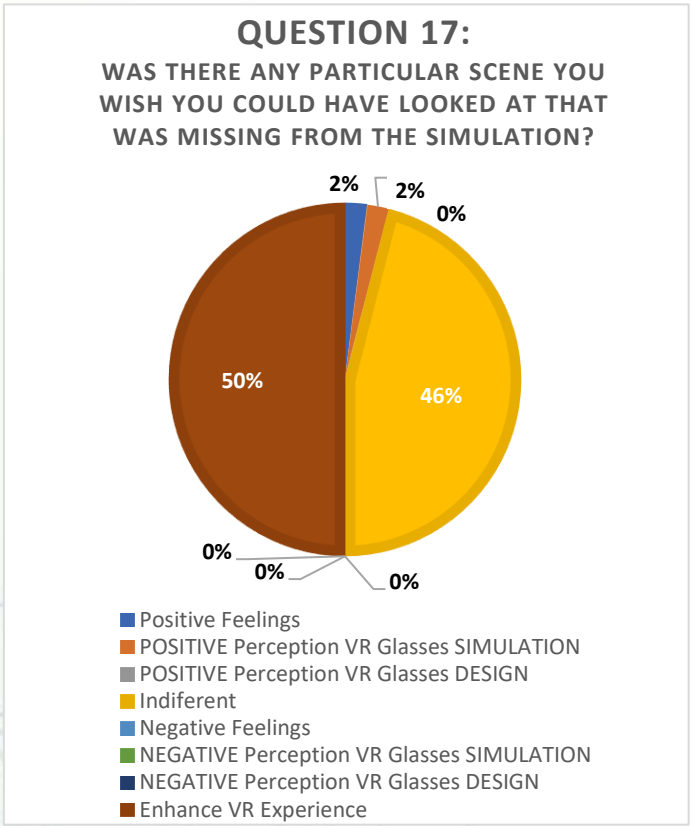


Figure 16 – Open-ended Questions 14-17

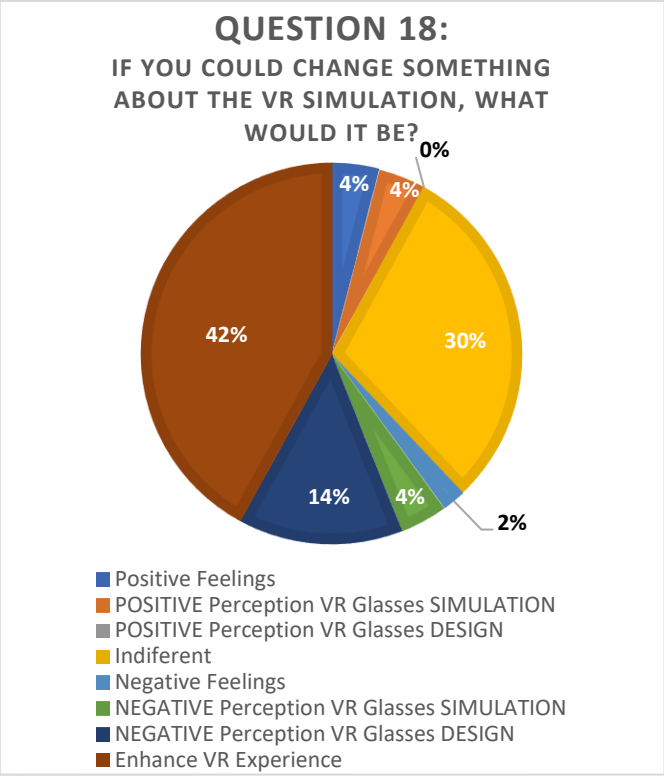


Figure 17 – Open-ended Questions 18

"Everything – especially the kids playing, picking flowers, stepping in the water. I liked the water fountain and the waterfalls." (Subject 12)

"Very calming effect, lovely images, distracted me and took me away from thinking about where I was (a cancer facility with sick people)." (Subject 27)

"It took my mind off the procedure and made me much more relaxed." (Subject 28)

"It gave me something to focus on other than what was happing." (Subject 34)

"It makes me feel as though I was actually visiting the park." (Subject 47)

The responses from "What did you dislike about the VR simulation?" revealed that 26% of the subjects had a negative perception of the VR design, 24% had a negative perception of the VR simulation, but on the other hand, 32% expressed that they had positive feelings about the VR experience. Here are some negative and positive perceptions about the VR experience:

"Sharpness (of the simulation)." (Subject 1)

"Wish I could wear my glasses." (Subject 15)

"Bulky headset." (Subject 19)

"The VR headpiece pinched my nose, but with adjustment, it was much better." (Subject 28)

"Nothing." (12 subjects used this word)

In response to the question "How did the VR simulation make you feel?" 78% of the subjects expressed that they had positive feelings about the VR experience while they were at the IV station. The subjects used the words peaceful, calm, pleasant, and relaxed, among others, to express their feelings (see Tables 8 & 9). The word "relaxed" was used 23 times and "distracting" 13 times to express positive feelings, while the words nature, pleasant scenery, and music were found 7 times each to express positive perceptions of the VR Simulation.

Table 8 – Open-ended Words A

Positive Feelings	n
Distracting	13
Happiness	4
Different Experience	1
Relaxed	23
Took my mind away	7
Nice	5
Immersed	1
Enjoyed	1
Love it	1
Calm	5
Pleasant	2
Good Memories	4
Interested	1
Peaceful	2
Comfortable	3
Good Effect	1

Positive Perception VR Simulation	n
Beautiful	3
Nature	7
Pleasant Scenery	7
Flowers	6
Outdoors	1
Foliage	1
Waterfall/water	6
Kids	2
Colors	3
Music	7
Squirrel	1

Negative Feelings	n
Anxious	1
Motion sickness	1
Couldn't see around	1

Table 9 – Open-ended Words B

Negative Perception VR Simulation	n
Adjustable sound to hearing aid	1
Music too loud/dislike	6
Lack of closure	1
Too much water	1
Color off	1
Blurry/Sharpness	7

Negative Perception VR Design	n
Heavy Glasses	14
Wish to be able to wear Glasses	2
Thick Cushion	1

On the last two open-ended questions, more than 92% of the patients expressed their suggestions on how to improve the VR glasses design and the simulation. The majority of them suggested that the simulation should have more categories to choose from, such as themes like beaches, mountains, puppies, bike paths, among others. Music and video length were also proposed to add as an option in the future to enhance the simulation (see Table 10). Some patients suggested wearing the VR experience after the chemotherapy infusion as a distraction and relaxation tool. In addition, 14% of the subjects expressed that the VR glasses design could be lighter and allow space for their prescription glasses. Here are some of the quotes:

"Adjustable sound level to set for hearing aids." (Subject 9)

"More of the serene blue skies, a sunrise, sunset, and the ocean waves rolling." (Subject 11)

"Wear my glasses." (Subject 15)

"No music, natural sounds, voices, birds, traffic, etc. Needs choices in optics." (Subject 18)

"Mask is too big." (Subject 20)

"Make it more educational, Informative, i.e.: some knowledge, history, science, lives of people." (Subject 23)

"I would like a theme or a story to follow, the video would be less disjointed." (Subject 27)

"Mountains with snow and skiers. Everything blended in together from scene to scene." (Subject 30)

"Would love a choice in the videos and/or possibly choice on length." (Subject 35)

"Beach, fish tank, puppies." (Subject 37)

"I'd be able to wear my glasses. It was a bit fuzzy." (Subject 38)

"Walking thru a path in the woods, bike path." (Subject 44)

"I would have liked a higher resolution. Many scenes were slightly blurry." (Subject 47)

Table 10 – Enhance VR Experience Words

Enhance VR Experience	n
Add Animals	3
More Nature	1
More Waterfall	1
Mountain	2
Ocean	3
Speed Sports	1
Traffic/city	1
Birds	3
Sea life	1
Guitar Singing	1
Beach and waves	4
Strong waterfall	1
Make more Educational	1
Fish swimming	1
Aquarium	2

Enhance VR Experience	n
Wildlife	1
More motion	1
Do half hour later than chemo	1
Visit other countries	1
Flying	1
Bike path	1
Puppies	1
Dolphins	1
Live Content	1
More Flowers	1
Tell a Story	1
Choice of video and length	3
Snow	1
Walking thru woods	1
Plants	1

When analyzing the qualitative data of open-ended questions, the researcher concluded that *H_1=Patients will feel less stress when watching the VR simulation during their IV procedure or port access* was supported. The data showed that 31 subjects felt happiness, immersed, calm, peaceful, that took their mind away, and had an enjoyable experience with the VR simulation. In an informal interview with the subjects, after they had finished with the simulation, many expressed that some scenes reminded them of places that brought good memories from where they were raised or when they did something like picking flowers or fishing on the creek at the farm. Such memories could be good or bad. According to Dr. Suthana, without our memories, each of us would be lost in time and cut off from other people. Therefore, the loss of memories cannot be taken for granted. When individuals loses their memories, it devastates their quality of life (Suthana, 2018).

H_2=Patients will feel less pain when watching the VR simulation during their IV procedure or port access was not supported by the qualitative data analysis. The subjects did not use the word *pain* in the open-ended questions. During my informal interview with them after the VR experience, they did not mention pain. Therefore, based on the researcher observation, few patients who were feeling pain during the procedure felt distracted while immersed in the VR experience. While some expressed they forgot about their surroundings*, "It took my mind away from what the nurse was doing" (Subject 30),* the majority did not mention pain.

H_3=Patients will feel more relaxed when watching the VR simulation during their IV procedure or port access was supported by the qualitative data analysis. The words *relaxed,* and *calm* were the most used on the open-ended question responses (28 times total). Part of the data collected included observation during the VR experience. The researcher noted that while the patients were enjoying their VR experience, many of them took a deep breath and changed their

position on the chair from a tense to a more relaxed sitting position. The body language of the patients demonstrated that the VR simulation was affecting their minds and the body reacted by generating positive feelings and consequently positive results while facing a stressful situation. These were additional data sources that were used to triangulate the results.

H_4=Patients will feel more distracted when watching the VR simulation during their IV procedure or port access was supported by the qualitative data analysis. The words and expressions *distracting took my mind away, different experience,* and *bring good memories* were found on the open-ended questions responses 25 times. *"It kept me calm and distracted" (Subject 32)* was the statement that most the subjects used while expressing their positive feelings about the VR simulation. The researcher observed that the subjects turned their heads to the left, right, and up many times (see Figure 18).

Figure 18 – Patient Exploring the 360-Degree Video

This body expression reflected that the patients were exploring the 360° simulation video and taking their mind away from their present situation. The subjects' facial expression changed as well. While the subjects were experiencing the VR simulation, the researcher interviewed the caregivers who were accompanying and observing them at the same time. Both caregiver and researcher noticed the subjects' facial expression changed from a stressed countenance to an expression of relaxation based on facial muscles. Dr. Ekman studies show that happiness can be detected when individuals raise their lip corners and cheeks and narrow the eyelids. Thus, sadness would cause the subjects to narrow their eyes, bringing together their eyebrows and mouth turning down at the corners (Pelham, 2017). These were the exact description of the patients' faces before and after the VR experience. They went from sadness/stressful to a happy/relieved face. Therefore, in the qualitative data, body language and facial expression before and after the subjects watching the VR simulation were observed, bringing to the conclusion that the majority of the subjects were relaxed and/or positively distracted during their VR experience while at the IV station.

Limitations:

Subject mortality was a problem due to the following reasons:

- A few patients, who signed the consent form, decided to quit the VR experience during the second visit with the researcher. Some were not in a good mood and others were not feeling well.
- Subjects, who had participated in the control group and filled out the posttested questionnaire, did not show up as scheduled due to a health complication.

Moreover, 58% of the subjects were over the age of 65 years of age due to the clinic being near the location of a retiree community. It is yet to be seen, but the results of a younger patient diagnosed with cancer experiencing the VR simulation may differ from the older individuals who participated in this study.

CHAPTER 5: DISCUSSION

In the search for support of the hypotheses of this study, the researcher found the importance of making good memories, which in return could positively affect cancer patients during treatment. Corrie Ten Boom, a Christian Dutch watchmaker who helped many Jews escape from the Nazi Holocaust and was imprisoned for her actions during World War II, once said, *"Memories are the key not to the past, but to the future."*

The research findings have revealed that Virtual Reality simulation is a key that has the potential to unlock good memories in the cancer patient's brain and trigger a process of relaxation capable of reducing stress through sensory stimuli. The literature review has shown that emotions are intimately involved in the initiation or progression of cancer, among other diseases (Barak et al., 2006). An individual who experiences enjoyable emotions decreases cortisol levels caused by stressors factors and strengthens the immune system (Salimetrics, n.d.). In addition, this study confirms that human beings are biologically programmed to respond to a wide variety of environmental cues and natural stimuli (Barton et al., 2016). Therefore, contact with nature is vital for human intellectual development since the natural world is the most information-rich and sensory-stimulating environment people can ever encounter (Kellert et al., 2012). Humans and nature were designed by God – The Creator – to have a symbiotic relationship between them. In the current age, technology, like VR, can play an important role in an individual's life. Visual exposure to natural scenes and natural sound can facilitate mood recovery (Benfield et al., 2014). The quantitative data of this research illustrates that VR simulation of nature scenes, while oncology nurses are aiding IV procedure or accessing an individual's port, has the potential to distract, relax, and reduce frustration in cancer patients.

Hence, hypothesis 3 and 4 were statistically significant. Moreover, the qualitative data, in the same setting, showed that the subjects were less stressed, more relaxed, more distracted, and less frustrated. Thus, hypothesis 1, 3, and 4 were supported.

The size of the cancer center where this study took place contributed to this research especially during the qualitative data collection. The researcher had the opportunity to spend more time with the patients, informally interviewing them with the objective of discovering connections between their life experiences and the relationship with their responses on the open-ended questions regarding the VR simulation. This dialogue helped the researcher's understanding regarding stimuli that trigger patients' positive or negative feelings toward the VR simulation during their IV procedure. However, it is important to note that prior to the cancer center visit, the Design Thinking strategies paved the way, uncovering to the researcher the reactions of the healthcare professionals, caregivers, and former cancer patients towards nature scenes presented during the process. The data analysis from the interviews helped the researcher better understand the type of VR simulation that was necessary for cancer patients' engagement. Thus, a pilot version of the VR simulation was designed for the cancer patients at the clinic. It was concluded that each person has his or her own way to manage stress.

According to the qualitative data analysis, the words *relaxed, distracted,* and others similar were used 53 times in the open-ended questions. The researcher observed the body language and the facial expressions of the patients before, during, and after the VR experience (see Figure 19). It was verified that the subjects responded very well to the VR simulation and this innovative solution has the potential of improving patients' perception of the hospitals and clinics. This kind of implementation could likely grow patient satisfaction, loyalty to the establishment, as well as increase trust to the treatment. At the same time, this research has

Figure 19 – Patient's Body Language

revealed that a good number of subjects would like to see improvements in the design of the VR glasses and the sharpness of the simulation images. They used expressions like *bulky headset, lack of sharpness, heavy mask,* and so forth. Future research should re-design the VR glasses and use better equipment as well as software that could produce higher-quality images.

The implication of these results is that memories matters. The future investigation could go one-step forward tracking brain waves of cancer patients while experiencing VR simulation with the purpose of building a therapeutic prescription for each patient. Ten Boom must be right stating that *memories are the key to the future*. Virtual Reality is a tool that triggers one's memories, unveiling a sequence of healing processes that culminate in a better patient quality of life through stress reduction and increased relaxation during IV port procedures.

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APPENDIX A – Interview Consent Letter

College of Visual and Performing Arts Department of Design

RADFORD UNIVERSITY

P.O. Box 6967 Radford, VR 24142 – (540) 831-5386 – (540) 831-6719 FAX – www.radford.edu

VIRTUAL REALITY FOR CANCER PATIENTS: A DESIGN THINKING APPROACH FOR A SENSORY EXPERIENCE TO REDUCE STRESS AND PAIN LEVELS

You are invited to participate in a voluntary research study that will design the video content of a Virtual Reality Glasses simulation in order to reduce pain and stress levels among patients in a cancer treatment center. The purpose of this research is to interview participants who have experience with cancer to determine the design of the virtual scenes for the Virtual Reality headset device. The study is being conducted by Diana Scates, a graduate student in the Department of Design at Radford University (239 McGuffey Hall, Box 6967, Radford VA 24142, 321-234-2166, dscates@email.radford.edu).

As part of our Design Thinking process, we will individually interview oncologists, caregivers, oncology nurses, and former cancer patients. The purpose of the interview is to collect data that may determine which virtual scenes the student researcher will select for the Virtual Reality session that current chemotherapy patients will eventually experience. We estimate that it will take about 20 minutes of your time to participate in the interviews. You are free to contact the investigator at the above address and phone number to discuss the research.

The interview session will be audio-record for further analysis. Risks to participants are considered minimal. There will be no costs for participating, nor will you directly benefit by participating. There is no identifying information on the interview questions. Only Diana Scates will have access to the data during data collection and analysis. All responses will be kept private and will be stored in a locked file cabinet and/or a password-protected computer in a locked office.

You must be over the age of 18 to participate in this research study, and your participation in this study is voluntary. You may decline to answer any question and you have the right to withdraw from participation at any time without penalty. If you wish to withdraw from the study or have questions, please contact Diana Scates at 321-234-2166 or send an email to dscates@email.radford.edu.

If you have any questions about your rights as a study participant, or if you are dissatisfied at any time with any aspects of this study, you may contact -

anonymously, if you wish – Dr. Laura Jacobsen - Acting Dean of the College of Graduate Studies and Research, ljacobsen@radford.edu, 540-831-5470.

IRB approval number:

If you agree to participate, please sign below. Thank you.

_____	_____	_____	_____
Signature	Print Name	Profession	Date

APPENDIX B – Interview Questionnaire

INTERVIEW QUESTIONS:

For oncologists, caregivers, and oncology nurses.

1- During the timeline of the patient's treatment, when do you think the patient would experience more pain and stress? Would it be in the beginning, middle or towards the end of the chemotherapy? Please explain your answer.

2- In your experience, what have you observed patients doing to relief stress or pain during chemotherapy treatment?

3- What type of activities have patients participated in while receiving their chemotherapy treatments? For example, yoga/Pilates, music and stress management class, arts and craft.

4- Based on your experience, did patients express any side effect during treatment?

5- What do you recommend to patients when they express that they are in pain or experiencing stress?

6- Are you open to any integrative and complementary therapies that may help patients cope with side effects? Please explain your answer.

7- Have you ever recommended patients who are under pain or stress to observe nature scenes or walk (if possible) through a garden or a nature-like environment? Please explain your answer.

8- Which of the images or scenes do you find more peaceful, relaxing and tranquil? (nature images will be showed here) Why?

APPENDIX C - Interview Questionnaire

INTERVIEW QUESTIONS:

For former cancer patients (survivors)

1- During the timeline of your treatment, when did you experience more pain and stress? Would it be in the beginning, middle or towards the end of the chemotherapy? Please explain your answer.

2- In your experience, what did you do to relief stress or pain during chemotherapy treatment?

3- Did you participate in any activity while receiving chemotherapy treatment? If yes, which one(s): for example, yoga/Pilates, music and stress management class, arts and craft.

4- Were you part of some kind of support group?

5- Did you experience any side effect during your treatment?

6- At the time of your treatment, were you open to any integrative and alternative therapies that might help you cope with side effects? Please explain your answer.

7- In case you were not open for alternative therapies at the time of your treatment, would you consider or recommend to a new patient a holistic approach to reduce stress and pain?

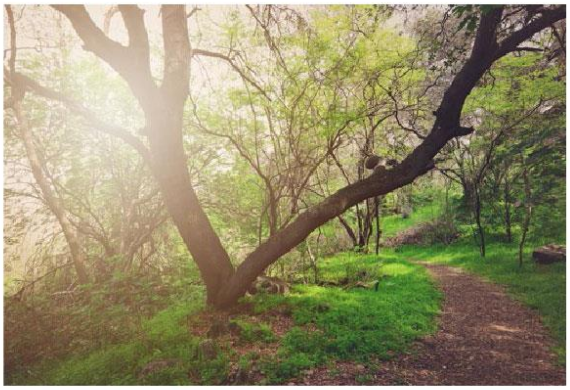
8- Did nature images (still or video) or walking at a garden/park make you few less stress during your treatment? Why? Please explain your answer.

9- Which of the images or scenes do you find more peaceful, relaxing and tranquil? (nature images will be showed here) Why?

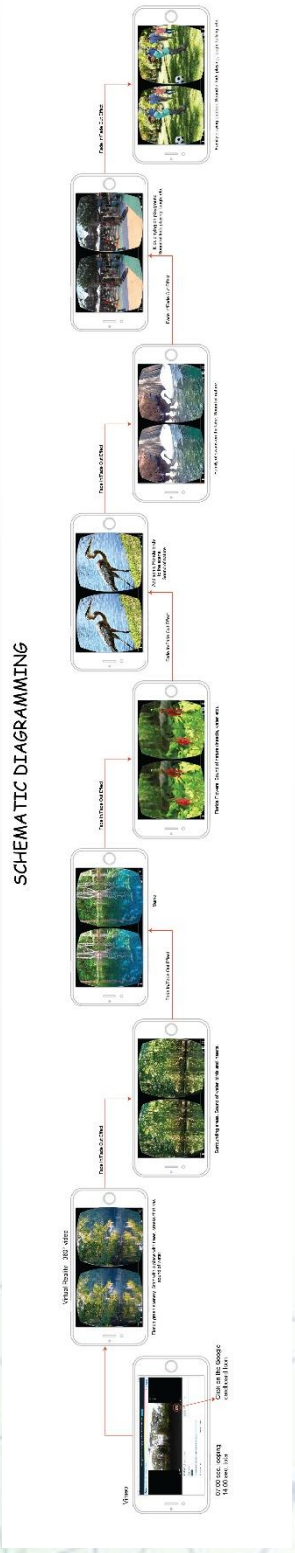
APPENDIX D – Nature Scenes

Virtual Reality for Cancer Patients: A Design Thinking Approach for a Sensory Experience to Reduce Stress and Pain

Nature Images


APPENDIX E – Schematic Diagramming



APPENDIX F – Storyboard

APPENDIX G – Think-Aloud Testing

College of Visual and Performing Arts Department of Design

RADFORD UNIVERSITY

P.O. Box 6967 Radford, VR 24142 – (540) 831-5386 – (540) 831-6719 FAX – www.radford.edu

VIRTUAL REALITY FOR CANCER PATIENTS: A DESIGN THINKING APPROACH FOR A SENSORY EXPERIENCE TO REDUCE STRESS AND PAIN LEVELS

You are invited to participate in a voluntary research study that will help design the video content of a Virtual Reality Glasses simulation in order to reduce pain and stress levels among patients in a cancer treatment center. The purpose of this research is to observe and listen to your reaction to the Virtual Reality Glasses simulation design. The study is being conducted by Diana Scates, a graduate student in the Department of Design at Radford University (239 McGuffey Hall, Box 6967, Radford VA 24142, 321-234-2166, dscates@email.radford.edu).

If you decide to be in the study, you will be asked to participate in a design thinking strategy, Think-Aloud Testing. The design thinking strategy will last one hour. During this time, you will be asked to use the video application designed for the Virtual Reality (VR) headset device. The purpose of this design thinking strategy is to observe and listen to people's reaction to the video content as it is intended to uncover opportunities for improvement of the application. Approximately three former chemotherapy patients will participate in this strategy. While you are using the Virtual Reality headset device, you will be asked to discuss out-loud your experience (what you like, dislike, how you feel, and your suggestions to improve). As you are talking about your experience, you will be audio-recorded and others in the group (i.e., the student researcher and two other former chemotherapy patients) will hear your thoughts. Each individual who participates will wear the VR headset for approximately 15 to 20 minutes.

Risks to participants are considered minimal. There will be no costs for participating, nor will you directly benefit by participating. There is no identifying information during this design thinking strategy. Only Diana Scates will have access to the data during data collection and analysis. All responses will be kept private and will be stored in a locked file cabinet and/or password-protected computer in a locked office. Recording of the session will occur on a password-protected cell phone. Data from the audio-recording will immediately be transferred to the password protected computer.

You must be over the age of 18 to participate in this research study, and your participation in this study is voluntary. You may decline to stop using the Virtual Reality headset device at any time and you have the right to withdraw from participation at any time without penalty. If you wish to withdraw from the study or have questions, please contact Diana Scates at 321-234-2166 or send an email to dscates@email.radford.edu.

If you have any questions about your rights as a study participant, or if are dissatisfied at any time with any aspects of this study, you may contact - anonymously, if you wish – – Dr. Laura Jacobsen, Acting Dean of the College of Graduate Studies and Research, ljacobsen@radford.edu, 540-831-5470.

IRB approval number:

If you agree to participate, please sign below. Thank you.

_____	_____	_____
Signature	Print Name	Date

APPENDIX H – Support Letter

College of Visual and Performing Arts Department of Design

RADFORD UNIVERSITY

P.O. Box 6967 Radford, VR 24142 – (540) 831-5386 – (540) 831-6719 FAX – www.radford.edu

Re: Letter of Support for the following thesis: *"Virtual Reality for Cancer Patients: A Design Thinking Approach for a Sensory Experience to Reduce Stress and Pain"*

To: **Florida Cancer Affiliates - Ocala**
433, SW 10th Street
Ocala, FL 34471
Tel: 352.732.4032

From: Dr. Joan I. Dickinson, Principal Investigator and Mrs. Diana Scates, Student Researcher

The purpose of this research study is to assess the design of a Virtual Reality (VR) simulation among cancer patients while the oncologist nurse is accessing the individual's port or executing the IV procedure in order to evaluate the reduction of stress and pain. Florida Cancer Affiliates (FCA) in Ocala, Florida will be the cancer center where the student researcher will implement this study. At FCA, the space designated to assess the patient's port and to do the IV procedure is called the IV station. Florida Cancer Affiliates has agreed to work with the principal investigator and student researcher by providing the following:

1. Florida Cancer Affiliates will identify a total of 50 (fifty) adult cancer patients who are scheduled to receive chemotherapy treatment using port access or IV procedures at the IV station. The patients must be over the age of 18 and must know how to read and fill out a questionnaire form at the end of the experiment.

2. The student researcher will meet with the research oncologist Dr. Rama Balaraman, MD ahead of time at the Florida Cancer Affiliates (FCA) clinic in Ocala, Florida and purposely select the participants assigned to the IV station. The goal is to recruit a total number of 50 (fifty) cancer patients who are over the age of 18. The same patient will participate in both the experimental and control groups. The experimental group will receive the Virtual Reality headset device glasses and the control group will not.

3. At the IV station, the oncologist nurse and the student researcher will meet each patient individually to review the consent form, explain the study in detail, and provide time for questions. The same patient will be recruited to participate in both experimental and control groups. After each volunteer has signed the consent letter, the participants will receive their usual port or IV access. Once the procedure is done, the participant will complete a questionnaire that examines their perceptions of pain and stress. The oncologist nurse will inform the student researcher of the patient's next visit where he or she will be participating as part of the experimental group.

4. On the patient's next visit, prior to receiving the usual port or IV access, the patient will receive a pair of Virtual Reality headset glasses to wear during the procedure. The student researcher will record how long each participant wears the glasses for a maximum of 15 minutes. The nature view simulation is based on a sequence of 3 to 5-minute videos. Participants may wear the VR headset glasses at their own pace for a maximum of 15 minutes. The VR device is lightweight and easy to remove from the face. During the simulation, the participant may take the VR headset glasses off at any time they wish. As soon as the 15-minute time limit period is up and the IV access procedure is done, the individual will be post tested on the dependent variables (stress and pain) throughout the completion of a questionnaire. An oncologist resident physician and oncology nurse will be assisting the student researcher during this study.

5. The student researcher Diana R. O. Scates will be the first author of this study. Radford University faculty advisory board Dr. Joan I. Dickinson, Dr. Holly Cline, Ms. Kathleen Sullivan, and Florida Cancer Affiliates researcher Dr. Rama Balaraman, MD will be co-authors of this research. In addition, the resident physician will be cited as an assistant. First author, co-authors, and assistant will be included in all publications and presentations related to this study.

Florida Cancer Affiliates has provided permission and support to conduct the research study at their facilities as listed above.

Signature:

_____

Rama Balaraman, MD
Medical Oncology, Hematology, and Research Doctor
Florida Cancer Affiliates
Rama.Balaraman@usoncology.com

APPENDIX I – Consent Letter Part 2

College of Visual and Performing Arts Department of Design

RADFORD UNIVERSITY

P.O. Box 6967 Radford, VR 24142 – (540) 831-5386 – (540) 831-6719 FAX – www.radford.edu

Adult Informed Consent – Survey Research

VIRTUAL REALITY FOR CANCER PATIENTS: A DESIGN THINKING APPROACH FOR A SENSORY EXPERIENCE TO REDUCE STRESS AND PAIN LEVELS

Researcher(s): This study is beingconducted by Diana R. O. Scates, a graduate student in the Master of Fine Arts in the Design Thinking program at Radford University (239 McGuffey Hall, Box 6967, Radford VA 24142, dscates@email.radford.edu) and Dr. Joan Dickinson, Professor, Department of Design at Radford University (239 McGuffey Hall, Box 6967, Radford VA 24142, 540-818-1669, jidickins@radford.edu).

We ask you to be in a research study designed to determine if a Virtual Reality nature simulation reduces stress and pain in cancer patients during their IV procedure or while the oncologist nurse is accessing the patient's port. There are two parts to this study. For part one, you will receive your typical port or IV access procedure and at the end of the procedure, you will fill out a questionnaire about your experience. Part one of the study will take 30 minutes of your time.

For part two, on your next visit to the Florida Cancer Affiliates, you will wear Virtual Reality (VR) headset glasses and headphones during your port or IV access procedure. The VR simulation will be a sequence of 7 minutes of video loop and the total duration of the VR Headset glasses experience will take 14 minutes. Once the 14 minutes is up and your IV procedure is finished, you will complete a questionnaire that asks you about your perceptions during the VR simulation. Part Two of the study will take 30 to 35 minutes of your time from start to finish. Approximately 50 people of any gender or race and over the age of 18 will be asked to participate in the study.

The risks to this study are minimal. The VR headset glasses and headphones are lightweight and can be removed at any time during your procedure. The simulation content used in the VR headset glasses is nature inspired meant to provide a tranquil, peaceful, and relaxing experience.

There is no fast movement in the simulation. In case of any discomfort when wearing the VR glasses, you can immediately take the glasses off.

There is no compensation for being in this study, and there are no direct benefits to you for being in the study. You can choose not to be in this study, and if you decide to be in this study, you may choose not to answer certain questions or not to be in certain parts of this study. There are no costs to you for being in this study. If you decide to be in this study, what you tell us will be kept private. If we present or publish the results of this study, your name will not be linked in any way to what we present.

You should not be in the study if you have any physical or mental illness or weakness that would increase your risk of harm from the study. If at any time you want to stop being in this study, you may stop being in the study without penalty or loss of benefits by contacting: Joan Dickinson, Professor, Department of Design, 540-818-1669. If you have questions now about this study, ask before you sign this form. If you have any questions later, you may talk with Diana Scates, dscates@email.radford.edu or Joan Dickinson, jidickins@radford.edu, 540-818-1669. If this study raised some issues that you would like to discuss with a professional, you may contact Joan Dickinson, jidickins@radford.edu, 540-818-1669.

This study was approved by the Radford University Committee for the Review of Human Subjects Research. If you have questions or concerns about your rights as a research subject or have complaints about this study, you should contact Dr. Laura J. Jacobsen, Interim Dean, College of Graduate Studies and Research, Radford University, ljacobsen@radford.edu, 1-540-831-5470.

It is your choice whether or not to be in this study. What you choose will not affect any current or future relationship with Radford University. If all of your questions have been answered and you would like to take part in this study, then please sign below.

_____	_____	_____
Signature	Printed Name(s)	Date

I/We have explained the study to the person signing above, have allowed an opportunity for questions, and have answered all of his/her questions. I/We believe that the subject understands this information.

_____	_____	_____
Signature of Researcher(s)	Printed Name(s)	Date

Note: A signed copy of this form will be provided for your records.

APPENDIX J – Letter of Support from FCA

FLORIDA CANCER AFFILIATES

Re: Amendment Letter of Support for the following thesis: *"Virtual Reality for Cancer Patients: A Design Thinking Approach for a Sensory Experience to Reduce Stress and Pain"*

To: **Radford University – IRB – Dr. Laura Noll**
P.O. Box 6967
Radford, VA 24142
Tel: 540.831.5386

From: Sharon Bucher, Practice Administrator of Florida Cancer Affiliates (FCA)

I, Sharon Bucher, Practice Administrator of FCA hereby declare that Dr. Rama Balaraman (medical oncologist, hematologist, and head of research at FCA) is fully authorized by the Florida Cancer Affiliates institution to sign the letter of support provided by Diana Scates - Radford University student researcher to conduct the M.F.A. in Design Thinking thesis in the FCA facility.

I further declare that the information provided in this letter is true.

Sincerely,

_____

Sharon Bucher
Practice Administrator
Florida Cancer Affiliates - Ocala
433, SW 10th Street
Ocala, FL 34471
Tel: 352.732.4032
http://floridacancer.com/

APPENDIX K – Questionnaire Pretest

QUESTIONNAIRE - 1=PRETEST (CONTROL):

Virtual Reality for Cancer Patients: A Design Thinking Approach for a Sensory Experience to Reduce Stress and Pain

Below are a number of questions related to your experience during your procedure.
Please read each question and indicate your response in the blank provided or circle the correct response.

Demographic Questions:

1. Name:_____

2. What is your age (please circle your response)?

○ 18-24 years old ○ 25-34 years old ○ 35-44 years old ○ 45-54 years old ○ 55-64 years old ○ 65+ years or older

3. What type of cancer are you diagnosed with?_____

4. What is the cancer stage?_____

5. What kind of procedure did you have today (please circle your response)?

○ IV procedure ○ Chemotherapy Port Access

Perceptions Regarding Your Procedure Today:

For the questions below, please circle your response.

6. Today, I had a good experience during my procedure:

○ Strongly Disagree ○ Disagree ○ Uncertain ○ Agree ○ Strongly Agree

7. Today, my experience at the Cancer Center was different:

○ Strongly Disagree ○ Disagree ○ Uncertain ○ Agree ○ Strongly Agree

8. My procedure was not stressful:

○ Strongly Disagree ○ Disagree ○ Uncertain ○ Agree ○ Strongly Agree

9. My procedure was not frustrating:

○ Strongly Disagree ○ Disagree ○ Uncertain ○ Agree ○ Strongly Agree

Perceptions Regarding Your Procedure Today (continued):

10. I was distracted during my procedure:

11. I was relaxed during my procedure:

12. I felt as peace during my procedure:

13. I felt no pain during my procedure:

Thank you so much for your participation today!

APPENDIX L – Questionnaire Posttest

QUESTIONNAIRE - 2=POSTTEST (EXPERIMENTAL):

Virtual Reality for Cancer Patients: A Design Thinking Approach for a Sensory Experience to Reduce Stress and Pain

Below are a number of questions related to your experience during your procedure.
Please read each question and indicate your response in the blank provided or circle the correct response.

Demographic Questions:

1. Name:_____

2. What is your age (please circle your response)?

○ 18-24 years old ○ 25-34 years old ○ 35-44 years old ○ 45-54 years old ○ 55-64 years old ○ 65+ years or older

3. What type of cancer are you diagnosed with?_____

4. What is the cancer stage?_____

5. What kind of procedure did you have today (please circle your response)?

○ IV procedure ○ Chemotherapy Port Access

Perceptions Regarding Your Procedure Today:

For the questions below, please circle your response.

6. Today, I had a good experience during my procedure:

○ Strongly Disagree ○ Disagree ○ Uncertain ○ Agree ○ Strongly Agree

7. Today, my experience at the Cancer Center was different:

○ Strongly Disagree ○ Disagree ○ Uncertain ○ Agree ○ Strongly Agree

8. My procedure was not stressful:

○ Strongly Disagree ○ Disagree ○ Uncertain ○ Agree ○ Strongly Agree

9. My procedure was not frustrating:

○ Strongly Disagree ○ Disagree ○ Uncertain ○ Agree ○ Strongly Agree

Perceptions Regarding Your Procedure Today (continued):

10. I was distracted during my procedure:

11. I was relaxed during my procedure:

12. I felt as peace during my procedure:

13. I felt no pain during my procedure:

Virtual Reality Simulation Perceptions:

Please only answer the questions below, if you experienced the Virtual Reality glasses today.
Please write your response in the blanks provided.

14. What did you like about the VR simulation? _____

15. What did you dislike about the VR simulation? _____

16. How did the VR simulation make you feel? _____

17. Was there any particular scene you wish you could have looked at that was missing from the simulation?

18. If you could change something about the VR simulation, what would it be? _____

Thank you so much for your participation today!