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DRIVING DOWN THE VIRTUAL BROADWAY: TESTING THE FEASIBILITY OF EDUCATING YOUNG DRIVERS IN VIRTUAL WORLDS

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DRIVING DOWN THE VIRTUAL BROADWAY: TESTING THE FEASIBILITY OF EDUCATING YOUNG DRIVERS IN VIRTUAL WORLDS

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ABSTRACT

The Clemson University Automotive Safety Research Institute funded the creation of a three-dimensional virtual representation of an established teen driver education program. This virtual safe driving program was created within the public virtual world of Second Life. The overall objective of this project was to explore the use of virtual worlds as potential mediums for teen driver education. The specific objectives of this study were: (1) to adapt and translate the Petty Safe Driving Program curriculum into a virtual world; (2) to create a virtual learning environment that can exist as an engaging, entertaining, and educational program addition; (3) to conduct a series of tests within the virtual world in order to determine if the learning environment is effective for teaching the desired safe driving knowledge; (4) to determine if knowledge acquisition is similar or dissimilar across delivery methods; (5) to use this gathered information to investigate the feasibility of teaching teens safe driving knowledge and practices in the virtual world as well as to help direct future developments on this project. It was found that the virtual safe driving program was effective in imparting a degree of safe driving knowledge over a relatively short period of time. It was also found that the real world program outperformed the virtual program in regards to safe driving knowledge after exposure. However, this may be due in part to limitations of this study. These findings also shed some light on the kinds of design principles that may be better suited to foster effective virtual world learning.

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CHAPTER ONE

INTRODUCTION

"Hiro is approaching the Street. It is the Broadway, the *Champs Elysees* of the Metaverse. It is the brilliantly lit boulevard that can be seen, miniaturized and backward, reflected in the lenses of his goggles. It does not really exist. But right now, millions of people are walking up and down it."

(Stephenson 1992)

We live in an age of great technological change. These changes have sent out ripples through every aspect of our collective lives, as the science fiction of yesterday becomes the reality of today. The above quote from Stephenson's landmark book *Snow Crash* illustrates this point as he wrote about a future where social interaction combined with technology, creating a "Metaverse." This Metaverse is still some time off but the seeds have already been planted and they are currently growing in the form of a multitude of virtual worlds. We have witnessed the genesis of these virtual worlds as they have grown from the vast expanses of the internet. They now provide millions of people around the world with a place for human interaction through technology allowing them to talk, explore, and create together. But is it also a space where they can learn? There is a body of research that suggests the answer might be "yes."

The youth of today are growing and learning in a technological and social landscape that mimics the science fiction of only a couple of decades ago. They have powerful computers in their pockets which keep them logged into their vast social networks at all times. They have the powerful resources of the internet constantly at their finger tips and they exist in a time of such steady technological progress that such progress has almost become common place. Yet, they still face many of the same issues that youth have always faced.

One such issue can be found in the startling statistics surrounding teens over involvement in traffic related incidences. For instance, traffic crashes are the single greatest cause of death for 16 year olds in the United States and an average of 12 teens die every single day in the U.S. alone (NHTSA 2002). It is clear that the traditional ways of educating these youth drivers is not working as well as we would like, because these statistics persist year after year. This creates an opening for research such as this, as there is significant room for improvement in regards to how we educate young drivers.
Here, I propose that we do so through the technology that surrounds them. Sometimes, the perception of technology is that it is a distraction in educational settings; however, this study attempts to turn it into an attraction.

It is thought that perhaps by exploring this new technological landscape we may be able to work with this tide of technology rather than against it. The following exploratory research exists with the goal of seeing if virtual worlds are a viable option for the education of teen drivers. More specifically, this study attempts to answer the question "Can students learn the desired material in regards to safe driving practices in the virtual world?" It also attempts to answer the question "How do students who have completed the virtual program compare to students who have completed the real world SDP program in their knowledge of safe driving practices?" With the knowledge gained here we may better understand this concept of using technology to teach and in particular we may better understand its applicability for teaching safe driving practices.

Background

CU-ASRI has a number of educational products and programs in which they attempt to reduce the over involvement of teens in traffic crashes. Specifically, they have partnered with the Richard Petty Driving Experience (RPDE) for whom they have designed the Safe Driving Program (SDP), which is targeted towards teens. This program currently exists at a number of locations around the Southeast and it may be expanding to new locations around the country in the near future. The Safe Driving Program itself takes place over the course of one day. The program leads students through a 6 hour course which is divided into "on track" training as well as "in tent" teaching. More specifically, the program assigns students to groups, which move together from one module to another alternating between the two modes of curriculum delivery.

The "on track" modules involve driving in vehicles with an instructor as they go through a number of maneuvers and courses. These range from imparting skills, such as obstacle avoidance and driving on wet pavement, to imparting knowledge such as how the weight of a vehicle will affect stopping distance. The students spend the other half of their time with the "in tent" modules that involve activities and lessons. These activities and lessons attempt to impart the reasoning and knowledge behind the skills students are learning on the track, as well as a number of safety considerations such as vehicle maintenance. Content for the activities and lessons can range from tire wear to the "no zones" of large trucks (areas to be avoided around trucks due to limited visibility). This culminates in a program that attempts not only to teach students the skills associated with safe driving, such as how to avoid tailgating, but also why they should avoid tailgating and the consequences that can result.

The *Immersive 3D Virtual World Safe Driving Laboratory* was an initiative by CU-ASRI to create a new and innovative addition to the already established SDP curriculum. One of the primary goals at the start of the project was to translate and adapt the tent activities into the virtual world of Second Life (SL). To begin this process, I investigated the use of SL itself as well as on some of the developments that are currently taking place in the virtual world literature in regards to education. After reviewing the literature I took curriculum elements and activities from the already established safe driving program curriculum and created SL equivalents using the originals as a template. This resulted in an ever-expanding educational environment that could serve a number of purposes for RPDE and subsequently the SDP. The virtual learning environment designed here could assist as a "bookend" program in which students could become exposed to a number of concepts and materials before they actually set foot at an SDP event. This environment was also designed to provide a place for renewed education after they completed the program. Finally, it could also serve to replace an "in tent" activity in which one of the classroom periods could be spent teaching students in the virtual world.

The environment itself includes a number of activities and lessons adapted from the real SDP events. I created these virtual versions of real world activities using objects and tools in Second Life such as slide boards, video displays, worksheet dispensers, and web links. Such delivery methods provided the means for conveying the desired curriculum information to the students as they explored the virtual environment. I embedded these tools within various structural contexts such as a stage for role-playing or a fully recreated Petty truck that has the "no zones" quartered off (see Appendix A for examples).

I should also mention that the design of this environment was not limited to only recreating the real world in the virtual world. Rather, a number of modules were either modified or created from scratch, which made use of the natural strengths of the virtual world. I did this for a number of reasons. First, comparing the real world to a real world recreation in the virtual world would be much like comparing apples to oranges. This is because the virtual world and the real world have within them a vast array of strengths, weaknesses and limitations. However, this does not mean that one is inherently better suited for the task of driver training; rather it means that the only really effective comparison of these two environments must acknowledge and account for the strengths and weaknesses of each.

In this case the virtual environment was designed with a number of modules that were recreations of real world modules. However, there were also a number of unrealistic or game-like modules that played more to the strengths of the virtual world. The purpose of this was so that later testing could shed some light onto which form of environmental design was most effective. Subsequently, I combined these elements in order to attempt to create a virtual learning experience for the student that played to the inherent strengths of virtual construction while staying true to the content and context of the real SDP events.

The following study was undertaken upon completion of the virtual learning environment in order to test the efficacy of the environment. More specifically, testing was conducted to investigate the effect of the environment on student's safe driving knowledge scores. It was also conducted in order to compare the scores from the virtual environment with those from the real world. It was my hope that these findings could then contribute in some way to both the fields of virtual world research as well as driver education. It was also my hope that the knowledge gained here could direct future work on this project by revealing which elements of environmental design appear to be most effective.

CHAPTER TWO

LITERATURE REVIEW

Driver Education Research

With the invention of the car, the world around us changed forever. The ripples of this new technology would spread throughout the world as it assisted in the metaphorical shrinking of land mass as people became more mobile. This technology has now become commonplace as it has evolved into a standard in American culture. The car has come to symbolize American ingenuity as well as American independence as we as a people have become the most mobile on the planet. The United States of America has approximately 251,422,509 registered vehicles which is the most of any nation in the world (WHO, 2006). However, with the countless benefits and advantages that the automobile has presented us, so too has it presented a number of issues. In particular, my focus here is on teen over-involvement in car crashes and other traffic related incidences. As the automobile became commonplace unfortunately so too have teen crashes. For instance, traffic crashes are the single greatest cause of death of Americans between the ages of one and thirty four years of age. In fact, an average of 12 teens die in road crashes every single day in the U.S. alone (NHTSA 2002).

As one can see, the issue of teen crashes has become a severe concern. Studies all over the world wrestle with common themes such as appropriate ages for driving privileges as well as proper education to prepare teens for the road (Langford 2006, Senserrick 2004, Mynttinen 2010). This is a global problem that has united researchers around the world under one cause - saving teen lives. “Worldwide, the number of people killed in road traffic crashes each year is estimated at almost 1.2 million, while the number injured could be as high as 50 million-the combined population of five of the world's largest cities" (World Heath Organization 2004).

History of Driver Education

Driver education programs first came about as far back as the 1910s but it was not until the 1930s that formal courses were actually available for the public (Williams 2009). There were a number of studies at the time that reported their effectiveness for molding safer drivers. However, these studies neglected to control for certain variables, thus negating much of their results. Nevertheless, these reports in conjunction with the "common sense" appeal of driver education resulted in the popularity and prevalence of driver education programs. These are very similar problems to what the field of driver education still faces to this day. This is because of perhaps the most famous driver education study, which would later be collectively known as The DeKalb Study. The first report originating out of this study was the *Evaluation of Safe Performance Secondary School Driver Education Curriculum Demonstration Project* by Stock et al in 1983.

The DeKalb Study was a massive study undertaken by the National Highway Traffic Safety Administration (NHTSA) to develop and subsequently evaluate a "state-of-the-art driver education program" (Williams 2009). They created two programs for this study. The first was the Safe Performance Curriculum (SPC), which involved intensive training (70+hours). The second was the Pre-Driver Licensing (PDL) curriculum, which existed merely to teach students enough to pass their driving test. The NHSTA then tested these two programs in DeKalb County, Georgia and then collected longitudinal data on the driving habits of their participants. The results sent ripples through the entire field of driver education because they essentially found that driver education did not work. The results showed that students from the SPC program were indeed safer drivers than the PDL students but only for the first month of licensure, after which the difference effectively disappeared (Williams 2009).

The results of the DeKalb Study have been looming ever since, as the world has had to reevaluate its efforts to prepare teens for the risks of the road (Stock et al 1983). This single study has spawned at least four other studies, all of which found similar results; driver education as it currently exists simply does not work (Williams 2009). The literature discusses a number of possible reasons for this lack of efficacy. These reasons not only help to explain why traditional driver education programs do not work, but they also help by pointing to possible directions for future developments in the field. One possible explanation is simply that our driver programs are not intensive enough because we spend too much time training teens about the mechanics of driving and not enough time teaching them safe driving practices (Williams 2009). Another possibility is that these courses are making teens over confident, which is actually resulting in more crashes instead of less (Langford 2006). There has even been a branch of research that posits that there are problems with asking teens to undertake such an intensive task at such a vulnerable time in their development. For instance, one study found that adolescent brain development results in a lack of proficiency in regards to processing risky situations while driving (Keating 2007).

Driver Education Today

Driver education policies as well as programs have been attempting to change since the results of The DeKalb Study became known, but they still retain much of their original form. This has resulted in a number of state and national initiatives that are attempting to standardize driver training as well as licensing policies in order to reduce teen traffic crashes. Perhaps one of the most beneficial recent developments has been the creation of graduated driver license (GDL) policies (Morrisey et al 2006). These policies stagger driving privileges over a period of time, thus delaying full driving privileges as teens learn the basics and gain more experience. GDL programs have proven to be rather effective in reducing overall teen crashes when compared to areas that have not implemented such requirements (GHSA 2010). Additionally, stronger GDL programs such as those that limit teen driving under certain conditions and times of day, are more effective in reducing teen crashes when compared to weaker GLD programs such as those that may only limit the number of passengers a teen may have at a time (Morrisey et al 2006). Yet such widespread polices have not eliminated driver education programs from still being a widespread option for helping teens stay safe.

As of this time most driver education programs involve 30 classroom hours and 6 behind the wheel hours. These programs usually fit into a high school curriculum. However, there has been an increase in commercial options, which may vary in time and content. These commercial courses (such as Petty Safe Driving Program) can range in duration from one afternoon to hours spread across weeks. These commercial options also vary in that some tend to integrate the use of technology into their curriculum more than others (Williams 2009). Some examples of new technologies being used by driver education programs include technology such as simulators and computer-based training programs. The Petty Safe Driving Program is an example of one such commercial driver training option as it is attempting to integrate technology with its already established classroom and track training.

Such program developments are in line with a recent push in "learning in the 21st century" which promotes the use of technology while educating today's youth (Partnership for 21st Century Skills, 2002). This form of education is "flexible, creative, challenging and complex" as it uses modern resources to speak to the youth of today (21st Century Schools, 2008). Program developments such as these are attempting to take established principles from disciplines such as cognitive psychology as well as education in order to attempt to craft new driver education programs. These new programs will hopefully reach teens in new ways while also attempting to teach teens in ways that work. It is worth noting, however, that this recent emphasis on technology does not mean that the use of technology is necessarily new to the field of driver education.

One area of driver education that the use of technology has assisted is that of perception training or risk awareness training. These training programs attempt to make teens aware of risks so that they can react to risks before they become "accidents." Essentially, these programs show risky scenarios and then help teach drivers how to spot the hazards (such as a child's ball in the street) as well as the potential hazards (such as the blind spots where a child could be playing) in such scenarios. This area of driver training has been using CD-ROM based programs that train drivers to better scan their environments with the goal of helping them to manage their perceptions. The use of technology has greatly assisted the work in this area, as these studies have shown significant improvements in risk perceptions after only a relatively short period of computer based training (Fisher 2002, Pollatsek 2006, Regan 1999).

This demonstrates the need for us as researchers and program developers to push out and attempt to educate teens in new ways. The use of new technologies, such as simulators and computer programs, is one such path that could be of great benefit as we can create situations and scenarios that can teach teens safely. As we have seen, learning on real streets is a dangerous task that all teens must go through but it is a risk that could possibly be mitigated to some extent by the use of technology to teach safe driving knowledge and practices. Teen traffic crashes are still significantly higher than any other age group regardless of location (NHTSA 2002) and while we have been making strides we still have some ways to go. The Petty Safe Driving Virtual Program is an attempt to create a new avenue to help teens. The safe driving program seeks to combine on the track driving experiences with in tent classroom instruction.

The focus of my research is the integration of new technologies into this instructional process. Specifically, I am implementing virtual worlds for the first time in order to create a safe computer based online learning environment to expose teens to a number of safe driving practices and information. However, as we have seen in the previous literature - what makes sense does not always result in more educated teens. Therefore, it is important to test the potential of this virtual world component to see if it has any effect (positive or negative) on the students who participate in it. Through testing and research we can continue to build on the work done in the past with an eye towards the future in order to perhaps better our driver education programs and subsequently save teen lives.

Virtual World Research

The quote used in the introduction of this thesis is from the book *Snow Crash* by Neal Stephenson (1992). This is the book that is credited with introducing the term "metaverse" into the public discourse (Wallace 2006). In his visionary tale Stephenson paints a picture of the not so distant future in which there exists one of the first representations of a "virtual world." In this virtual world people walk about and interacted like normal, a fractured but parallel reality that has no game element at its core but rather socialization and the exchange of information. His work has been the catalyst for many in the field of video game and virtual world development as well as research. Many see that the pictures painted in *Snow Crash* and other science fiction tales are not impossible and indeed are not even that far off (Spence 2008).

A more recent example from Hollywood stands out: The Matrix movies. In this dystopian future, mankind's bodies are encased in pods while their minds live full lives in "the matrix." The catch is that these encased humans do not realize that the world they inhabit is not real; rather it is a computer simulation of the real world. This means that essentially "the matrix" is an extremely advanced virtual world. While these stories reside on the science fiction shelves of entertainment vendors, in reality their predictions are not necessarily unfounded. Our technology is moving forward at an ever-increasing pace. Gaming and subsequently virtual worlds are at the forefront of these emerging technologies as new and more powerful computers allow for more advanced graphics and computational capabilities. Combined with the internet, the result is a vast network of not only powerful computers but people using them in tandem to reach out to each other and the world around them. With this combination of computers and the internet, a substantial amount of human interaction (such as that seen on Facebook) has transitioned into the realm of what was science fiction only a couple of decades ago.

Definitions of Virtual Worlds

To begin this discussion we must first create a shared concept of virtual worlds. In its infancy one of the most difficult tasks that the field of virtual world research faces is coming to a consensus on what is meant by the term "virtual world." While many still define it themselves depending on what kind of virtual world they are looking at, over time some common definitions have begun to float to the surface.

The broadest definition is that virtual worlds are "a place described by words or projected through pictures which create a space in the imagination, real enough that you can feel you are inside of it" (Damer 2008). However, as one can easily see this is too broad of a definition to suit our purposes as a painting or a poem could then be considered a virtual world (Damer 2008). A closer definition that better narrows the field is by Bell (2008) who states that virtual worlds are, "a synchronous, persistent network of people, represented as avatars, facilitated by networked computers." This definition is more suitable because it points out the persistence of people and objects as components fundamental to the concept of virtual worlds. A virtual world in our case needs to be social by its very nature and this definition comes closer to that need.

An extremely social definition of “real virtual worlds” can be found in the work of Sivan (2008) who posits that there are differences between your traditional “game centered” virtual worlds and “real virtual worlds.” This distinction lies in the social aspects of the world as Sivan posits that “real” virtual worlds contain four key elements: three-dimensionality, community, creation, and commerce. This definition, while taking note of many key elements of virtual worlds, is perhaps too specific as it dismisses too many virtual worlds that are not “real” by Sivan’s definition. Specifically, Sivan’s definition is too narrow when it comes to the creation element. In this instance Sivan posits that the user’s ability to generate content (such as objects and textures) is one of the essential elements to a real virtual world. While user created content is key to a number of virtual worlds (such as Second Life) I feel that it is not required in order to have a real virtual world. This is because a virtual space without the ability to create objects outside of the designer’s original constructs is still a shared social space. A virtual shared social space can have function beyond the original intentions of its designers due to the possible social interactions that naturally take place therein.

Sivan’s concept of creation may be more applicable if one could consider these social interactions as having elements of creation rather than simply as the creation of “physical” objects. However, in this case it is the creation of virtual content such as tables and clothes that restricts this definition. Limiting the field of real virtual worlds to social spaces that allow for content creation simply narrows the range of real virtual worlds too much. Therefore, after some divergence in interpretation the definition used in this paper will be that of Spence (2008),

> Virtual worlds are persistent, synthetic, three-dimensional, non-game centric space. Virtual worlds are primarily social spaces that allow for other uses depending on the theme of the particular virtual world. Virtual worlds are either commercial or open source in design and implementation.

This definition holds within it all of the key elements for an in-depth analysis of virtual worlds as a social space. Within this definition there is an important distinction in that games can exist within a virtual space but that the virtual space itself is not a game, for at its core it is a social space (Spence 2008). However, here I will use a slightly different interpretation of this definition.

In this instance, I will interpret "non-game centric space" as excluding games that have no firm social structure or shared social space at their foundation. For example, games may have virtual spaces in the form of arenas (such as traditional first person shooters) which allow people to interact via virtual combat; however this game centric nature restricts the potential for any repurposing of the social landscape in these games as there is no persistent shared social space. However, in games such as World of Warcraft (which has a strong game foundation) social interactions are supported and fostered as one of its key design elements. This creation of a social space within a game world is essential to this interpretation because it means that virtual worlds can be "non-game centric spaces" even if they have game foundations because they still allow for in-depth social interactions.

One reason why the Spence definition is still useful here is that it makes it clear that virtual worlds are "primarily social spaces" and this statement roots any observance of virtual worlds in the realm of social science, as human interaction and exchange is fundamental to the existence of the world itself. To use World of Warcraft as an example once more, there are hundreds of video games that have almost identical game play elements and mechanics; however, what they lack is the fundamentally social space mentioned here. Said another way, one can play many role-playing games on home consoles and personal computers in which there is never any interaction with another human. These games are "single player games" and they have been the hallmark of the genre for some time. However, a shift has occurred which has taken these single player game mechanics and applied them to fundamentally social spaces thus giving us the modern "massively multiplayer role playing game". Therefore, this definition when viewed in this context allows us to consider a broader range of virtual worlds; while not expanding the focus too wide as to lose sight of the subject matter being observed, which is social interactions in three dimensional, persistent, synthetic, virtual spaces.

The area of virtual world research is still in its infancy, as the research communities surrounding virtual worlds (academics) tend to fall into four groups. The first group consists of those researchers and professionals who embrace virtual worlds. The second group consists of those who have ignored the rapid evolution that is taking place in virtual worlds. The third group consists of those who are aware of virtual world use but have yet to take that first step into exploring virtual worlds. The final group consists of those that don't even know that virtual worlds exist (Spence 2008). These polarizing camps have spawned a research field that is still attempting to catch up and fully grasp the importance of the developments occurring everyday.

Another issue facing virtual world research stems from studying a topic that is not only so new but so quickly evolving. To articulate this point further, consider the social saturation of this technology over its relatively short life span. Over the course of a few decades virtual worlds have moved from a technological toy for the elite to a relatively common and accepted social technology. Currently the total number of virtual world citizens hovers around 330 million registered users world wide and growing (Spence 2008). This element of exponential growth is almost by itself reason enough to justify the study of this development, Gartner (2007) has predicted that by the end of 2011 80% of Americans will be involved in some sort of virtual world. (However, for this figure to be applicable today loose interpretations of virtual worlds such as Facebook would have to be included.)

Predictions such as these demonstrate the importance of these worlds and how they impact our lives in a multitude of ways through shared spaces and interactions. This has resulted in a field that is ever expanding as it seeks to answer a wide range of questions outside of using virtual worlds solely for education. For instance, questions have arisen about the impact of virtual body image on real body image (Dean 2009). There have also been many questions asked about how economics of virtual worlds function (Castronova 2005). There have even been questions asked in regards to the existence of distinct cultures within these worlds (Boellstorff 2008). Such questions demonstrate the vast array of topics that can be posed to virtual worlds, as they have become valid realms for research. These realms, while relatively new in terms of research awareness are not without a history unto themselves.

History of Virtual Worlds

We have already mentioned a couple of authors who have written specifically about the history of this new social medium (Damer 2008, Sivan 2008). Damer's history is invaluable as it is written from an insider who was there at the beginning. A brief timeline of the development of virtual worlds as we know them today would begin in the late 70's. During this time we saw the development of MUDs or Multi-User Dungeons. These were text based online environments that allowed for only the most basic forms of social role-playing. These would later integrate very generic and simple graphics such as those in one of the first "first person shooter" known as *Maze War*. NASA developed *Maze War* and it was a "world" in that players would navigate simple hallways attempting to shoot other players. What made this game significant was that it had a chat function built into it. This revolutionary addition created a space where it became common to find people "playing" *Maze Wars* simply to chat with one another.

In the early 80's we saw another jump as home computers and more affordable graphics cards became a reality and with the jump in technology came another jump in virtual world evolution. Here we begin to see virtual worlds such as Lucasfilm's *Habitat. Habitat* was of particular note because this was the first time player representations were referred to as "avatars." The players existed as simple two-dimensional characters that moved in a side scrolling fashion in order to explore the changing world and talk with other avatars. This is also where we saw another instance of how users helped to shape virtual worlds, because after some time people started to barter items and eventually would create their own government that was separate from the controls built into the servers.

Finally, in the 90's we begin to see the virtual worlds of today take shape. There was a proverbial virtual world boom that existed in tandem with the "dot.com boom." This resulted in many different virtual worlds all developed at once. Examples include virtual worlds such as *Active Worlds*, *Whyville* and *Ultima Online* just to name a few. However, this virtual prosperity was short lived because the dot.com crash was soon to come in 2000. After the crash many of these worlds vanished, but this left the fittest to survive and emerge stronger than ever. The virtual Darwinism that took place narrowed the field to a few staple virtual worlds such as *Active Worlds* and *Second Life* (Damer 2008). It also allowed for the evolution into gaming arenas as popular games such as *Everquest* and *World of Warcraft* came onto the scene and inducted a whole generation into the fold of virtual world socializing. Virtual worlds are now a technology that is going to be as second nature and commonplace to this generation as telephones and televisions were to the ones before it (Damer 2008). But outside of gaming and socializing, what are other uses of these worlds?

Virtual worlds are useful for a number of professional reasons, ranging from places to have business meetings to providing a place to help people get over their phobias (Murphy 2010). However, one of the biggest areas for the use of professional virtual worlds is that of education. Many educators around the world have realized the potential of virtual worlds to provide a safe and innovative space for students to learn and interact. We now know how these worlds can exist as virtual learning environments rather than just game environments. “While games are the most prominent example of the use of a 3D-graphics interface, our experience and research suggests that the use of this technology in non-game settings can positively impact learning and communications among students and with their instructors” (Jones 2007). While quotes such as this one demonstrate the possible effectiveness of virtual worlds to teach, this also points us to a common gap in the virtual world literature.

Virtual world literature usually revolves around answering the questions of “who” and “how” rather than “why.” For instance, often times a great deal of attention is paid to environment construction which answers the question of “how” to use virtual worlds. We also devote a sizable portion of the scholarship to determining which kinds of students and teachers may best benefit from virtual worlds thus answering the question of “who” should use virtual worlds. However, sometimes the rather important question of “why” is neglected by leaving out justifications for choosing virtual worlds over the real world (Smith-Robbins 2010).

This is a difficult question to answer here because in most cases virtual world learning is secondary to real world learning. There are a number of studies that have found that students report higher satisfaction with their learning experiences in virtual worlds. However, one drawback to most of these studies is that they are usually comparing virtual worlds with other online delivery methods, such as distance learning online courses (Johnson 2009, Hew 2010). In terms of examining the relation between real world and virtual world instruction, there are a few quantitative studies. One such study is by Sourin et al (2006) in which they used virtual worlds to teach a course on computer graphics concepts. The results of this study revealed that there was a 14% increase in the mean exam scores as a result of the use of virtual worlds. This study demonstrates that virtual worlds may have the potential to enhance learning even when compared to teaching in the real world.

There are also a number of articles that examine the strengths and weaknesses found in virtual worlds from a pedagogical standpoint (Dickey 2003). This body of research looks at the issues with virtual teaching (such as chat logs becoming too chaotic as many people type at once) as well as advantages (such as being able to create scenarios that would be too costly, dangerous, or impossible in the real world) (Dickey 2003, Ryan 2008, Wang 2009). These examples demonstrate some of the questions that currently exist in the literature and reveal a number of gaps in our knowledge of why and how we should use virtual worlds. With research opportunities such as the one present here, we can begin to close that hole by making direct comparisons between a real world program and a virtual world counterpart.

Virtual worlds provide shared spaces and interactive places in which people can create and share experiences. Many of these worlds not only allow for user generated content, but are completely based upon it. *Second Life* is one such example where the digital hands of its inhabitants almost entirely craft the world itself. Many of these worlds are also "free" in the sense that one does not have to pay any sort of subscription fee to participate (though there are fees associated with owning land or buying items within the world). These elements have set the stage for new virtual realms that can be used to educate people, as teachers can rapidly construct content and students can access it for free. Like the internet before, virtual worlds are rapidly increasing in usage and prevalence among youth as well as other age groups. This has not gone unnoticed by universities worldwide, as over 150 colleges have now created virtual campuses and moved certain classes into the virtual world (Clark 2001, Messinger 2008, Minocha 2010, Salmon 2009, Wang 2009). There is even the possibility that the virtual island of tomorrow will become as essential as having a web page today (Wallace 2006).

Educating in Virtual Worlds

University funded islands have a number of uses and purposes depending on the level of support as well as the faculty's willingness to participate. One example of the use of virtual worlds by universities is that of recruitment. In this example, a university uses virtual spaces as a means of drawing potential students to their campus by giving them a taste of campus life in the virtual world. Another use is that of prototyping or experimenting with modeling, computer programming, and simulator design as these environments come equipped with essentially free tools with which students can practice. Then there is the use of these worlds for synchronous learning environments to compliment a distance learning program or an online course (Bronack 2006, Dickey 2003, Hew 2010). All of these examples demonstrate how virtual worlds can be used to educate students on a wide range of topics, with a wide range of goals in mind.

With all of these examples I have unfortunately found none in regards to the use of virtual worlds for educating drivers. This does not mean, however, that there is no previous research that can help guide the study presented here. For example, there is the work done with virtual worlds in regards to nursing and the medical profession in general

(Danforth 2009, Johnson 2009). This field has used virtual worlds to create “virtual hospitals” in which nurses and doctors are able to practice and learn a vast range of skills. These skills include patient interaction (such as bed side manner), clinical diagnosis skills, and virtual classroom situations (Danforth 2009, Johnson 2009). These examples are important in guiding the work here because they demonstrate a few key factors.

One key factor is that we can see here how virtual worlds are useful for teaching skills and knowledge that are directly applicable to the real world. This is in line with the goal of teaching youth how to drive, as that knowledge must be applicable in reality to be of any benefit. Another factor demonstrated by the example provided by the medical field is that of the importance associated with the information being taught. For instance, the knowledge that nurses learn in the virtual world can have very real “life or death” consequences in reality. This is also the case in driver education because if students do not learn the proper practices, then this can have very real and dangerous consequences. Factors such as these provide a foundation for exploring the use of virtual worlds to teach drivers education.

Virtual worlds are useful in the distance-learning domain as a means of supplementing or complimenting an online degree program. There are many reasons for this but essentially they all boil down to a few key factors that continually crop up in the literature, and one such factor is the creation of a sense of “presence.” This notion of presence is essentially that virtual worlds allow people to have a sense of “being there” and perhaps more importantly the feeling of “being there with others” (Cheney 2008, Bronack 2008, Wang 2009). It is posited that this sense of presence is key in the learning process in virtual worlds as it allows for people to have in-depth experiential interactions, not only with their environment but also with others (Bronack 2008, Johnson 2009, Tichon 2007).

This also taps into a key element of virtual worlds in that they are synchronous learning environments (Petrakou 2010). Basically, though virtual worlds persist and students can access the information within them at any time, the primary means of communication between participants (i.e.-students and teachers) still occurs in real time. This ties into an essential aspect to our definition of virtual worlds in that they provide environments that allow for real time social interactions with others. Such synchronous interactions in virtual worlds can contribute to the learning process through the creation of a sense of community that has been shown to improve perceived learning engagement (Liu et al 2007). Finally, a substantial strength of presence is that it can provide a more robust interaction than a traditional online course could provide, as it allows for people to "see" each other and with that information they can observe gestures and other social cues that can denote information (Dickey 2003, Wang 2009).

Another benefit to education in virtual worlds is the custom generation of content. When instructors have the ability to create their own content in a virtual world, this gives them limitless options for activities. These activities can be even more complex than activities in the real world, as teachers are not constrained by many typical hindrances that exist in reality. "SL (second life) instructors can design authentic tasks whereby learners can explore the world, solve problems, construct and negotiate meaning, and collaborate with other learners. (Wang 2009)" This vast freedom to generate content has opened up virtual worlds for use in almost anything - from training skills such as hand ball movements on the court to skills such as how to properly wire sound stage equipment (Lopes 2009, Ryan 2008). This ability to create environments that serve specific educational purposes is paramount to the success of virtual education, as it allows for almost any activity or environment that a teacher can dream up and then execute. It is reasons such as these that lead to the creation of the first safe driving environment – an environment with the sole purpose of educating teens about safe driving practices.

Another reason for the practice of education in virtual worlds is concern with safety. Virtual worlds also allow for the creation of learning environments and experiences that would simply be too dangerous or costly to execute in the real world. Whenever heavy machinery or other people are involved in a training of any kind, there is a certain element of risk. This is especially true when training young and inexperienced drivers to navigate a multi-ton vehicle through busy streets. Many driver education programs have helped to control this risk with the design of on-track training in relatively controlled environments. In these situations the driver education program typically sets up a series of obstacle courses in a vacant parking lot and then the students run through the courses with much of the risk typically associated with learning on the road.

Virtual worlds on the other hand provide a unique risk-free environment to train almost anyone in almost any field. One example of this is in the training of highway patrol officers in how to assess car crashes and direct the traffic and responders at the scene (Hadipriono 2003). Another example is teaching train conductors to deal with stress and hazards. In this virtual training program the conductors learn how to react to high stress situations without the real world risks associated with such training (Tichon 2007). These are both examples of virtual environments assisting in both knowledge and skill acquisition that would be dangerous otherwise, an element that would seem to lend itself well to driver education.

A number of articles have demonstrated the usefulness of virtual worlds and as a result, a number of frameworks and theoretical perspectives have been adapted to help explain learning in virtual worlds. One such theoretical perspective is that of the constructivist and subsequently the social constructivist frameworks for learning. The constructivist perspective states that people construct their own knowledge through experiential learning. Basically, humans have a propensity for learning and seeking out new knowledge and we construct that new knowledge by way of exercising our own reasoning and experimentation. In this way we "construct" our own knowledge from the world around us (Larson 2005).

This theoretical perspective has its roots in the works of Jean Piaget (1967) as well as the organismic model for learning. The organisimic learning model views organisms as naturally adaptive. More specifically, organisms must adapt and learn in order to survive their environment (Lerner 2002). Piaget took this concept and then posited that humans in particular are very proficient at adapting to their environments. This high adaptability subsequently entailed a high propensity for learning as well. Piaget viewed this propensity for learning and adapting as fundamental to our species. In terms of educating youth, this means that learning is not something we must force on youth as it is something that they are naturally inclined to do on their own.

Jean Piaget was perhaps the most influential constructivist as his work took these ideas of innate learning proclivities and began to test to see if they were observable. Piaget conducted a number of studies with children at different developmental levels and observed how they learned certain key concepts. For example, Piaget conducted a study in which he observed how babies learned concepts such as object persistence. He did so by showing them an object and then hiding that object from view, and revealing it again. Through their own reasoning, these children eventually began to develop the concept that objects persisted even when hidden from view. Thoughts and observations such as these lead to the constructivist learning theory. This theory states that children construct their own knowledge through natural experimentation and reasoning. Piaget would even go a step further by positing that children learn most efficiently when they are either on their own or learning together with peers (Larson 2005).

This is a useful theory when looking at virtual world education because virtual worlds give us the ability to control the context that students will hopefully construct their own knowledge within. Instructors can design the scaffolding for learning and then the students can reason/experience that environment, thus constructing their own knowledge about the topics within. "The Virtual World is an ideal three dimensional environment to develop a constructivist virtual learning environments where students are provided with a sense of place and context, and are able to explore, build and share their learning experience" (Clark 2001).

The social constructivist framework takes this concept one step further. This theory has many of the same principles as the constructivist framework; however, this theory puts a greater emphasis on learning in groups. This theoretical perspective not only has its roots in the works of Piaget but also in the works of Vygotsky (1978). Vygotsky posited that learning was a collaborative process and that it does not originate solely from within the child but rather it also originates from the interactions a child has with other people. In this sense, learning is not limited to an internal process or one that is shared exclusively with peers as learning can take place during any interaction whether that is with a peer or an adult. In this way, learning and development are a collaborative process (Larson 2005). This is important for our discussion here for a number of reasons, but perhaps the most important of which is that this theory states that the development of "scaffolding" can assist learning. In this case knowledgeable adults, who can help to guide and direct young people's learning, provide the scaffolding. This scaffolding is not teaching in the traditional sense, rather it can be as simple as posing the right questions to help guide learning or simply being there keeping learners motivated while they construct their own knowledge (Larson 2005). These adults can give context to the learner's experiences, which help them to learn the right material without necessarily having to be "taught" in the traditional sense.

In the case of the virtual safe driving program, I feel that this concept of scaffolding takes on a slightly more literal sense in that virtual environments allow us to construct "scaffolding" into the environment itself. This means that the scaffolding that provides some context or structure to an individual's or a group's learning experience can exist in the learning environment itself, guiding students into the proper direction by surrounding them with contextual clues. These clues can exist in a number of ways, such as designing an environment with a learning theme in place that could immerse the youth in the desired topic. There are also other ways scaffolding could provide some structure for learning, such as using metaphors in environmental design in order to facilitate the learning of a desired topic. One example of metaphor design could be building an environment that has verticality of thought built into how students move through the environment. Said another way, this would mean that as students explore and master lower level concepts they would then move upward to the increasingly challenging problems, which would be built on higher elevations of environment. This elevation of subject material could connate progression of thought upward, or growth and development, as students explore vertically in an environment rather than laterally (Tashner 2005). It is ideas such as these that make virtual worlds a suitable testing ground for scaffolding based learning.

In terms of social constructivism, learning is not exclusively an intrinsic process but an extrinsic one as well (Bronack 2006). With this theoretical model in mind, we construct knowledge together in that knowledge is social in nature. We first generate knowledge through participation in groups and then on an individual level as the group knowledge is internalized. This is of particular value in virtual world education, as virtual worlds are by definition a social space. The social constructivist approach to learning is present in the virtual world as we build knowledge together as a social activity, an aspect of virtual worlds that separates them from typical graphical interfaces (Bronack 2006).

Both of these theories provide clear benefits for looking at virtual learning environments because they play to the strengths of the virtual world's ability to create situations that foster experiential/participatory learning. They also articulate the strengths associated with synchronous learning situations, which encourage students to learn in real time as a group. While it is not the goal of this study to test these theoretical perspectives, I do feel that they provide adequate justification to test learning in the virtual world. This theoretical background lays the groundwork not only for distance learning programs but also potentially for the safe driving program that I present here. This is due to the fact that one of the goals of the virtual safe driving environment is to create an environmental context in which students "experience" safe driving program elements.

Consistent with the social constructivist perspective, it is my intent that the students will not only experience the information embedded in the environment but hopefully that they will also do so in groups where they generate knowledge together. This is an element of the real world Petty Safe Driving Program events, as the teens are put into groups for the entirety of their experience so that they can learn together. However, while the literature has found that virtual learning environments support a constructivist framework it has also posited that further research is necessary in order to explore this option more fully (Dickey, 2003). This is another area in which the current study may shed some light as we examine the efficacy of virtual learning environments in teaching teens about safe driving.

After a brief overview of the literature it is apparent that this is a medium that is being used increasingly for educational purposes and in increasingly innovative fields as time moves forward. Educators have now used virtual worlds on topics such as healthy eating, languages, computer programming, environment conservation, and even programs that teach nurses how to better care for patients (Hew 2010). This is just a sample of some of the uses of these worlds and it demonstrates the versatility of these environments for teaching a vast array of material. We have also seen how virtual worlds can help to enhance learning when compared to other methods such as traditional online formats (Sourin 2006). I feel that these examples in the use of virtual worlds for educational purposes provide more than adequate grounds for attempting to push into yet another area of education, driver education.

As we have seen above, educators and academics have been using virtual worlds for some time now as a platform for not only reaching students that may have been previously out of reach but also to reach students in new ways. As technology evolves we must play to its strengths as well as adapting to new generations of students (21st Century Schools, 2008). Virtual learning environments provide us with an opportunity to test out these new frontiers while not sacrificing substance for flash. With a theoretical backing such as the constructivist/social constructivist frameworks, virtual learning environments have the potential to educate in an entirely new way to a new generation. With that in mind we would be remiss if we did not attempt to push and test this developing field and I feel that the virtual safe driving program provides us with one such opportunity. Testing has proven to be essential in driver education in order to avoid repeating ineffective program elements. Testing is also essential in the realm of virtual world research to fully realize the potential that lies within virtual worlds. By observing the dilemmas of the driver education community in their search for new and effective ways to educate young people and by witnessing the rapid expansion of virtual learning environments as a plausible and effective environment to teach skills and knowledge, I feel that this study is in a particular position of advantage to perhaps advance both causes simultaneously.

CHAPTER THREE

VIRTUAL SAFE DRIVING PROGRAM STUDY

This study tests the efficacy of the virtual safe driving program laboratory. This branch of testing included two distinct halves. The first half was an internal comparison between the pre-and post-test scores of participants in the virtual safe driving program. The second half was an external comparison between the real world Safe Driving Program scores and the virtual safe driving program scores. It has always been a goal of the virtual safe driving program laboratory to eventually conduct various levels of testing to see how effective this avenue could be for driver education. I have shown above how traditional driver education is in a state of flux, and program designers and developers worldwide are searching for new ways to impart safe driving knowledge and skills. The goal of the creation of the virtual safe driving environment was to explore new avenues of driver education, as it attempted to use modern technologies in new and innovative ways in the hopes of reaching the teens of today.

The testing of such a program is essential in order to establish its validity as a method of teaching safe driving. Testing is also fundamental, for it may reveal the areas that need improvement or modification in order to make the program more effective. In order to observe if any specific areas required such attention, individual module performance measures were also used. The survey used here contained 14 knowledge questions, which could be subdivided into four different module/topic areas. These four different areas included: braking, reaction time, tailgating, and loss of control. The inclusion of these module specific demarcations allowed for the measuring of change in regards to specific topics. Analysis of the knowledge specific module performance could help to us learn which areas the virtual world is best suited to teach. Such knowledge could also help to guide future development on the project by indicating potential strengths and weaknesses of the virtual safe driving program.

The knowledge gained from my study could also prove valuable to virtual research as a whole, as it applies virtual learning environments to a new domain – driver education. Another key reason this research could benefit the whole of virtual world research is that in this instance there is a comparable measure between the real world students and the virtual world students. This places this proposed study in a particular position of advantage, as it is rather rare to have the opportunity to compare virtual data with its real world counterpart in the teaching of any material. Said another way, this virtual program was based off of a real world program and I subsequently evaluated it using the same measurement instrument. This allows me to make direct comparisons between real and virtual education. Such a comparison may then provide virtual world research with a potential insight into whether or not virtual worlds are viable even when presented with a real world option. It may also provide insight into which elements of design best suit virtual learning environment construction.

Most studies into virtual learning environments do not have the distinct advantage of having an actual real world counterpart, which exists in the form of the RPDE Safe Driving Program. In my study, the virtual safe driving learning environment was not only based on the RPDE curriculum in terms of content but also in regards to context. Subsequently, I measured the virtual program using the same measures as those used in the field with the SDP. Therefore, the data gathered from these RPDE events (surveys and quiz scores) provide a prime opportunity for a comparison between the real RPDE events and the virtual safe driving program laboratory. This study took data gathered from real world RPDE events and it then made direct comparisons with it against the virtual world safe driving program laboratory using these same measures. As I mentioned briefly above, this was done through the use of the exact same knowledge measure. This measure is a short 14-question quiz on safe driving knowledge and practices that students take at the beginning and end of every Safe Driving Program event. I recreated this same measure and format for use in the virtual world to gather comparable knowledge between the two groups.

In summary, my research had access to both survey data as well as the knowledge measures employed at the real SDP events. Therefore, I recreated these measures and surveys in Second Life (SL) and then compared the resulting two sets of data to see if the knowledge transfer was comparable. Once again this comparability would not be limited to only overall safe driving knowledge scores, as it would also entail individual module scores. One could then answer any number of research questions, such as “Do students learn more from the virtual world environment than the real SDP events?” and “Do students retain different kinds of information in the virtual world as opposed to the real SDP events?” The knowledge available as to the efficacy of the 3D virtual safe driving program laboratory is invaluable in order to guide future development on this project, as well as in order to help to explore new options in the delivery of driver education. This research is also beneficial for the whole of virtual world research as it provides a direct comparison of a virtual program with a real world equivalent. Therefore, this research could have a significant impact on the use of virtual worlds such as SL by educators and program developers alike.

CHAPTER FOUR

RESEARCH QUESTIONS AND HYPOTHESES

This study could help to answer a wide range of questions in regards to the use of virtual worlds for educational purposes. I used the resources available at CU-ASRI in order to test the virtual safe driving learning environment against the data gathered from real world SDP events. More specifically, I used the data to compare the knowledge transfer between the real events and the virtual events. It was my hope for this study that the results presented here could then shape the viability and direction of future work in the use of virtual worlds for teaching safe driving to teens. These findings could also assist in providing valuable information for the whole of virtual world research by directly comparing the real world with the virtual world for conveying a subject matter. Therefore, the research questions were as follows:

1. Can students learn the desired material in regards to safe driving practices in the virtual world?
2. How do students who have completed the virtual program compare to students who have completed the real world SDP program in their knowledge of safe driving practices?

The above research questions, as well as the current state of the literature surrounding this topic, allowed for a number of hypotheses. I state all hypotheses as null hypotheses and I designed my analyses to allow the results of "rejecting" or "failing to reject" the null hypothesis. In some cases, the alternative hypotheses are directional. When the alternative hypothesis is directional, I also discuss this.

The first and second hypotheses follow from research question 1, whether students exposed to the virtual world driving environment would show a change in their skill and knowledge test scores. Hypothesis 1 states that exposure to the virtual environment will result in no change to the safe driving knowledge scores of the virtual world students. The alternative hypothesis is that post-environment safe driving knowledge scores will be significantly higher than pre-environment safe driving knowledge scores. Since this is a directional hypothesis, I will evaluate it using one-tailed statistical tests.

Hypothesis 2 states that the amount of time spent in the virtual learning environment will be unrelated to participant safe driving knowledge scores. The alternative hypothesis is that time spent in the virtual world environment will be positively associated with safe driving knowledge scores. Given that the alternative to hypothesis 2 is directional, I will evaluate it using one-tailed statistical tests.

Hypothesis 3 applies to the second research question, a comparison between students who completed the virtual and real world versions of the safe driving course. Hypothesis 3 states that there will be no association between the environment in which the students took the course and their safe driving knowledge test scores. This hypothesis assesses evidence for an association between students' driving knowledge and the environment in which they completed their driving course. Current research examining this topic is relatively scarce; of the research available, none of the virtual programs that I discussed in the literature review outperformed their real world counterparts when tested in isolation (rather than in conjunction with an already established program). Therefore, there is no basis for expecting that the virtual environment would outperform the real world environment when the measure of interest is an increase in driving knowledge. Thus, hypothesis three predicts the null hypothesis of no association and there is no alternative hypothesis. Furthermore, since this hypothesis is not directional I will evaluate it using a two-tailed test.

In summary, the three hypotheses are:

Hypothesis 1: There will be no difference between safe driving scores collected before participation in the virtual safe driving program environment and scores collected after participation in the virtual safe driving program.

Alternative Hypothesis 1: Scores collected after participation in the virtual safe driving program will be higher than those collected before participation in the virtual safe driving program.

Hypothesis 2: Time spent in the virtual safe driving program environment will be unrelated to safe driving knowledge scores.

Alternative Hypothesis 2: There will be a positive association between time spent in the virtual safe driving program environment and post-environment test scores.

Hypothesis 3: There will be no association between the environment in which the training occurred (virtual vs. actual) and the level of knowledge when compared to the real SDP event scores.

CHAPTER FIVE

METHODOLOGY

Virtual Environment Design

I designed the virtual safe driving program environment over the course of approximately nine months. Over the lifespan of this design process, I used a number of social learning theories and construction principles. These construction principles such as environmental layout, game play concepts and "user friendly" design choices stemmed from my personal experience as a video game player. Video games are most often designed and tested on a multitude of levels in order to create a smooth and accessible experience for players. I felt that many of these same principles could be adopted for the creation of this learning environment. This resulted in the design and construction of an environment that had at its core a number of different elements. To begin this brief discussion of the design of this learning environment, we must first start the initial goals that were set forth in its construction.

The initial goals for this environment were to create an environment that was entertaining, engaging, and educational. These three design motifs would come to be known as the "3E's" which embodied much of the design philosophy behind this environment. The concept of the 3E's was simply that in order to "hook" the youth of today the environment needed to be entertaining. This element of entertainment had a basis in game design like that seen in video games. I felt that by attempting to infuse game play elements into the learning environment, this could be used to attract youth and then subsequently engage them in the learning process.

Therefore, engagement was the second design principle. In this case, I felt that the environment needed to engage the youth in order to make them a part of their own learning experience within the environment. This engagement, both in the environment and amongst themselves, could then lead to moments of social construction. Once engaged in the environment the students could begin to have learning experiences. I then felt that the doors would be opened in order to educate the youth more effectively. Therefore, the 3E's were very much a reciprocal system in which one element set the stage for the next in the hopes of generating an environment that could entertain, engage, and then most importantly - educate.

These three design philosophies also had a number of elements of Social Constructivism woven throughout. As I mentioned previously, Social Constructivism posits that we all construct own knowledge. It also states that we do so through experiential learning and our own reasoning. This is then taken one step further in asserting that these processes are further strengthened by constructing knowledge together as a group by learning with peers. The above design elements attempted to create a system of design elements which would allow for the natural fostering of such experiences and group dynamics. This seeped into every aspect of the design of the environment, as it was always a goal of the construction process to build an environment that allowed people to naturally flow together and participate in learning activities together.

This is visible in large scale design choices, such as how the modules are arranged within the environment. The modules are laid out along a road in no particular order. The purpose of this was to allow for people to approach the environment how they wished, but it also allowed for one central "channel" to run through the center of the environment. I hoped that this roadway would allow people to flow freely but also to flow together as people naturally clustered around modules and activities.

Social Constructivist thought is also visible in smaller scale design choices, such as how most of the modules either had covert or overt elements that were designed to draw people together. For instance, less obvious elements of group fostering were included in the lesson tent design. While students could easily absorb the information in the lesson tents on their own, they were set up to be larger spaces with chairs for many students. This imbeds the notion of group participation into the design of the lesson tents as the number of chairs reveals that these spaces were designed for multiple students. However, other more obvious elements of group fostering exist in modules such as the role play theater. This activity requires group forming as students have to assume roles in order act out safe driving scenarios on a virtual stage. This activity can not be accomplished without the grouping of students. Grouping in this case is two-fold in that groups have to act out their roles together in order to complete the scenario. There is also another layer of group participation that can exist in this module in the form of audience. These elements all result in an environment that attempts to harness the social constructivist ideas and apply them to the creation of environment that would foster experiential learning as well as the social construction of safe driving knowledge.

Another element of design used for this project was that of "realistic vs. unrealistic." Originally the goal of this concept was to design an environment that was split into a very realistic recreation of the real world safe driving program events as well as a very unrealistic theme park like interpretation of the safe driving program curriculum. This idea later evolved into the idea of designing an environment that had both realistic modules as well as more unrealistic video game like modules and elements. In this case, “unrealistic” becomes more of an idea of playing to the strengths of virtual worlds by creating game like modules and activities that would be improbable in the real world. On the other hand the realistic design remained that of creating real world equivalents and recreating real world design choices.

Creating unrealistic game elements involved using game play ideas such as objectives, level progression and interactive activities to inform module creation. To once again use the lesson tents as an example, these tents are essentially 1:1 recreations of their real world counterparts. They are recreations physically as well as conceptually as they basically only serve as virtual classrooms with little interaction or game play elements. In contrast, the crash street activity has a virtual car crash take place in the middle of the environment. The students are then charged to quickly work together to discover all of the human errors that lead to the crash. This module harnesses many of the strengths of virtual worlds because it creates an interactive group activity that would be improbable and dangerous to execute in the real world. It also uses elements of game play logic in that the students are given an objective to accomplish rather than just tasking them to passively absorb information about the many kinds of human error that can result in a crash. This allows the students to construct their own knowledge in regards to this topic of loss of control and human error.

One final element of the design of the environment was my idea of a two phase design process. These two phases were the construction phase and the functionality phase. The construction phase was, as the name implies, the phase of design where concepts were sketched out and then the assets were physically created or modified to suit the design goals. I built many of the assets that were used in this environment from scratch, which can be seen in Appendix B. However, a number of assets were also purchased and then repurposed for use in the environment. What is meant by this is that some environmental components such as the Petty truck were originally purchased as a generic 18-wheeler. This model was then heavily modified to look like the Petty truck.

The next phase of design was the functionality phase. This phase involved taking the created or modified assets and then making them functional. In this case, functional is seen as making them instructional in some way as well as interactive in some way. For instance, to refer back to the Petty truck example, the truck was not only modified to look like the Petty truck as it was also made functional through the inclusion of slide show boards, various video displays, and the creation of the "no-zones" around the truck. These elements turned a static object into a functional learning activity. The combination of these two phases of design was used throughout the environment in order to create an environment that not only looked the part but functioned accordingly.

Methods

I collected data for this study through work done at the Automotive Safety Research Institute and I have obtained permission from ASRI to employ these data for the study presented here. The Clemson Institutional Review Board approved the study protocol and instruments. The primary form of data collection I used in this study was survey data gathered through a “virtual field trip”. In short this process entailed gathering a pool of volunteer participants from classes where the professors agreed to allow access to their students. These professors also agreed to include an incentive of extra credit points to those who participated. However, these points were not dependent on participation in the virtual safe driving program study itself. These participants then divided themselves into manageable groups over the course of two weeks by selecting which days they wished to participate. During the first week these groups learned how to use Second Life during the course of one hour long session. Afterwards, during the second week they visited the virtual safe driving environment. Once in the virtual safe driving environment they had the option to complete a pre-test survey and then spend about a maximum of 30 minutes exploring the environment. Following the exploration phase they then completed a post-test survey.

The following is a more detailed account of the data collection process. The virtual field trips occurred on Clemson’s campus using volunteer participants from a number of classes. This opportunity was open to all students enrolled in these select classes. Three different sessions were offered each week so that the students had sufficient opportunities to participate and were able to pick the times that best worked for their schedules. However, it should also be mentioned that some of these classes were offered only early in the morning. The goal of these virtual field trips was not only to test the actual “usability” of the environment but also to provide an opportunity to administer a survey/quiz to the students. The students took these tests in computer labs that were preloaded with Second Life. During the first session students were asked to create a Second Life account before participating in the tutorial phase. They then received guidance on many of the skills necessary to use Second Life effectively. This tutorial phase took approximately one hour.

During the next session they then took a "field trip" to the virtual safe driving program laboratory. Once there they listened to a brief introduction to the environment as well as a reminder that they had the opportunity to participate in this research by filling out two surveys. This was the time in which they had the option to complete the pre-test online survey. They then took a brief tour and looked over a handout with a number of activities. These activities were chosen around the relatively short period of time they had to explore the environment but the students were largely left to proceed at their own pace. After roughly 20 minutes of exploration they were given a warning that their time was coming to an end and if they wished to complete the second post-test survey then they should do so now. In this study, I only used the data from those who completed both the pre-test and post-test surveys.

The knowledge measure that was used during these field trips was created and is currently being used by CU-ASRI and RPDE to gather knowledge-based data from the real world SDP events. This short measure consists of 18 questions total. Of these 18 questions 14 are knowledge measures pertaining to safe driving practices while the remaining 4 gather some simple demographics such as the age and when the student began driving. Once again, these 14 knowledge questions could be subdivided into four different module/topic areas. These four different areas included: braking, reaction time, tailgating, and loss of control. The inclusion of these module specific demarcations allowed for the measuring of change in regards to specific topics. The following is an example of one such knowledge measure:

What is the single most effective safety system in your vehicle?

a. Anti-Lock Braking System
b. Safety Belt System (Correct Response)
c. Electronic Control System
d. Traction Control System

This measure is given to the real world students during their orientation period and it is then given to them again before they leave. For my study, this same measure was also given to the virtual world students. This was done so that a comparison could be made between the real world environments and the virtual world environments. The times at which the survey was administered was also mimicked in order to track knowledge change. For instance, the students at real world events receive the survey when they first arrive during their orientation and then right before they leave at their debriefing. This allows for ASRI and RPDE to observe any changes in knowledge after participating in their program. This format was recreated in the virtual world for the same reasons. Students took the first survey upon their arrival at the virtual safe driving program laboratory and then they took it again right before they left. This made it possible to see if there were any changes in the knowledge level of students after participating in the virtual program.

These virtual field trips also began with the administration of a pre-test survey. This survey was conducted through the use of the Snap survey tool. This is a web based survey tool that can be conducted through a web portal, which was integrated into Second Life. This tool allowed for easy data analysis as it was easily exported into SPSS. The survey was set up online so that it could then be administered during the field trips. The data gathered from the pre-test survey provided the baseline for the students' knowledge in regards to safe driving. After the first survey was complete the students had roughly half an hour to explore and interact with the environment. During this time the students were loosely guided to complete activities, read slide shows, and watch some videos in the form of a handout. This half-hour timetable is significantly reduced from real Safe Driving Program, which runs for six hours. This reduction in time spent was both for logistical reasons as well as because it has always been a goal of the virtual safe driving program to allow for shorter (or longer) visits while still imparting safe driving knowledge. Therefore, upon completion of this activity phase of testing the post-test survey was administered to the students. This survey consisted of the same measures as before, which allowed for the charting of any changes in the level of knowledge gained by the students during their time in the virtual world.

These measures, when taken together, allowed for three things. The first thing it allowed for was a comparison to be drawn between pre-and post-test results. This addressed the first research question in that it allowed us to see if there was a statistical difference between the first test and the second test. Essentially, this test assessed whether students were more knowledgeable about safe driving after spending time in the virtual learning environment. Second, these data were then compared directly to that of the real world safe driving events. By collecting the same information in the same way it was possible to address the second research question. This allowed me to draw comparisons between the pre-test and post-test scores of the real world events in order to determine if there were any statistical differences in knowledge acquisition between these two groups. Third, this measure also allowed for an observance of any knowledge change that was specific to any one particular topic or module area. This permitted me to draw comparisons for individual module performance as opposed to only general knowledge change.

Data

The data for this study were comprised of two sample populations. I have touched on these two sample groups briefly above, but here I will discuss their composition and characteristics in more detail. The first group to be discussed is the virtual student sample. This group was comprised of 49 respondents. These respondents were all at least 18 years of age or older and currently enrolled in college courses. While their specific ages were not recorded, it is worth noting that the actual classes that were presented with this research opportunity were introductory level courses. This information does not guarantee a particular age bracket but it does suggest one as these courses are primarily populated with freshmen and sophomore students. These students were all informed about this research opportunity and then petitioned to participate; however, no formal reward or incentive was given and participation in this study was voluntary. There were more female virtual students than male students, as approximately 58% were female and

42% were male. Finally, 79% of respondents stated that they began driving at the age of 15.

The second sample group that composed the data used in this study consisted of real world Petty Safe Driving Program students. This sample group has some significant differences from the virtual students. This sample group was composed of 28 respondents who were 18 years of age or older and 24 respondents who were 17 years of age. These two age groups were then combined to create a total sample of 52 real world students. This means that this sample group has a lower average age than the virtual students, which I will discuss later. These students all signed up and attended one of the real world Petty Safe Driving Program events. Not only did they have to register in advance but they also had to pay a fee to participate. The majority of these students' parents brought them and paid the fee for them. These students are typically still in high school; however, a large portion of these respondents already had their full driver's license with 46% followed by learners with 23%. Most of these students also began driving at the age of 15 with approximately 56% followed by age 16 at 17%. In regards to gender the majority of the real world students were male with 54% reporting male and 46% reporting female.

In regards to this data, I should mention briefly here that this disparity could be seen as a limitation. This is due to the possibility that the older virtual world students will have more experience than the younger real world students. One possible consequence of this greater experience could be that the younger students have more room for improvement in regards to their safe driving knowledge scores than the real world students. Another difference of note is that the virtual students spent an average of 14.43

minutes exploring the learning environment. This is in contrast to the six hours that the real world students spend at real world events. I accounted for these differences during the data analysis process. More specifically, I created a variable for age, and controlled for it during the regression analysis. In this case, I found that age was not significant. This means that the differences between the ages of these two groups did not have an effect on the results presented here. In regards to the disparities between time, I also created a subsequent variable and found that this too was not significant. However, without any time data for the real world students, I could not account for this limitation completely. Therefore, this limitation should be kept in mind during the following analysis.

Measures

Safe Driving Knowledge. The primary focus of this study was to test to see if participation in a virtual safe driving program could increase a student's knowledge of safe driving practices. I measured safe driving knowledge through the use of an instrument developed by ASRI to test for the desired subject knowledge. This knowledge measure is broken down into a number of key components that attempt to measure knowledge acquisition regarding certain module topics. These module topics include braking, tailgating, loss of control, and reaction time. Braking consisted of five questions while the other three modules were composed of three questions each. The result is a 14-question instrument that could be used to not only observe overall safe driving knowledge change but also individual subject matter module change.

I subsequently created a number of variables to capture and analyze this data. First, I created a duplicate question variable for each of the fourteen questions which was recorded in such as way as to report if an answer given was simply right or wrong rather than a specific individual response. The result was a new set of questions in which a “1” denoted a correct response while a “0” denoted an incorrect response. This allowed for an overall score to be easily calculated out of a 14-point scale. I subsequently created a “Pretest” as well as a “Posttest” variable to capture these overall scores for each respondent. Said another way, I created two variables, which calculated a respondent’s total pre-test and post-test score. I did this by adding all of a student’s correct responses together for their pre-test and then their post-test which resulted in two scores that could range from 0-14. The result was two variables that represented the total pre-test as well as post-test scores of any given student.

There were also “pre” and “post” related variables created for each of the individual modules such as “braking” and “postbraking.” I created these variables in a very similar way and with very similar goals as the variables outlined above. In this case I created two variables for each module, which calculated the overall pre-test and post-test module scores of each student in regards to their specific module performance. In other words, I created a variable which captured the total module score of each student both pre and post. These total module scores could range from 0-5. This was done so that safe driving knowledge could not only be measured as a whole but so it could also be analyzed on a module based level allowing for comparisons to be drawn in regards to how students learned certain topics compared to others.

Time Spent Exploring. In order to further examine the effects of the virtual safe driving program on the student's level of safe driving knowledge a measure for time had to be created. An understanding of the amount of time students spent exploring the environment would allow for us to observe if more or less time had a positive or negative effect on their safe driving knowledge scores. In essence, this variable is the number of minutes spent exploring by each student. I created this variable by subtracting the time the students *completed* the first survey from the time in which they *began* the second survey. This created a variable that consisted of the actual time that was spent exploring the virtual environment rather than accounting for the time it took taking the survey itself combined with exploration.

In the time calculation, seconds were lost during data manipulation. More specifically, the seconds from each time stamp for each respondent's survey time were erased leaving only an hour and a minute notation. This hour notation was largely irrelevant for this analysis, due to the fact that there were no students that spent more than an hour participating in the environment. However, the hour notation was still accounted for if a student's time spent exploring crossed from one hour to the next. Said another way, if a student completed their pre-test at 1:55 and began their post-test at 2:10 then the hour was noted in order to calculate their total exploration time. This left a simple minute notation for when the students finished the first survey as well as when they began the second survey. These two time values could then be subtracted from one another. The result was a simple numerical representation of the approximate time that was spent by each student exploring the environment.

Environment. Environment was a variable created for this study, which recorded the particular learning environment that a student participated in. During the data manipulation process the need arose for a combined data set to allow for the comparison of the real world and the virtual world students. Subsequently, this also created the need to have a signifier that allowed for these two groups to still be recognized so that a comparison could take place. I then created the variable "environment" to fill this need. This dichotomous variable contained two categories where a "1" signified participation in the virtual environment while a "0" signified participation in the real world environment. I created this variable before the actual merge process so that the student's environment was noted before they were combined. Furthermore, during the data manipulation processes all of the students (both real and virtual) received a case ID number. These numbers also signified the environment they participated in as ID numbers 001-099 where reserved for virtual world students while ID numbers 100-199 were reserved for real world students.

Participant's Age. During the course of this study, age was a factor that needed to be controlled for during the data analysis process. This was due to the fact that there were certain inherent differences between the real world sample and the virtual world sample in regards to their age. Therefore, I used two variables to account for both the real world students' and the virtual world students' age. The first age variable used was based off of a demographic question that appeared on the SDP survey. This question asked respondents to select their age out of a list of four possible choices ranging from "15" years old to "18+." This age variable allowed for the parsing of respondents in order to gather a sample group that was as close to the virtual world sample as possible. The virtual world sample itself consisted exclusively of students who responded that they were at least 18 years of age. Therefore, in order to gather a real world sample of comparable size as well as age distribution only students who responded that they were at least 17 years of age were selected from the real world population. Afterwards, I created a dichotomous recoded age variable. This variable divided up the students by the only two relevant remaining age categories. For the recoded age variable a "1" meant that the respondent was 17 while a "2" meant that the respondent was at least 18 years of age. This recoded age demographic then allowed for participants to be divided by age and for age to be controlled for during this analysis.

CHAPTER SIX

ANALYSIS

I used a number of descriptive statistics such as frequencies and crosstabs in order to gain insights into the effect of the virtual program on the knowledge scores. More specifically, I conducted frequency distributions for overall safe driving knowledge performance as well as for the individual modules and questions. These results could then be used in order to test the first hypothesis regarding if the virtual environment had an effect on safe driving knowledge scores. I used these frequencies to gain a qualitative insight into not only if students increased their scores but also to observe how much they increased their scores and in what areas they increased their scores the most. I also conducted crosstabs for similar reasons. However, in this case rather than looking at specific modules and questions for comparison, pre to post individual student performance was the primary focus. I ran crosstabs on the individual modules in order to observe more specific improvements (or decreases) in individual student scores.

Further analysis for the first research question and the first hypothesis consisted of a paired-sample t-test which compared the pre and post knowledge measures against each other. This t-test analysis tested for statistically significant change between the pre-test and post-test scores of the virtual participants after exposure to the virtual learning environment. I also employed a regression model, which observed the effects of time exploring the environment on the post-test scores while controlling for their pre-test scores. This was done to satisfy the second hypothesis which predicted that time spent exploring would not have an association with safe driving knowledge scores.

I also conducted another series of analyses in order to answer the second research question. This question required a comparison analysis to be conducted between the virtual world program students and the real world program students. To begin this analysis, I used simple descriptive statistics such as frequency distributions. After examination of the frequency results, I created a regression model. This regression model was used in order to observe if there were any statistical difference between these two groups of students and subsequently the effects of the two programs being compared. This regression model also allowed for the controlling of both age and pre-test scores. The regression analysis that followed allowed for the observation of the change in scores caused by these two programs. These tests were also run using each of the individual models in order to gain a more in-depth look at the effects of these two programs and how they compare.

CHAPTER SEVEN

RESULTS

Comparison of Safe Driving Knowledge Scores after Exposure to Virtual Program

The following findings are presented as a test of the first hypothesis. This hypothesis predicted the null hypothesis of no change between pre- to post-test scores. There were a total of 49 valid virtual student participants. The average score for the virtual students on the pre-test was 7.59 correct responses out of 14. The median score was 8 correct responses while the mode was 7 correct responses. The average score for the virtual students on the post-test was 8.82 correct responses out of 14. The median score was 9 correct responses while the mode was 8 correct responses. The average time spent exploring the virtual learning environment was 14.43 minutes. The maximum amount of time that was spent exploring the environment was 19 minutes while the minimum amount of time exploring was only 3 minutes. Both the median and the mode for time spent exploring were 15 minutes.

For the purposes of this study, I created a “passing” criterion for the data analysis. For the overall survey the “passing” criterion is as follows. There were 14 knowledge questions asked on the safe driving knowledge survey. Therefore, on traditional 100 point scale each question was worth approximately 7.14 points. This meant that that in order to have a passing score of at least a 70 then a student had to answer at least 10 questions correctly on the quiz. Subsequently, a student with 10 correct responses would receive a calculated score of approximately a 71 on a traditional 100 point scale. Thus, for this analysis 10 or more correct responses is considered a “passing score,” while 9 or fewer correct responses is considered a “failing score”. I also created an equivalent “passing” criterion for each of the individual module areas using the same process outlined above.

While testing the first hypothesis I analyzed descriptive statistics such as frequencies, as they provided a very important in depth insight into the potential effects of the virtual safe driving program. I felt that gaining such a contextualized perspective regarding student performance was essential for this analysis. To elaborate further, such a perspective could help to answer questions beyond simply “can the students improve their safe knowledge score?” by moving on to such questions as “can students improve from a failing to a passing score?” To begin these analyses, frequencies were run on both the pre-test and post-test variables. To reiterate once more, in this case the pre- and post-test scores consisted of 14 questions which when calculated on a traditional 100 point scale resulted in each being worth approximately 7.14 points each. Therefore, a score of 10 points or above was considered passing with a calculated score of 71 for this analysis.

The frequency distributions for the overall pre- and post-test scores can be seen in Table 1 below. In regards to the pre-test frequency distributions, 80% (or 39 students) of test takers received a failing score of a 9 or below. Conversely, this also meant that only 20% (or 10 students) received a passing grade of at least a 10 or higher. The highest score was a single score of 12 points, which calculates to roughly an 86 on a 100-point scale. The frequency distributions for the post-test scores paint a much-improved picture of the student’s safe driving knowledge after their expose to the program. In the case of the post-test results 57% (or 28 students) still failed the posttest. However, the number of students who passed the post-test rose to 43% (or 21 students). This figure of a 43% (or

21 students) pass rate stands in stark contrast to the student's pre-test pass rate of only 20% (or 10 students). These results suggest that there was a 23 % (or 11 student) increase in passing scores after just a short exposure to the virtual safe driving program.

Table 1: Frequency for Safe Driving Knowledge Quiz Scores

	PreTest		Posttest		P-Value
Valid Score	**Frequency**	**Valid Percent**	**Frequency**	**Valid Percent**	
Failing (3 – 9)	39	79.60%	28	57.10%	
Passing (10 – 14)	10	20.40%	21	42.90%	
Total	49	100%	49	100%	.000***

***Pretest mean = 7.5918, Posttest mean = 8.8163, ***p<.001. (two-tailed tests)**

During the testing of the first hypothesis, I also ran similar frequencies on all of the individual modules in the hopes of gaining a more in-depth understanding of the changes seen in the previous statistics. These individual module frequency distributions can be seen in Table 2 below. It should also be mentioned that all of the significance tests reported here are for two-tailed distributions. This is because the first alternative hypothesis has the potential to be directional by stating that the virtual environment could have a positive effect on safe driving knowledge scores. For the *braking module* four or more correct responses out of five were viewed as a "passing" grade. Only 20% (or 10 students) got 4 or more questions correct on the braking pre-test. However, 30% (or 15 students) got 4 or more correct on the braking post-test. In this case we see a module passing increase of 10 percentage points (or 5 students) after exposure to the program.

The remainder of the following modules consisted of only three questions thus for our purposes here we will only look at the perfect and non-perfect scores for comparison.

For the *reaction time module* there were 6% (or 3 students) that got a perfect score of 3 correct answers on the pre-test. The number of perfect scores after exposure to the virtual environment increased to 25% (or 12 students). Thus in looking at perfect scores after the intervention we can see an increase of 19 percentage points (or 9 students). We see similar results in the *tailgating module*. The percentage of pre-test perfect scores in this module was 27% (or 13 students). This number increased to 37% (or 18 students) after exposure to the virtual program. Thus we saw a 10 percentage point (or 5 student) increase in perfect scores on the tailgating module.

Finally, I also observed the frequencies for the *loss of control module*. In this module 16% (or 8 students) received a perfect score on their pre-test. This number increased to 29% (or 14 students) after exposure to the program. Thus we once again see an increase of 13 percentage points (or 6 students) after the students spent a small amount of time exploring the virtual environment. It appears from these frequencies that the virtual environment not only had an effect on safe driving knowledge scores, but that this effect was positive. Further still, not only did the environment appear to have a positive effect overall on the scores of the students, but it also had a positive effect in regards to all of the specific modules. These findings lend themselves to the rejection of the first null hypothesis that the environment would not have an effect on the students' safe driving knowledge.

Table 2: Frequencies for Individual Module Scores

	PreBraking		PostBraking		P-Value
Valid Score	**Frequency**	**Valid Percent**	**Frequency**	**Valid Percent**	
Failing (0 – 3)	39	79.60%	34	69.40%	
Passing (4 – 5)	10	24.40%	15	30.60%	
Total	49	100%	49	100%	.023*

	PreReaction		PostReaction		P-Value
Valid Score	**Frequency**	**Valid Percent**	**Frequency**	**Valid Percent**	
Failing (0 – 2)	46	93.90%	37	75.50%	
Passing (3)	3	6.10%	12	24.50%	
Total	49	100%	49	100%	.070^

	PreTailgating		PostTailgating		P-Value
Valid Score	**Frequency**	**Valid Percent**	**Frequency**	**Valid Percent**	
Failing (0 – 2)	36	73.50%	31	63.30%	
Passing (3)	13	26.50%	18	36.70%	
Total	49	100%	49	100%	.012*

	PreLossofControl		PostLossofControl		P-Value
Valid Score	**Frequency**	**Valid Percent**	**Frequency**	**Valid Percent**	
Failing (0 – 2)	41	83.70%	35	71.40%	
Passing (3)	8	16.30%	14	28.60%	
Total	216	100%	143	100%	.052^

^p<.10. *p<.05. **p<.01. ***p<.001. (two-tailed tests)

To analyze this data in more depth, I also created frequency distributions for each of the individual questions themselves. This item analysis was done to gain an even greater in-depth look at the areas of greatest and least improvement. The individual results of each frequency comparison will not be gone over in detail here rather only key points will be highlighted. To begin this analysis, some very basic statements can be made in regards to these results. First, there was some level of improvement on almost all of the 14 questions with only 2 exceptions. Question 2 experienced a 5% (or 3 student) drop in correct answers. Question 7 also experienced an 8% (or 4 student) drop in correct answers given. As stated above these were the only two questions that experienced a drop in scores. Question 7 is of particular interest here as it is also a recurring issue for the real world Petty Safe Driving Program. In the real world, this question also experiences drops suggesting that it may be a flaw in the question itself.

In spite of the above two cases, all of the other questions experienced some level of improvement. These improvements ranged from a 2 percentage point (or 1 student) increase to a 27 percentage point (or 13 student) increase. To elaborate further, there were six questions (Q3, Q8, Q11, Q12, Q13, and Q15) that had a moderate to low improvement of a less than 10 percentage points in correct answers given. However, there were also six questions (Q4, Q5, Q6, Q9, Q10, and Q14) that had a strong improvement of more than 10 percentage points in correct answers given after the exposure to the virtual environment. It is even the case that two of these six questions improved by even more than 20 percentage points in correct answers given. As I mentioned above, Question 9 improved by 27% (or 13 students) while Question 10 improved by 23% (or 11 students).

Despite these results that demonstrate the potentially positive effect that exposure to the virtual safe driving program may have, there are no significant discernible patterns in these results in terms of question clusters. This is because the student scores span both module topics as well as module locations within the virtual environment, suggesting that there are no patterns in improvement. In other words, neither one module area nor any one module topic saw overwhelming improvements; rather improvement was seen scattered throughout the environment. The improvements seen in this study were not localized to any particular area of the learning environment. For example, the above over performing questions (9 and 10) are located in different areas of the environment and they also involve two different safe driving topics (reaction time and tailgating). Thus, there appear to be no discernible patterns in improvement.

To further test the first hypothesis, I also conducted supplementary analysis using crosstabs. The details of this crosstab analysis as well as the crosstabs results themselves can be found in Appendix D and Appendix E. I conducted this supplementary analysis to give a more in-depth observation of the student's scores in order to attempt to reveal any specific or overall changes in scores from pre to post for individual students. Said a different way, I used crosstabs to observe any changes in regards to particular students rather than overall groups of students. In essence, these crosstab results revealed that out of the 49 students who completed both tests, nine students stayed the same resulting in no change of score between the pre-tests and post-tests. However, in total 31 students improved their scores between the pre-tests and the post-tests revealing that the vast majority of students improved their scores to some degree and half of those who did not improve at least stayed the same. This is one more piece of evidence that the virtual safe driving program had an overall positive effect on the students' safe driving knowledge, as the virtual safe driving program in most cases improved knowledge in the desired subject areas and at the very least did not detract much from them.

I also conducted a paired-sample t-test to test the first hypothesis, which compared the mean pre-test scores of the virtual safe driving program students with their post-test scores. The mean scores, degrees of freedom, as well as the two-tailed p-values of these paired-sample t-tests can be found in Table 3 below. Once again it is worth noting that due to the possibility of a directional alternative hypothesis, the two-tailed p-values are presented for this analysis. The goal of these tests was to observe any positive or negative change that could possibly be attributed to the virtual program. Any findings gleaned from this test would then provide more evidence for or against the rejection of the first null hypothesis. The results of this analysis were significant df=48, t=-4.093, p=.000. There was a significant difference in the pre-test scores (M=7.6, SD=2.2) and the post-test scores (M=8.8, SD=2.4). This means that there was a 1.2 point (or 16%) increase in scores after the virtual program intervention, and that this difference was greater than what would be expected from chance alone.

I then conducted another set of paired-sample t-tests using the individual module measures. This was done in order to see if the above increase in overall knowledge could be attributed to particular areas of learning. Most of these findings were significant at the p=.05 level however there was quite a bit of variation in the strength of that significance in regard to the individual modules. The first module analyzed was the *braking module* which consisted of five questions. The pre-test braking scores (M=2.6, SD=1.1) and the post-test braking scores (M=2.9, SD=1.2) were found to be significant; df=49, t=-2.354, p=.023. These results point to an increase of .35 points (or 12%) in the students braking knowledge scores after exposure to the virtual learning environment.

I then conducted the same test for the *reaction time module,* which consisted of three questions. The pre-test reaction time scores (M=1.7, SD=.57) and the post-test reaction time scores (M=2.0, SD=.79) were found to be approaching significance; df=49, t=-1.853, p=.070 (two-tailed test). These results demonstrate an increase of .22 points (or 18%) in the student's reaction time knowledge scores.

The next test that I conducted was in regards to the *tailgating module* which also consisted of three questions. The pre-test tailgating scores (M=1.7, SD=.1) and the post-test tailgating scores (M=2.1, SD=.83) were found to be significant; df=49, t=-2.6, p = .012 (two-tailed test). This means that there was a .39 point increase (or 24%) in the students tailgating knowledge scores.

Finally, I also ran this test on the *loss of control module,* which consisted of three questions. The pre-test loss of control scores (M=1.6, SD=.94) and the post-test loss of control scores (M=1.8, SD=.95) were found to be approaching significance; df=49, t=-1.996, p=.052. This means that there was an increase of .27 points (or 12%) in the student's loss of control scores.

Table 3: Paired Sample T-Test

Testing Area	Pre		Post		
	Mean Score	DF	Mean Score	DF	P-Value
Overall	7.5918	48	8.8163	48	.000***
Braking	2.5714	49	2.9184	49	.023*
Reaction Time	1.7347	49	1.9592	49	.070^
Tailgating	1.7347	49	2.1224	49	.012*
Loss of Control	1.551	49	1.8163	49	.052^

^p<.10. *p<.05. **p<.01. ***p<.001. (two-tailed tests)

Upon analyzing the above results it appears that most of the increases in scores for the specific module areas are around the same percentage increase. However, the area with the most significant improvement was the tailgating module. This module was the one with the highest improvement in scores with a .39 point increase (or a 24 percentage point increase) after exposure to the virtual safe driving program. The modules with the weakest improvements were braking and loss of control each with only a 12 percentage point increase in scores. However, regardless of these weaker module improvements these results still demonstrate clearly that students improved by some modicum in all of the module areas. These findings permit rejection of the first null hypothesis. Furthermore, most of these findings demonstrate clearly that in general exposure to the virtual environment did indeed have a positive effect overall on knowledge scores from pre to post.

The following analysis was done to satisfy the first research question and to test the second hypothesis. The second hypothesis predicted that time spent in the virtual environment would be unrelated to post-exposure safe driving knowledge scores (or change between pre- and post-environment scores). For this portion of the analysis, I created a regression model that accounted for the variable of time spent in the environment. I conducted this regression analysis in order to see if the amount of time that participants spent exploring the virtual safe driving program had a significant effect on their resulting scores. Due to the possibility of a directional result the one-tailed significance tests are reported below. A table of this regression analysis can be found in Table 5 below.

As previously stated, in order to test the second hypothesis, I conducted a regression analysis. The first model included just the post-test variable as well as the time variable. The results of this model revealed that time did not have a significant effect on safe driving knowledge. More specifically, in the first model time does not explain the variation in the student's post-test scores with a p value of .222. However, once the pre-test variable is added in the second model then it was found that pre-test was significant at p=.000 though time was still not significant. The proportion of variance of the post-test scores, which are explained by time, is only 1%. Meanwhile, the proportion of variance of the post-test variable that is explained by time combined with the pre-test variable in model 2 is 32%. This would suggest that the pre-test results are a greater predictor of post-test results than just time spent, in this case. In terms of the reported coefficients a 1-minute increase in the amount of time spent in the virtual environment was associated with a .059 point improvement in scores pre vs. post. Likewise, a 1 standard deviation in time spent is associated with a .075 standard deviation improvement in score pre vs. post.

I then conducted a similar regression analysis to test the second hypothesis for each of the individual module topics. The findings for these subsequent analyses can also be found in table 4 below. It was found that in the case of all but one of the modules that time was not associated with an increase in student's scores from pre to post. However, the one exception to these findings was the loss of control module. In this module it was found that time was indeed significant at the .05 level. In terms of the un-standardized coefficients, it was found that every 1 minute of time spent exploring the virtual environment was associated with a .068 point improvement in scores, pre vs. post. Likewise, in regards to the standardized coefficients, a 1 standard deviation in time spent exploring the virtual environment was associated with a .214 standard deviation improvement in scores, pre vs. post.

These findings seem to indicate that time was not a significant factor in the increase in students scores, except in the singular case of the loss of control module. In this case time was able to predict change in student's scores pre to post. However, overall time was not a significant predictor of change in student's scores pre to post. Thus in this case we partially failed to reject the second null hypothesis, meaning that time in general was not associated with any change in safe driving knowledge scores though it was associated with change in scores in regards to the loss of control module.

Table 4: Overall and Module Regression for Time

	PostTest	PostBrak	PostReact	PostLoss	PostTail
PreScore	0.574***	0.613***	0.221	0.521***	0.393**
Time	0.075	0.034	0.154	0.214*	-0.122
Observations	49	49	49	49	49
Adj R Squared	0.323	.354	0.047	0.280	0.112

All values from model 2. *p<0.05, ** p<0.01, ***p<0.001 (one-tailed values)

To help further explain these results for the second hypothesis, I ran a frequency distribution in order to gain a more in-depth look at why time did not seem to have an impact on the post-test scores. After observing this frequency distribution, a possible reason for time's inadequacy for explaining the variation in the post-test scores is perhaps due to the lack of variation in the time variable itself. The average time that a student spent exploring the virtual environment was approximately 14 minutes. The exploration times recorded range from a single outlier of 3 minutes to two students who spent a total of 19 minutes exploring. While this range could possibly be a significant enough variation in time spent, I found that the vast majority of the students fell within 5 minutes of each other in regards to duration of exploration. More specifically, 76% (or 37 students) spent between 13 and 18 minutes exploring the environment. This could be one possible explanation for why time was not found to be a significant factor in accounting for the change in post-test scores.

Comparison of Virtual World Students with Real World Students

In order to answer the second research question and to test the third hypothesis, I conducted an analysis that compared the results of the virtual world students with a sample of 52 real world PSD students. This sample of 52 real world students was composed of every student who reported that they were at least 17 years of age. This was done in order to gather a real world sample that was a sufficient approximation to the virtual world group's age and size. The original goal was to have a real world sample that was composed entirely of students who were 18 years of age or older. However, there were not enough students within that age group to make an adequate comparison. Therefore, I expanded the age acceptance to include 17-year-old respondents as well. This real world sample was drawn over the course of the all of the Petty events that were held in 2010, for which there were usable data. This resulted in 28 students who were 18 years or older and 24 students who were 17 years old. These real world students completed the same survey/quiz that the virtual world students completed, which allowed for comparisons to be drawn in regards to group performance.

To begin this analysis of the third hypothesis, I ran descriptive statistics in order to examine if there were any differences or similarities that may exist between these two groups. The frequency distributions for the overall pre-test and post-test scores can be seen in Table 5 below. The frequency results for the virtual world pre-test scores reported that the mean score was 7.59 while the mean score for the real world students was 7.58. This revealed that while there were some differences in the age composition of these two groups that their baseline knowledge was relatively equal. However, in regards to their post-test scores a clear difference between these groups begins to emerge. The mean post-test score for the virtual world students was 8.82 while the mean post-test score for the real world students was 10.81. This means that there was approximately a two point difference in post-test scores between these two groups, in which the real world students scored higher on average.

In keeping with the previously used passing criteria this also means that on average the virtual world students were still failing by the end of their short time in the virtual environment. Conversely, the real world students on average would be considered passing after attending a real world PSD event. Said another way, 42.9% (or 21 students) of the virtual world participants were considered passing after exposure to the environment while 84.6% (or 44 students) were considered passing after participation in a real world PSD event. However, while these results are clearly in favor of the real world PSD program in terms of output, what we really wish to examine here is the actual change that can be attributed to these two programs in terms of score improvement rather than just raw scores.

Table 5: Frequencies for Virtual World and Real World Student Scores

	PreTest		Posttest	
Virtual Valid Score	**Frequency**	**Valid Percent**	**Frequency**	**Valid Percent**
VW Failing (3 - 9)	39	79.60%	28	57.10%
VW Passing (10 - 14)	10	20.40%	21	42.90%
Total	49	100%	49	100%

	PreTest		Posttest	
Real Valid Score	**Frequency**	**Valid Percent**	**Frequency**	**Valid Percent**
RW Failing (0-9)	44	84.60%	8	15.40%
RW Passing (10 - 14)	8	15.40%	44	84.60%
Total	52	100%	52	100%

***Pretest VW mean = 7.59, Posttest VW mean = 8.8163, Pretest RW mean = 7.58, Postest RW mean = 10.81**

In order to observe the impact of the learning environment on post-test scores while controlling for pre-test scores as well as participant age, I created a regression model to further test the third hypothesis. This model served two key purposes. The first purpose as stated previously was to observe any significant change between these two groups, rather than just overly simplistic post-test results. The other purpose was to run an analysis that could control for both students' pre-test scores as well as their age in order to observe if either had a significant effect on the students' post-test scores. This controlling of the pre-test scores would also allow for a more sound comparison as this would account for any possible disparity that existed between gaps in baseline safe driving knowledge that might have resulted from differences in age/experience. See Table 6 below for the following regression results.

In this regression model, I found that 29% of the variation in post-test scores was explained by the combination of pre-score, learning environment, and age. When the pre-test score variable was added in the second model, this changed the interpretation of post-test scores so that it was no longer simply a measure of the students' post scores but rather it was a measure of the *change* in the students' scores from pre to post. I found that moving from real world to virtual world decreased students' overall knowledge scores by one third of one standard deviation (-.327). In this model the environment was found to be significant with a p-value of .002. The pre-test scores were also found to be significant in this model with a p-value of .000, while age was not found to be significant. These results support the above frequency distributions in that the virtual world students did significantly worse pre vs. post than the real PSD students. Thus, it would appear that the third hypothesis would be rejected on the basis that there did appear to be a difference between the two environments, and this difference would appear to be a negative one in which the virtual world environment performed worse.

In order to delve deeper into these results and to further test the third hypothesis I also employed similar regression models for each of the four knowledge modules. I did this to investigate if the virtual students did worse than the real world students on each module, or if there was variation in module performance. The first module examined was the braking module. The results for this module can be found in Table 6 listed under the column title "PostBrak." In this case, I found that in the second model 25% of the variation in post-test braking scores was explained by the combination of pre-score, learning environment, and age. Once again the addition of the pre-test score variable changed the interpretation of the dependent variable to the change in score, rather than simply the post-test score itself. In terms of the reported coefficients it was found that when controlling for pre-score and age, moving from real world to virtual world decreased students' braking knowledge scores by one third of one standard deviation (-.378). In this model, I found the environment to be strongly significant with a p-value of .000. Once again as with the overall scores, the pre-test braking score was very significant with a p-value of .000 while age was not significant.

The next module I investigated was the reaction time module. The results for this module can be found in Table 6 listed under the column title "PostReact." I found in this case that in the second model 11% of the variation in post-test braking scores was explained by the combination of pre-score, learning environment, and age. Once again as with the previous models and all that follow, the addition of the pre-test score variable changed the interpretation of the dependent variable to the *change* in score rather than simply the post-test score itself. In terms of the reported coefficients, I found that when controlling for pre-score and age, moving from real world to virtual world decreased students' reaction time scores by one fourth of one standard deviation (-.248). In this model, the environment was marginally significant with a p-value of .029. Once again as with the overall scores and the braking module, the pre-test reaction time score was significant with a p-value of .002 while age was not significant.

The following loss of control module represented the first and only deviation in the above pattern. The results for this module can be found in Table 6 listed under the column title "PostLoss." In this regression model, I found that 14% of the variation in post-test loss of control scores was explained by the combination of pre-score, learning environment, and age. In terms of the reported coefficients, I found that when controlling for pre-score and age, moving from real-world to virtual world decreased students' reaction time scores by a fraction of one standard deviation (-.06). However, this was the only module in which the environment was not found to be a significant predictor of post-test scores with a p-value of .601. In model 2 for loss of control the only variable that was significant was that of the pre-test loss of control scores with a p-value of .000.

Finally, I also conducted a similar regression model for the tailgating module. The results for this module can be found in Table 6 listed under the column title "PostTail." In this regression model, I found that 22% of the variation in post-test tailgating scores was explained by the combination of pre-score, learning environment, and age. In terms of the reported coefficients, I found that when controlling for pre-score and age, moving from real world to virtual world decreased students' reaction time scores by one fourth of one standard deviation (-.259). In this model the environment was significant with a p-value of .016. Once again as with the majority of the previously reported results, the pre-test tailgating score was significant with a p-value of .001 while age was not significant.

Table 6: Overall and Module Regression for Environment

	PostTest	PostBrak	PostReact	PostLoss	PostTail
PreScore	0.429***	0.384***	0.299**	0.397***	0.316**
Learning Environment	-0.327**	-0.378***	-0.248*	-0.058	-0.259*
Age	-0.077	-0.004	0.050	-0.090	-0.131
Observations	101	101	101	101	101
Adj R Squared	0.294	.247	0.114	0.140	0.217

All values from model 2. *p<0.05, ** p<0.01, ***p<0.001 (two-tailed values)

The results above clearly demonstrate that the virtual world students did worse in almost every category of measurement, thus rejecting the third hypothesis of no association. However, I felt that these results might not be conveying the full scope of the data gathered. Therefore, I conducted an additional qualitative examination of the data. After examination a pattern began to emerge from the data, which can be seen in Table 7 below. I found that in general the virtual world students scored between approximately one to two points below their real world counterparts. This means that on average, if a real world student were to receive a score of three out of three then a virtual world student with the same pre-test score would be more likely to receive a score of two out of three. This demonstrates that while the virtual students are indeed underperforming they are at least not falling to the bottom of the scale; rather on average they are only missing one more question than their real world counterparts. Essentially, this means that they are still learning something. However, they are not learning on the same level as the real world students. The above pattern was consistent in all but one case – the loss of control module. Once again, this module broke from the norm as in this case the virtual world students performed as well as the real world students.

Table 7: Comparison of Mean Scores Between Environments

Testing Area	Real Students		Virtual Students	
	Mean Score	**N**	**Mean Score**	**N**
Overall	10.8077	52	8.8163	49
Braking	3.7885	52	2.9184	49
Reaction Time	2.3077	52	1.9592	49
Tailgating	2.7115	52	2.1224	49
Loss of Control	2.0000	52	1.8163	49

All of these findings for the third hypothesis give more substance to this comparative analysis in that they articulate that in most cases, while the virtual world students performed worse they were still relatively close to that of the real world students. These findings also shed more light on the one module that deviated from this pattern – the loss of control module. Regardless, if these findings are taken in hand with the above internal comparison analysis then it becomes clear that in general the virtual world program improves scores significantly. However, this improvement is not as drastic as the real world equivalent in the current study.

CHAPTER EIGHT

DISCUSSION

This study set out with the overarching goal of exploring the viability of using virtual worlds such as Second Life for driver education purposes. More specifically this study aimed to conduct a two-tiered analysis, which not only tested the effectiveness of the virtual safe driving program itself but also compared these results against a real world counterpart. This created both an internal analysis as well as an external analysis, which in turn produced two distinct research questions and hypotheses. The first research question explored if students could learn the desired safe driving material in the virtual world. The second research question explored how the virtual program students compared with a sample of real world SDP students in regards to their safe driving knowledge.

To examine the first research question further, I generated two hypotheses. The first hypothesis predicted that the virtual safe driving program environment would not have an effect on safe driving knowledge scores. However, I found that students who were exposed to the virtual environment did indeed learn the desired material in that most students improved their score after exposure to the environment. Further, I found that there was a 23% (or 11 student) increase in passing scores after only a short exposure to the virtual environment. In other words, out of the 49 students who were exposed to the virtual environment, only 20% passed the pre-test while 43% passed the post-test. These results revealed a rather drastic increase in passing scores after only approximately 14 minutes of exposure on average. Finally, when I looked at this data in more detail I found that 63% (or 31 students) improved their score to some degree. These results demonstrate that the virtual environment appeared to not only have an effect on the students' scores but that this effect appeared to be a positive one overall. Thus the first null hypothesis was rejected, as the virtual environment did appear to have an effect on the students' safe driving knowledge scores.

However, there were a small percentage of students who actually dropped in scores from pre to post. There is no clear reason for this drop. However, one possible explanation could lie in the time of day that a number of the "virtual field trips" took place. A few of the classes took place early in the morning and a number of students appeared to be very tired and disengaged. Another possible explanation for this underperformance is that it could be a result of student's aversion to being so quickly thrust into a new environment. The majority of students tested here had no Second Life experience and they were not given much time (roughly an hour) to acclimate to this new environment. This could result in some students feeling uneasy or not being able to fully engage in the learning environment. However, this was a part of my research design, as the program was going to eventually be employed with youth that most likely did not have any Second Life experience. So while the nine students who dropped are unfortunate they may help to guide future design and research by revealing that more time may be necessary to acclimate and engage in virtual environments of this nature.

To further analyze the first research question I generated a second hypothesis, which predicted that time would not have an association with safe driving knowledge scores. In order to test this second hypothesis, I created and included a variable that accounted for time spent exploring in the virtual environment. This was done in order to test to see if an increased amount of time spent exploring resulted in higher scores. I found in this case that time was not significant and did not help to predict post-test scores in most cases. However, I also found that time was indeed a significant predictor of safe driving knowledge scores for the loss of control module. This means that this current study partially failed to reject the second null hypothesis of no association between time and safe driving knowledge scores in all areas except loss of control. While I found that the virtual environment did have a positive effect on student's safe driving knowledge scores, these results did not appear to be correlated with time spent exploring the environment. These findings seem to be enough to validate the future exploration and use of virtual worlds in the realm of driver education. One key factor in this assertion is that the above improvements were seen after only 14 minutes of environmental exposure on average.

To examine the second research question, I generated a third hypothesis. This hypothesis predicted that there would be no association between the type of environment and the level of knowledge when compared to the real SDP event scores. This hypothesis essentially predicted that the null hypothesis of no association would fail to be rejected because there is no basis to claim that there would be an association of any kind between these two environments. Therefore, the purpose of this hypothesis was to establish a prediction that there would be no association between the virtual environment and the real world environment meaning that the type of environment did not have an effect on scores. This prediction would allow for a number of results to be drawn in regards to how the virtual world students compared to the real world students. Said another way, we can observe any possible differences between the virtual students' and the real world students' performances by investigating if the type of environment has an effect on test scores.

I also employed a regression analysis to gain a further insight into any possible relationship between the virtual world environment and the real world environment. I investigated this relationship (or possible lack thereof) to observe if one environment outperformed the other. If this were the case, then relationship between environments would be significant. Another possible outcome was that if the environments performed the same, then this relationship between environments would not be significant. I found that in all but one case (loss of control) the environment was indeed significant, demonstrating that in general one environment outperformed the other.

I found that the average post-test score for the virtual world students was 8.82 while the average post-test score for the real world students was 10.81. This means that there was approximately a 2 point difference between the real world and the virtual world students in terms of safe driving knowledge. This also means that on average the virtual world students were still failing while the real world students would be considered passing when using the criteria established previously. More specifically, approximately 43% (or 21 students) of virtual world students were passing while approximately 85% (or 44 students) of real world students were considered passing.

I also found that when controlling for pre-score and age, moving from real world to virtual world was associated with a decline in students' overall knowledge scores by one third of one standard deviation (-.327). These findings demonstrate that the virtual world students did not perform as well as their real world counterparts. I also used a gologit2 model, which revealed that while the virtual world students were performing worse than the real world students, they were at least not performing horribly and as such were still clearly learning some of the safe driving material.

Therefore, in terms of the above research question and the third hypothesis I found that the null hypothesis was indeed rejected, as there was an association between the two environmental types in which the virtual world had a negative effect on scores when compared to the real world environment. There was one exception to this broader pattern – loss of control – as this was the one module in which the environment was not found to be significant. In regards to the second research question this means that overall, when compared to the real world students the virtual world students performed worse in regards to safe driving knowledge - except for the loss of control module where there was no difference between real and virtual world performance.

To put these findings into context one key element should be discussed here: the element of time. The above findings clearly demonstrate the superiority of the real world program over the virtual world program. However, I must point out once more that there is a great disparity in time spent across this comparison. This is because on average the virtual world students only received 14 minutes of unstructured “instruction,” while the real world students participated in a 6 hour intensive structured day long program. Therefore, while these results paint a clear frontrunner they are hindered significantly by a lack of equality in terms of exposure. I also feel that any increase at all in virtual students' scores after such a short period of time is significant and provides justification for future exploration. Then there is also the case of the loss of control module. This module defied the above trends by being the one case in which the type of environment was not significant. This means that in this one case the virtual world students performed as well as the real world students on average. This could be some inherent aspect of the environment itself but after examining the environment no clear reason for this module's over performance emerged.

This leaves two intertwining reasons that could possibly be responsible for why this module was the one exception. The first possible explanation could simply be due to the difficulty or ambiguity of this module's question set. The second possible explanation could be that the real world students are actually underperforming on this module. The loss of control module (and subsequently its associated question set) has routinely underperformed in the real world relative to the other modules. Therefore, one likely explanation for the above findings is simply that the real world students are dropping down to the virtual world student's level in the one instance. However, I should also mention that perhaps there is some element of the virtual environment that is more conducive to this particular module area. I feel that the final possible reason that this module performed at the same level as the real world may be its entertainment and engagement value through the use of game elements. This module, perhaps more than any other, maintained the use of game elements. These game elements existed in the form of a scavenger hunt / detective challenge that was given to those who witnessed a virtual car crash in real time. It is possible that this high level of game like interactivity may have given this module an edge over many of the others which simply recreated real world modules in a virtual space.

In the case of the loss of control module, the students were just as able to learn the desired material in the virtual world as they were in the real world. This means that one of the most complex modules (as it involves risky on the track maneuvers in order to simulate loss of control) can be taught more easily and perhaps more effectively, in the risk free environment of a virtual world. Thus the loss of control module becomes a good example of how a virtual representation of a real world program can be just as effective, but with all of the benefits that are attached to being virtual (risk free, portable, accessible, etc). All of the above findings point to a future where a virtual program such as the one presented here could be useful in helping to educate young and older drivers as to various safe driving practices. These findings also point to a possible future where much could be gained by using these two environments in tandem as one could perhaps reinforce the other.

In light of these findings and a number of observed experiences during data collection, it may also be prudent to revisit the theoretical basis for this project – social constructivism. This theory essentially states that we construct our own knowledge through shared experiences with others. While the above findings are not intended to serve as tests of social constructivism, I still feel that they are able to serve as examples to help inform social constructivist ideas. As was stated previously virtual worlds are social by their very definition, which makes them interesting environments in which to employ social constructivist ideas. In this case the environment itself allowed for social interactions to consistently take place. The module areas and activities were all designed for groups to participate together rather than just individuals participating on their own. This means that the scaffolding was in place to not only help direct students' construction of their own safe driving knowledge but to also aid in the natural formation of groups from which to construct knowledge together.

This group formation was visible during testing in a number of instances. Upon entering into the virtual environment, most students began to form groups almost immediately. I feel that this is due at least in part to the scaffolding that was set into place to foster such clustering. Some examples of this observed clustering can be seen in Appendix C. The structure of that day in no way emphasized or suggested that students should or needed to form groups, however most did naturally. This could be a result of students' previous experience with other students in these classes but it appeared that in most cases students just gravitated toward activity areas and then began to converse and form groups from there. I feel that the above results are useful in conjunction with this knowledge of natural student grouping to provide some validation for social constructivist ideas in regards to both environmental design as well as student learning processes. This means that while social constructivism can provide insights into how people learn and how they learn from and with others, it can also provide a firm basis for the designing of online three dimensional virtual spaces with the goal of fostering shared learning experiences.

These observations and findings can help to guide future virtual learning environment development by showing that creating environments and activities that foster natural grouping may lead to more effective learning experiences. However, in this case the virtual environment underperformed the real world environment in all but one case, the loss of control module. This I believe can help to guide virtual learning environment development even further by revealing another important finding. This finding is that simply recreating real life in the virtual world is not enough. As stated earlier, there is no reason to believe that a virtual world program would be able to outperform a real world counterpart as this in many ways is like comparing apples to oranges. However, I believe that the findings associated with the loss of control module reveal that when a virtual world program plays to the inherent strengths of virtual worlds then it may be able to perform as well as the real world.

The loss of control module used perhaps the most exciting and interactive game elements out of the entire environment, and this could potentially be one of the reasons why it performed on the same level as the real world program equivalent. A lesson one may take from these findings is that virtual world design can not be treated in the same way as real world design. Rather in order to create even more effective environments we need to play to the strengths of virtual worlds. Virtual worlds provide a number of benefits such as portability and safety but another benefit could be its potential for the implementation of video game elements. The implementation of these video game concepts in the design of virtual world environments might allow us to better entertain, engage, and subsequently educate our youth.

Limitations

I accounted for and negated many of the presupposed limitations of this study during data analysis. However, a number still persisted into the final iteration of this study. The first limitation of this study is sample size. After filtering and sifting through the data there were only 49 virtual students who had completed the survey entirely. This limitation in sample size was then mirrored in the real world sample size, as there were only 52 students that were of close enough approximation in regards to age from the real SDP events. Ideally, this sample size would be larger and it would also be younger as the mean age for a real world PSD student is 16.

I should also mention here that there was a difference in the gender composition of the two groups compared in this study. In the case of the virtual world students approximately 58% were female and 42% were male. However, this gender composition was almost the reverse of the real world events distribution, which saw 54% of respondents reporting male and 46% reporting female. This difference is of note because it has been posited elsewhere that females tend to be safer drivers than males (Constantinou 2011, Rhodes 2011). Females also tend to do better in school. Therefore, in future studies it may be of interest to better account for gender differences between these two groups. It may also be of interest to investigate if a particular environment is more or less effective regarding specific genders.

Another limitation of this study is that there may not have been enough variation in the time that the virtual students spent exploring, to allow for the time variable to become significant. As stated previously, the average time spent exploring the virtual program was 14 minutes. However, the vast majority of students spent within 1 to 2 minutes of that duration, which essentially eliminated variation in all but a few cases. I feel that this constraint of the time variable greatly limited the effectiveness of observing time's effect on knowledge scores. Time is also a factor in regards to comparing the virtual world students with the real world students as I have already established that the virtual world students' 14 minutes of instruction is an unfair comparison with the real world students' 6 hours of instruction.

Another possible limitation of note is that the vast majority of the virtual world students had no Second Life experience. This means that most were probably not yet comfortable with some of the fundamentals, such as moving around and interacting with the environment. This could limit the effectiveness of the environment as students are still learning how to exist virtually. However, it is also worth mentioning that this virtual program was designed for inexperienced SL users, so this limitation was a part of the design of this study.

Finally, one possible limitation that could be lodged against this current research, in general, is that there is no actual driving data to correlate with these findings. Said another way, this study aimed to test to see if a virtual environment could instill safe driving knowledge; however it did not aim to investigate any of the possible effects that this newly acquired safe driving knowledge could have on actual driving performance. This has been one of the most challenging aspects of driver education research, as gathering data on actual driving habits is often very difficult and resource intensive.

Therefore, this study limited itself to testing knowledge acquisition rather than the effects that any increase in safe driving knowledge could have on actual driving performance.

Future Research

The above limitations provide a substantive roadmap for possible directions to take this and other similar projects in the future. Testing this environment with a larger sample size could significantly expand the current exploratory research. It would also be of interest to conduct a similar study with a younger sample in order to see if younger students approach the virtual world differently. It may also be interesting to test this environment with "Second Life Natives" (experienced SL users) in order to see if a greater level of experience with the actual virtual world technology itself could maybe increase the environment's effectiveness.

Another area of future research that will be tested imminently is the combination of the virtual program used in conjunction with the real world program. It was always a goal during the design of the virtual environment to one day use it as a "bookend" or preparatory/refresher program which could be used to bolster the experiences and knowledge of the real world students. Therefore, in the future this concept will be tested to see if the inclusion of the virtual program in tandem with a real world program can increase the real world scores further.

The findings presented here in regards to the potentially beneficial results of using video game concepts and elements to create more entertaining, engaging and educational learning environments also opens up a new path for future research. In this case, I believe that it would be very beneficial to pursue a line of research that investigates the dichotomy between realistic and more game like environments in more depth. It would be very interesting to compare these two building philosophies against each other to see if one is more effective. Such findings could be very beneficial to the whole of virtual world research for a number of reasons.

First and foremost, a better understanding of which environmental design philosophy is more successful could help us improve the effectiveness of virtual learning environments as a whole. Second, such findings could not only help to make virtual learning environments more effective but also more entertaining and engaging as we learn what attracts people the most. Lastly, these findings could help us solve issues of visitor attraction and visitor retention. It can prove challenging to attract and retain visitors in the virtual world, but knowing which kind of design philosophy works best could help raise the profile of virtual learning environments towards their chosen audience. It would then naturally be of note also to compare these two build designs against a real world counterpart. Finally, future research will bring with it future technologies that will need to be tested in their own right. As new technologies and virtual worlds emerge, this will result in more immersive and potentially more effective environments in which to test the concepts laid out here.

Conclusion

Virtual worlds and the technologies that power them are constantly evolving. This evolution is not limited to simply computing power but also in terms of how these technologies are becoming permeable and intertwined with our everyday lives. For instance, the Internet once restricted to networked computers now spans out over the globe and into our pockets, where it resides at all times keeping us connected to everything and everyone. I feel that virtual worlds are a part of this technological arch as they grow with use and increase in functionality. As this evolution continues to flourish, the technological limitations that are currently inherent to many virtual worlds such as poor graphics (respective to video games at large), heavy resource consumption, etc. will begin to melt away as the technologies that fuel them gain more power.

However, while these technological improvements have the potential to increase factors such as immersion, it is the social evolution that will likely have the greatest impact on their use. It is not so much the technology itself, but how it becomes socialized that will truly dictate its future. Will virtual worlds one day hold a social presence on the scale of current social networking sites such as Facebook? Will a virtual environment be able to pull in traffic on the scale of a website? Right now it is hard to say. However, we are laying the groundwork for how these technologies will be used and thought about in the future that is quickly approaching. We are at a point still close enough to the genesis of this technology to help guide its flow. Gaming is making virtual worlds more and more of a common place concept and we as educators and social scientists have the opportunity to simultaneously guide this increasing awareness into directions of education and research.

This study will at the very least help to guide future work on this project. This exploratory research has shed some light on the potential of virtual worlds for driver educational purposes. It has also provided a series of guideposts to help direct future development and testing. In particular, the knowledge gained here has revealed through the loss of control module that there are particular elements that are just as effective in the virtual world as they are in the real world. With that knowledge, we may be able to equalize more of the module areas with their real world equivalents. Furthermore, this study has revealed the need to study the effects of this environment with greater time exposure to investigate if that improves the program's efficacy. This study will also help further development on this project as we take the experiences and insights gained through its testing and attempt to improve upon usability issues. For instance, we may begin to remedy usability elements such as visitor flow and survey trafficking issues. The result will hopefully be an even more evolved and effective program that can further both the cause of driver education as well as that of using virtual worlds for educational purposes.

These worlds are real. Their populations are growing and their impacts on our world are becoming more pronounced. Virtual worlds with very real economies, friendships, interactions, and perhaps most importantly, experiences, are very real in their effects. Whether they take place in a virtual realm or the real world, the impact of a shared experience can have an everlasting effect on a person. We stand at a point where we can use these worlds to create new and innovative experiences for the benefit of our young drivers as well as people in general. So then let us continue our trip down the "brilliantly lit boulevard" of this emerging metaverse, as we continue to lay the foundation for a future where virtual worlds may bring about very real positive change in the world around us.

APPENDICES

Appendix A

Visual Aids for SDP and VSDP

Figure A-1: Real World Petty Event Lesson Tent

Figure A-2: Virtual World Lesson Tent

Figure A-3: Lesson Tent Activity Area

Figure A-4: Virtual Lesson Tent Participation

Figure A-5: Real World Petty Truck

Figure A-6: Virtual World Petty Truck

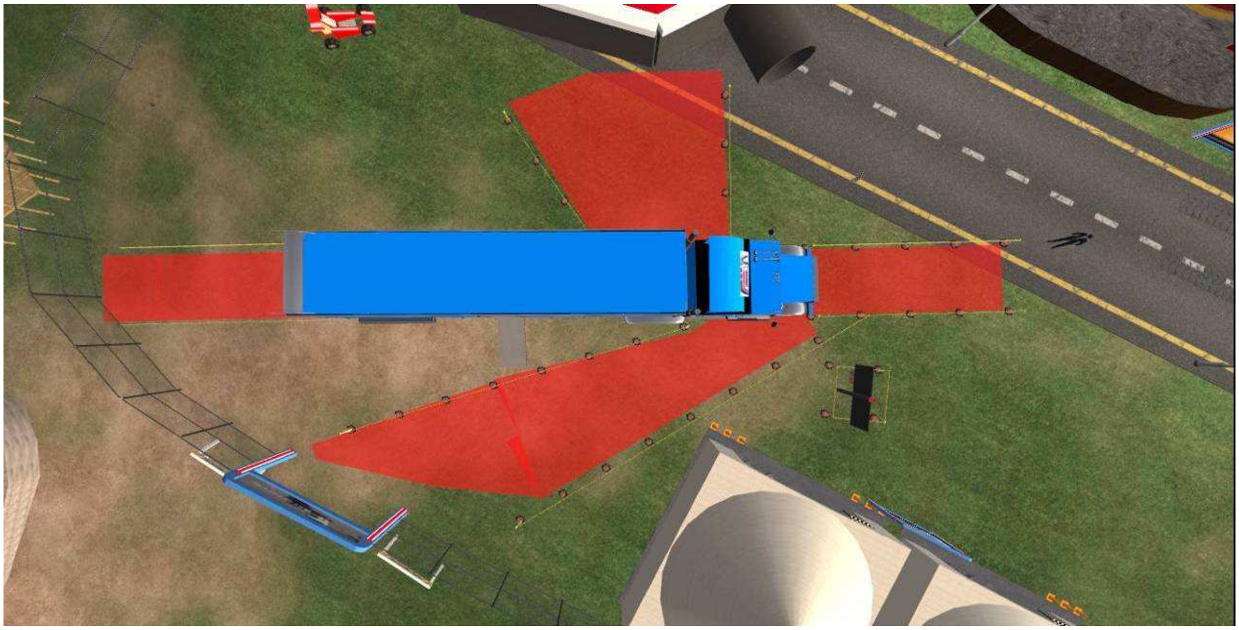


Figure A-7: No Zone Activity Area

Figure A-8: Virtual World Role Playing Activity Area

Figure A-9: Real World Tire Change Activity

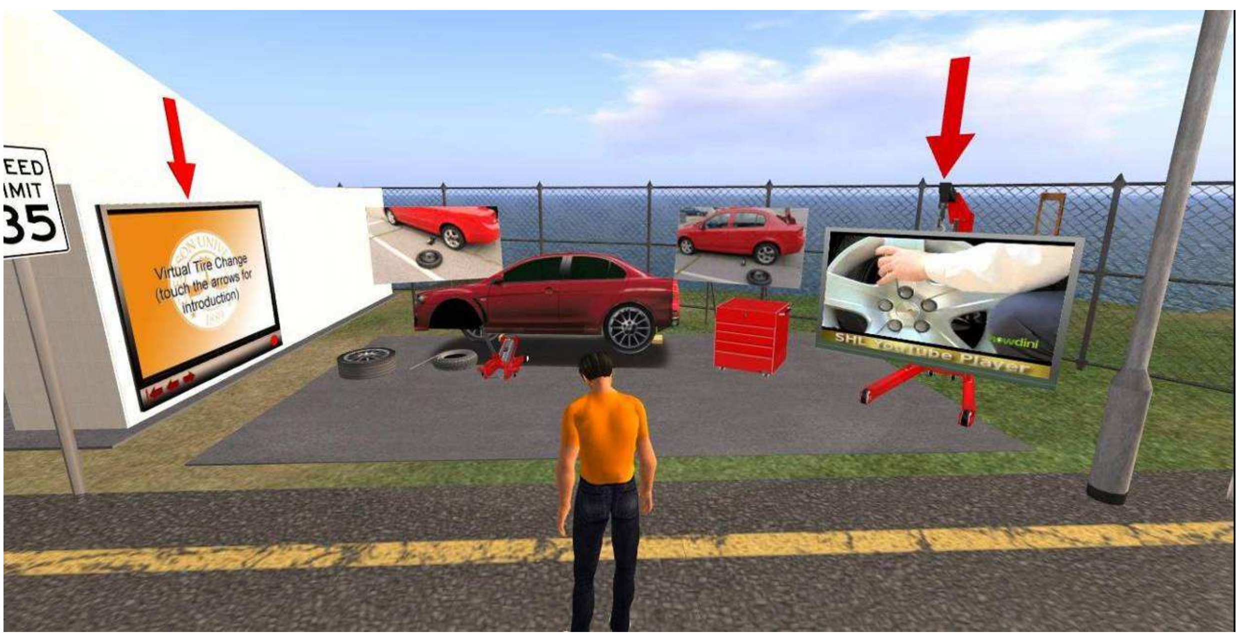


Figure A-10: Virtual World Tire Change Activity

Appendix B

Virtual Construction Example

Figure B-1: Real SDP Lesson Tent

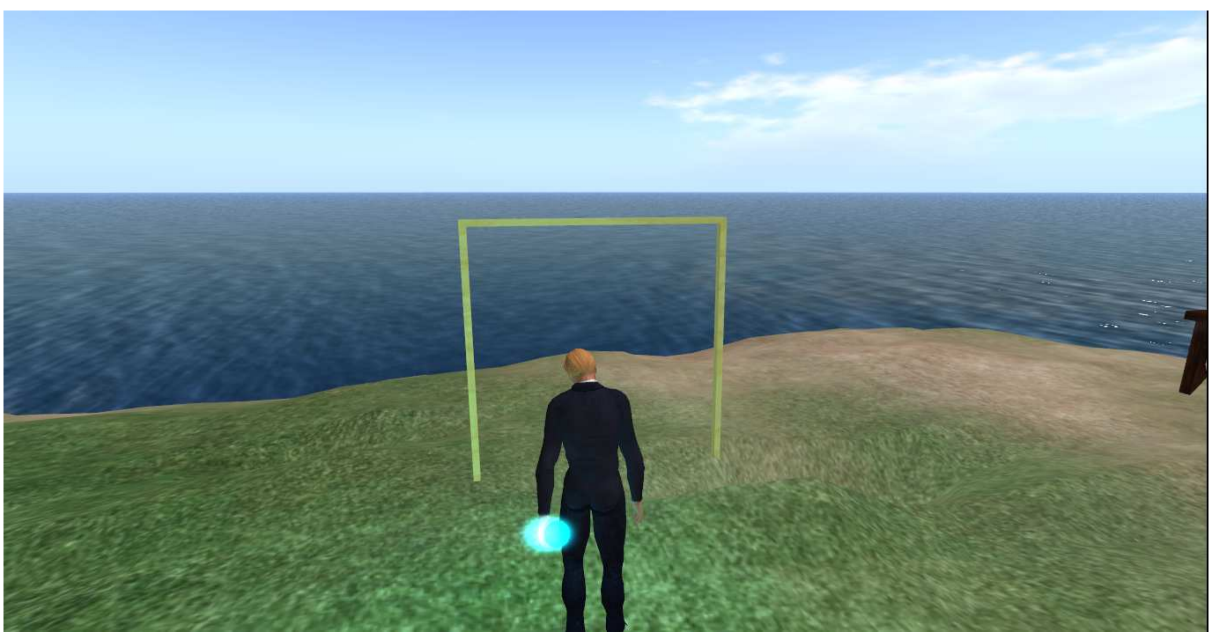


Figure B-2: Beginning of Virtual Tent Frame

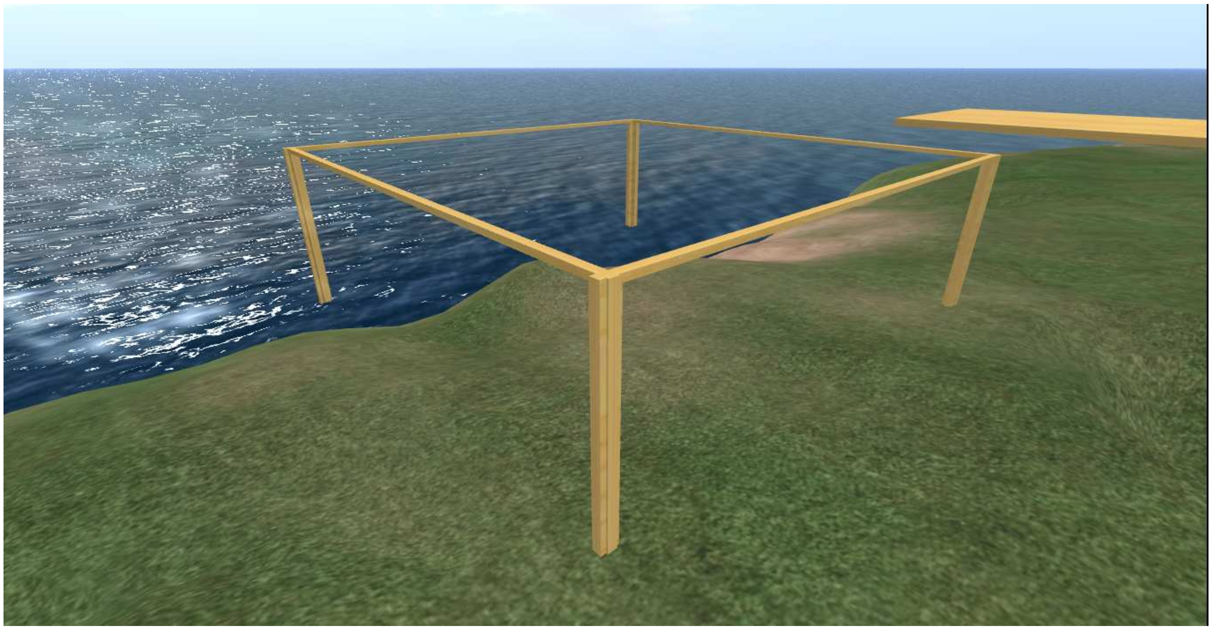


Figure B-3: Virtual Tent Frame Progress 1

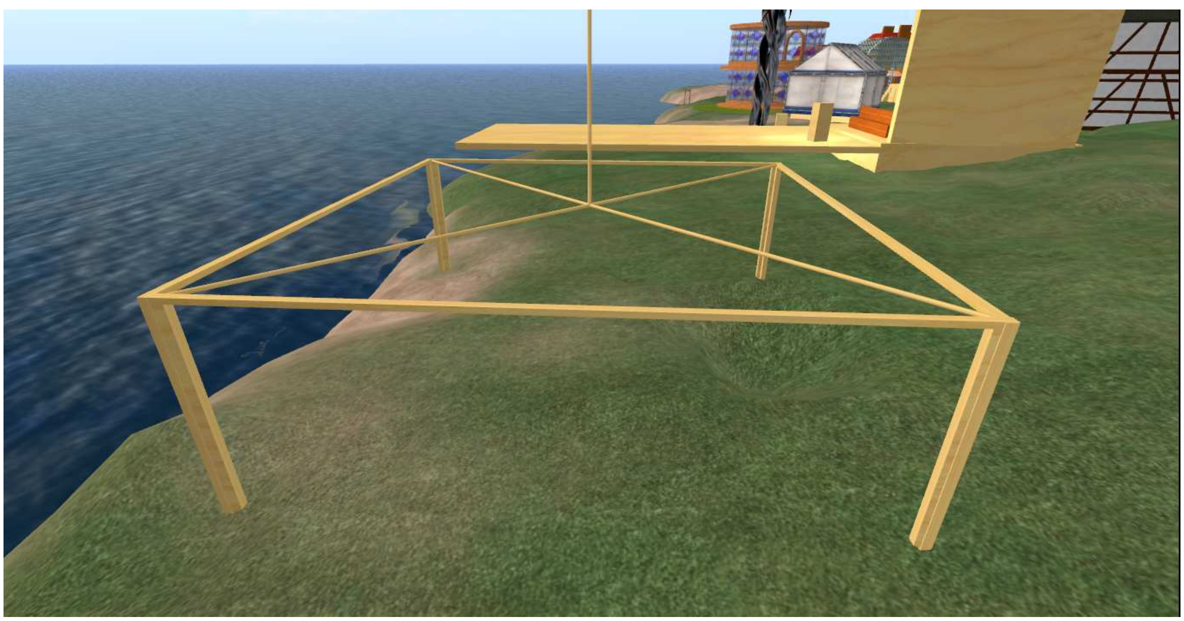


Figure B-4: Virtual Tent Frame Progress 2

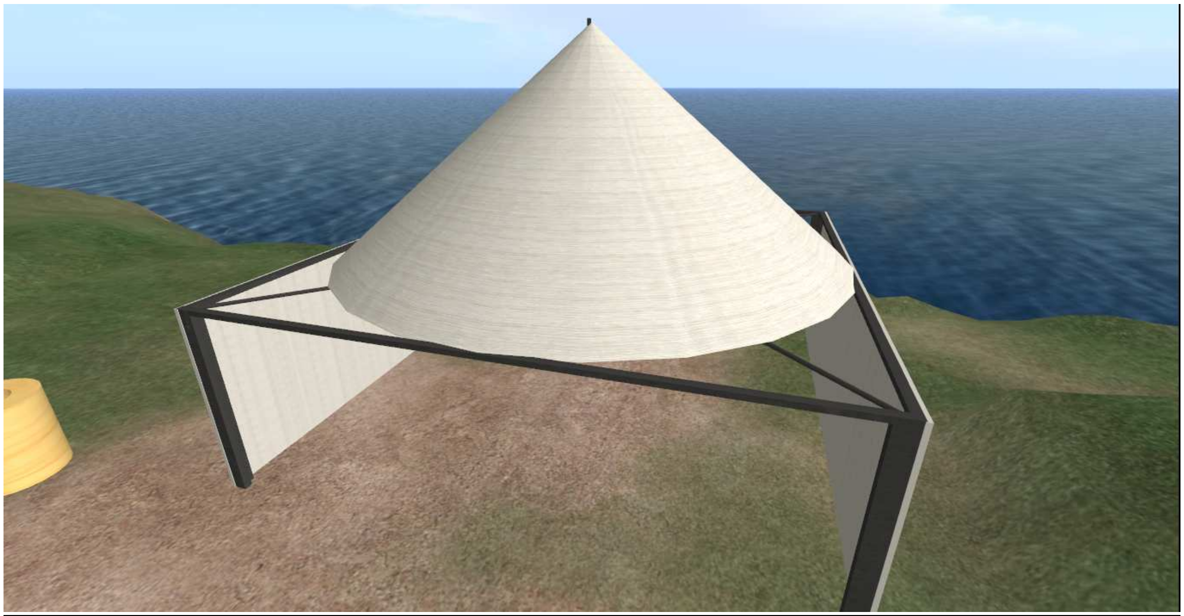
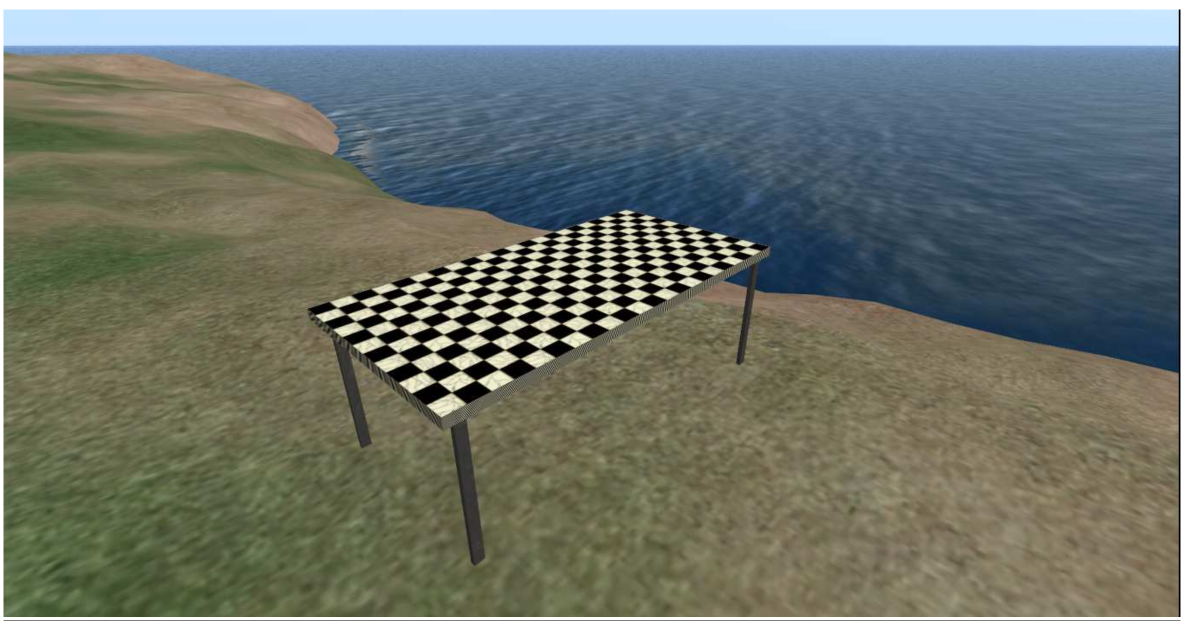


Figure B-5: Draping Virtual Tent Frame 1


Figure B-6: Draping Virtual Tent Frame 2

Figure B-7: Modeling Windows



Figures B-8: Modeling Tables

Figure B-9: Modeling White Boards

Figure B-10: Completed Virtual Tent Model

Appendix C

Visual Aids for Natural Group Clustering

Figure C-1: Day 2 – Two Naturally Occurring Module Clusters

Figure C-2: Day 2 – Lesson Tent Group

Figure C-3: Day 4 – Tire Change Group


Figure C-4: Day 4 – Crash Street Group

Appendix D

Supplementary Crosstab Analysis

The next series of analyses to test the first hypothesis consisted of a crosstabs between the pre-test and the post- test scores. These crosstab results consist of many points of data and thus only the most significant features of these data will be discussed here. The crosstab charts themselves can be found by referencing Appendix D. This analysis was conducted to give a more in- depth observation of the student's scores in order to attempt to reveal any specific or overall changes in scores from pre to post for individual students. Said a different way, the following crosstabs were used to observe any changes in regards to particular students rather than overall groups of students. To begin this analysis I started by observing the individual student scores for the overall pre- and post- tests. Out of the 49 students who completed both tests nine students stayed the same resulting in no change of score between the pre- and post- tests. However, in total 31 students improved their scores between the pre-tests and the post- tests revealing that the vast majority of students improved their scores to some degree and half of those who did not improve at least stayed the same. This is one more piece of evidence that the virtual safe driving program had an overall positive effect on the students' safe driving knowledge.

There were also a few more improvements of note. As mentioned above the highest score on the pre- test was a single score of a 12. However, after exposure to the environment there were a total 5 students who scored a 12 on their post-test. There was even one student who scored a perfect 14. This perfect 14 is of particular note because it was a score that increased from a base pre-test score of 7 meaning that this student in particular doubled his or her score after spending time in the virtual learning environment.

A look at these crosstabs also revealed that there was indeed a population of students who actually did worse on the post-test then they did on the pre-test. In total out of the 49 students there were 9 who experienced a drop in scores after spending time in the virtual environment. However, it should be stated that most of the drops in final scores occurred as a result of getting 1 or 2 more questions wrong on the post-test than they did on the pre-test. The maximum drop in score was by one student who dropped by three questions resulting in a score that went from an 11 to an 8 for a total of a 3 point drop. This particular student was a singular case as the rest stayed within 1 or 2 points of their original score. This information is of interest as it articulates that not only were drops less frequent than increases in scores but that these drops were also less pronounced than the increases. Therefore, while some drops in scores were recorded these findings reveal that the increases in scores are much more consistent and greater than the decreases.

In terms of improvement with the exclusion of the previous example of the perfect 14 there were also two examples of students who increased their scores from two 4's on the pretest to an 8 and a 10 respectively which demonstrates scores that doubled or more than doubled. There are also examples such as two students in particular that received a failing score of a 7 on their pre-test but then they improved to passing scores of a 10 and an 11 on their post-test scores. While there were some students whose scores declined slightly or moderately after exposure to the environment these results demonstrate that they were in the minority and that these cases are outweighed by the many more students who not only did better but did so by a larger margin.

To further examine these findings another crosstab was also run on each of the 4 lesson modules. The results on the individual module level painted a somewhat different picture for each module. As found above there were some students who dropped or stayed the same and then there were those who improved. The first module to be examined was the *braking module* and it was found here that a total of seven students dropped in their scores after exposure to the environment. This drop in scores is in line with the overall results presented above in that a small portion of students declined in scores. However, one notable difference is that in this case it was found that a total of 21 students actually stayed the same which is over twice as many as the overall statistics show. This subsequently resulted in only 21 students showing improvement on the braking module. There were two students who made a perfect 5 on the pre-test and both of their scores stayed the same demonstrating in part a lack of detriment as a result of the program. While it is evident that this module was not detrimental overall a closer look at the results shows that some students improved significantly. For example one student who made a 2 on the pre-test made a perfect 5 on the post-test. Likewise, out of the eight students who made a score of a 4 on the pre-test one student dropped to a 3 while five students stayed the same and then two students were given a bump to a perfect 5. This demonstrates how the majority of students either stayed the same or improved in regards to the braking module.

The next module to be examined was that of the *reaction time module* which was out of 3 questions as opposed to the 5 in braking. In this case 12 students dropped in scores after exposure to the environment while 15 students stayed the same and 22 students improved. Out of the 16 students who scored a 1 on the pre-test, 11 of them increased to a 2 and one student even increased to a perfect 3. Out of the 30 students who scored a 2 on the pre-test ten of them increased to a 3 while 12 students stayed the same and 8 dropped to a 1. In the end there were three students who scored a perfect 3 on the pre-test and this number increased to 12 students after the program intervention.

The next analysis was to be done on the *tailgating module*. This module like the one before it is also out of 3 questions. In total nine students did worse after exploring the environment while 20 students stayed the same and 20 students improved. Of the six who did not get a single question right on the pre- test 83% percent (or 5 students) improved their scores. Out of the 14 students who scored a 1 on the pre-test there were none that dropped while 42% (or 6 students) increased to a perfect score. Out of the 16 students who scored a 2 on the pre-test eight of them stayed the same and 31% (or 5 students) increased to a perfect score.

Finally, there was an analysis done with the *loss of control module* which once again consisted of 3 questions. In this case six students dropped in their score between the pre- and the post- tests while 27 students stayed the same and 16 students improved. Of the 7 students who did not get any questions right on the pre-test 71% (or 4 students) improved their scores and one of those students even increased their score to a perfect 3. Out of the 18 students who got a score of 2 on their pre-test 56% (10 students) stayed the same while 28% (or 5 students) improved to a perfect 3. These results once again demonstrate that in the majority of situations either the student's knowledge of a particular subject area either stays the same or improves as a result of exposure to the virtual learning environment.

The above figures reveal that the reaction time module had the greatest amount of students drop in scores with 12 students dropping from pre to post while the loss of control module experienced the least amount of students that dropped in scores. These results also reveal that theses modules were the most polarizing in that braking also had the most students improve their scores with 22 students improving while loss of control experienced the least amount of student improvement with only 16 students improving. In the end these results reiterate that the virtual safe driving program in most cases improves knowledge in the desired subject areas and at the very least does not detract much from them.

Appendix E

Crosstab Output

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
PostTest * PreTest	49	100.0%	0	.0%	49	100.0%

PostTest * PreTest Crosstabulation

			PreTest				
			3.00	4.00	5.00	6.00	7.00
PostTest	4.00	Count	0	1	0	2	0
		% within PreTest	.0%	25.0%	.0%	40.0%	.0%
	5.00	Count	1	1	0	0	1
		% within PreTest	50.0%	25.0%	.0%	.0%	11.1%
	6.00	Count	0	0	1	0	0
		% within PreTest	.0%	.0%	33.3%	.0%	.0%
	7.00	Count	1	0	1	0	0
		% within PreTest	50.0%	.0%	33.3%	.0%	.0%
	8.00	Count	0	1	1	0	3
		% within PreTest	.0%	25.0%	33.3%	.0%	33.3%
	9.00	Count	0	0	0	2	2
		% within PreTest	.0%	.0%	.0%	40.0%	22.2%
	10.00	Count	0	1	0	1	1
		% within PreTest	.0%	25.0%	.0%	20.0%	11.1%
	11.00	Count	0	0	0	0	1
		% within PreTest	.0%	.0%	.0%	.0%	11.1%
	12.00	Count	0	0	0	0	0

		% within PreTest	.0%	.0%	.0%	.0%	.0%
	14.00	Count	0	0	0	0	1
		% within PreTest	.0%	.0%	.0%	.0%	11.1%
	Total	Count	2	4	3	5	9
		% within PreTest	100.0%	100.0%	100.0%	100.0%	100.0%

PostTest * PreTest Crosstabulation

			PreTest				
			8.00	9.00	10.00	11.00	12.00
PostTest	4.00	Count	0	0	0	0	0
		% within PreTest	.0%	.0%	.0%	.0%	.0%
	5.00	Count	0	0	0	0	0
		% within PreTest	.0%	.0%	.0%	.0%	.0%
	6.00	Count	1	0	0	0	0
		% within PreTest	14.3%	.0%	.0%	.0%	.0%
	7.00	Count	1	1	0	0	0
		% within PreTest	14.3%	11.1%	.0%	.0%	.0%
	8.00	Count	2	2	0	1	0
		% within PreTest	28.6%	22.2%	.0%	33.3%	.0%
	9.00	Count	1	1	0	0	0
		% within PreTest	14.3%	11.1%	.0%	.0%	.0%
	10.00	Count	1	2	2	0	0
		% within PreTest	14.3%	22.2%	33.3%	.0%	.0%
	11.00	Count	1	2	1	2	0
		% within PreTest	14.3%	22.2%	16.7%	66.7%	.0%
	12.00	Count	0	1	3	0	1
		% within PreTest	.0%	11.1%	50.0%	.0%	100.0%
	14.00	Count	0	0	0	0	0
		% within PreTest	.0%	.0%	.0%	.0%	.0%

	Total	Count	7	9	6	3	1
		% within PreTest	100.0%	100.0%	100.0%	100.0%	100.0%

PostTest * PreTest Crosstabulation

			Total
PostTest	4.00	Count	3
		% within PreTest	6.1%
	5.00	Count	3
		% within PreTest	6.1%
	6.00	Count	2
		% within PreTest	4.1%
	7.00	Count	4
		% within PreTest	8.2%
	8.00	Count	10
		% within PreTest	20.4%
	9.00	Count	6
		% within PreTest	12.2%
	10.00	Count	8
		% within PreTest	16.3%
	11.00	Count	7
		% within PreTest	14.3%
	12.00	Count	5
		% within PreTest	10.2%
	14.00	Count	1
		% within PreTest	2.0%
	Total	Count	49
		% within PreTest	100.0%

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
PostBraking * braking	49	100.0%	0	.0%	49	100.0%

PostBraking * braking Crosstabulation

			braking				
			.00	1.00	2.00	3.00	4.00
PostBraking	.00	Count	0	0	2	0	0
		% within braking	.0%	.0%	11.1%	.0%	.0%
	1.00	Count	1	1	1	1	0
		% within braking	100.0%	16.7%	5.6%	7.1%	.0%
	2.00	Count	0	2	6	2	0
		% within braking	.0%	33.3%	33.3%	14.3%	.0%
	3.00	Count	0	3	7	7	1
		% within braking	.0%	50.0%	38.9%	50.0%	12.5%
	4.00	Count	0	0	1	4	5
		% within braking	.0%	.0%	5.6%	28.6%	62.5%
	5.00	Count	0	0	1	0	2
		% within braking	.0%	.0%	5.6%	.0%	25.0%
	Total	Count	1	6	18	14	8
		% within braking	100.0%	100.0%	100.0%	100.0%	100.0%

PostBraking * braking Crosstabulation

			braking	
			5.00	Total
PostBraking	.00	Count	0	2
		% within braking	.0%	4.1%

	1.00	Count	0	4
		% within braking	.0%	8.2%
	2.00	Count	0	10
		% within braking	.0%	20.4%
	3.00	Count	0	18
		% within braking	.0%	36.7%
	4.00	Count	0	10
		% within braking	.0%	20.4%
	5.00	Count	2	5
		% within braking	100.0%	10.2%
	Total	Count	2	49
		% within braking	100.0%	100.0%

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
PostReaction * reaction	49	100.0%	0	.0%	49	100.0%

PostReaction * reaction Crosstabulation

			reaction			
			1.00	2.00	3.00	Total
PostReaction	.00	Count	2	0	0	2
		% within reaction	12.5%	.0%	.0%	4.1%
	1.00	Count	2	8	0	10
		% within reaction	12.5%	26.7%	.0%	20.4%
	2.00	Count	11	12	2	25
		% within reaction	68.8%	40.0%	66.7%	51.0%
	3.00	Count	1	10	1	12

		% within reaction	6.3%	33.3%	33.3%	24.5%
	Total	Count	16	30	3	49
		% within reaction	100.0%	100.0%	100.0%	100.0%

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
PostTailgate * tailgati	49	100.0%	0	.0%	49	100.0%

PostTailgate * tailgati Crosstabulation

			tailgati				
			.00	1.00	2.00	3.00	Total
PostTailgate	.00	Count	1	0	1	0	2
		% within tailgati	16.7%	.0%	6.3%	.0%	4.1%
	1.00	Count	2	4	2	0	8
		% within tailgati	33.3%	28.6%	12.5%	.0%	16.3%
	2.00	Count	3	4	8	6	21
		% within tailgati	50.0%	28.6%	50.0%	46.2%	42.9%
	3.00	Count	0	6	5	7	18
		% within tailgati	.0%	42.9%	31.3%	53.8%	36.7%
	Total	Count	6	14	16	13	49
		% within tailgati	100.0%	100.0%	100.0%	100.0%	100.0%

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
PostLossCont * losscont	49	100.0%	0	.0%	49	100.0%

PostLossCont * losscont Crosstabulation

			losscont				Total
			.00	1.00	2.00	3.00	
PostLossCont	.00	Count	2	1	1	0	4
		% within losscont	28.6%	6.3%	5.6%	.0%	8.2%
	1.00	Count	3	10	2	0	15
		% within losscont	42.9%	62.5%	11.1%	.0%	30.6%
	2.00	Count	1	2	10	3	16
		% within losscont	14.3%	12.5%	55.6%	37.5%	32.7%
	3.00	Count	1	3	5	5	14
		% within losscont	14.3%	18.8%	27.8%	62.5%	28.6%
	Total	Count	7	16	18	8	49
		% within losscont	100.0%	100.0%	100.0%	100.0%	100.0%

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