Assessment of the Fixed-Base Driving Simulator as a Learning Tool for Young Adults with Autism Spectrum Disorder and Cognitive Disabilities in the Vocational Rehabilitation Center at the UW-Stout

by

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Abstract

The purpose of this study was to evaluate if the fixed-base driving simulator, located in the Vocational Rehabilitation Center at the University of Wisconsin-Stout, was an effective learning tool for those with Autism Spectrum Disorder and Cognitive Disabilities. The significance of this study was to assess how effective the simulator was as learning tool for teaching individuals the proper driving principles to assist them in passing their drivers' or permit exam. To determine the effectiveness of the simulator, eleven students from the Transitional Partnership School, affiliated with the Vocational Rehabilitation Center, volunteered to participate in the study. Each of the students were assessed based on the Wechsler Abbreviated Scale of Intelligence (1999), the DSM-IV (American Psychiatric Association, 2000), and were observed by a teacher or an observer who would note the students progression, reactions, and

behaviors throughout each session. The students, the observer, and the teacher were subsequently given a post-interview questionnaire to assess the effectiveness of the fixed-base driving simulation. The results of the study were based on the student observational notes taken by the observer and the teacher, as well as the post-interview questionnaires. The concluding results of the study found the fixed-base driving simulator to be an effective learning tool based on the progression, behaviors, and reactions of the students throughout the program, as well as the results of the post-interview questionnaire. However, the simulator program was found to have numerous glitches throughout various sessions which may have hindered the students learning as well as their perception of the overall effectiveness of the simulator.

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Table of Contents

List of Tables

Chapter I: Introduction

Simulation by definition means "to give or to create the effect or appearance of, or to imitate" (Merriam-Webster, 2004, p. 671). The use of computer simulation today is being used to imitate environments and scenarios so that humans can learn and abilities can be assessed. Two of the most popular forms of computer simulation being used today are virtual reality (VR) and driving simulation. VR by definition is "an artificial environment that is experienced through sensory stimuli (as sights and sounds) provided by an interactive computer program" (Merriam-Webster, 2004, p. 809). VR differs from driving simulation in that it depicts a three dimensional field of view, while driving simulators are typically two dimensional. The use of simulation to create real life environments for assessment and education purposes is becoming more and more popular as a learning tool for various industries; consequently, Salas and Bowers (2003) reported that the investment in simulation technologies and training strategies by organizations is over $300 billion a year. Simulation systems work well as learning and training tools by allowing an individual to enter into an environment or circumstances that may not otherwise be possible in real time due to the danger of the situation.

Tichon (2007) attested that across a variety of operational environments, VR is increasingly being used as a means of simulating hazardous work conditions in order to allow trainees to practice advanced cognitive skills such as problem-solving and decision-making. Various industries where simulation has been utilized for training individuals on task specific situations include NASA, the aviation industry, the military, surgical settings, truck driving schools, and industry, as well as drivers' education programs. In the United States, both the Air Force and the aeronautics industry have made extensive use of VR technology for many years, since simulator training here has proved to be an efficient and cost effective way to train pilots

(Lathan & Stanley, 2002). NASA and the aviation industry are huge proponents of simulation use; currently NASA is using a "Virtual Motion Simulator" to train employees; this simulator has the capabilities of simulating any aerospace vehicle, as well as other vehicles. Existing vehicles that have been simulated include a blimp, helicopters, fighter jets, and the space shuttle orbiter (De Los Santos, 2008).

Similarly, multiple branches of the military have used simulation to train their cadets. One example of simulator use in the military is the application of the VR simulator to train Navy junior officers on the important skills required for ship-handling. Hays and Vincenzi (2000) expressed the need for the VR simulator for ship-handling training; Officer of the Deck ship-handling training is primarily obtained through on-the-job experience, which is adversely impacted by the operational constraints of the submarine force and the limited surfaced steaming time of submarines. Furthermore, they added VR affords the potential to greatly reduce the cost of training systems because it can provide a trainee with an interface to training equipment without the necessity of replicating expensive hardware.

The use of driving simulation most notably is being used in truck driving industries and schools, as well as drivers' education programs. Lockheed Martin, a leader in the innovation of aeronautics, information systems and global services, electronic and space systems believes that driving simulators are a good investment. In 2001 Lockheed Martin Information Systems delivered a 16-vehicle, high fidelity Driver Training Simulation System (DTSS) to the Singapore Military. The 16-vehicle, high fidelity DTSS uses a computer-generated visual environment that interacts with an actual truck cabin (Mulleavey, 2001).

Additionally, various driving stimulator studies have been conducted to test the effectiveness of training on various age groups of drivers, to assess drivers' abilities, and last but not least, using the simulator as an assessment tool to reduce accidents. One example of a study done using driving simulators was Fisher, Pollatsek, and Pradhan (2006) research focused on combining personal computer (PC)-based learning, with driver simulation, and on the road training to teach drivers to recognize risks and hazards early on to prevent accidents. The study found that using a PC-based risk awareness training program to instruct individuals on the possible hidden risks one might encounter while driving, prior to using the driver simulator, proceeded to make some individuals drive more cautiously while using the driving simulator.

As previously indicated, the application of simulation typically has been used in various transportation industries as learning devices for novice fighter pilots, truck drivers, military cadets, and automobile drivers. However, with increasing technology and the inquisition of helping those with various mental disabilities, simulation is becoming an advanced learning and assessment tool for those with autism spectrum disorder and cognitive disabilities. Self, Scudder, Weheba, and Crumrine (2007) conducted a research study titled *A Virtual Approach to Teaching Safety Skills to Children with Autism Spectrum Disorder* on the use of VR simulation with autistic children. This study showed that between two groups (one group using the VR, the other using an integrated/visual treatment model) learning fire and tornado safety skills, the group that had had the VR simulation as a learning tool mastered these skills much more quickly than their counterpart.

Teaching those with autism spectrum disorder and cognitive disabilities can be challenging, therefore, it is important to utilize different approaches whenever possible to test their effectiveness on learning. Consequently, the Vocational Rehabilitation Center, located at the University of Wisconsin-Stout in Menomonie, inquired to take a different approach to learning driving techniques by using a fixed-base driving simulator, which had not been assessed for its effectiveness as a learning tool for young adults with autism spectrum disorder and cognitive disabilities.

Statement of the Problem

No assessments have been done to evaluate the effectiveness of the fixed-base driving simulator as a learning tool for young adults with autism spectrum disorder or other cognitive disabilities.

Purpose of the Study

The purpose of this study was to evaluate how effective the fixed-base driving simulator, located in the Vocational Rehabilitation Center, was as a learning tool for those with autism spectrum disorder and cognitive disabilities. This was done by means of conducting observations and interviews with the students, teacher, and the observer.

Objectives of the Study

The objectives of the study were:

1. Determine the disabilities of each student and how these disabilities may have affected their overall learning throughout the driving simulator program.
2. Determine the strengths and weaknesses of each student, and assess how the weaknesses may have affected the safety of their driving.
3. Determine the completion rate of each student throughout the course, as well as the contributing factors that may have helped or hindered the students from finishing the driving simulator program.
4. Determine how each student evaluated the use of the simulator as a learning tool to prepare them for their driver's or permit exam.

5. Determine how the observer and the teacher felt about the driving simulation program, and if it was a good assessment/learning tool for their students.

Significance of the Study

The significance of this study was to evaluate if the fixed-base driving simulator, located in the Vocational Rehabilitation Center, was an effective learning tool for those with autism spectrum disorder and cognitive disabilities. If the tool was deemed effective, it would hopefully help individuals to pass their driver's or permit exam, thus helping to give them independence and the opportunity to become a productive part of society. In addition, assisting those individuals with the ability to get to and from a job, or other functions they see fit. Finally, if the driving simulator is determined to be an informative learning tool it may be added to a new learning curriculum for students wanting to get their learner's permit or driver's license.

Limitations

The limitations of the study might include the following:

1. Time was a limitation because the simulator can only be used in hour blocks and an observer or teacher needed to be present to assist each student.
2. It was unknown what medications, if any, the participants were using throughout the study that may have affected their performance level.
3. Observational documentation of the student's progress, behavior, and reactions could vary; interrater reliability was not taken into account when documenting each of the student's progress, behaviors and reactions while using the driving simulator.
4. Individuals may feel uncomfortable being watched, especially the autistic students, therefore, their progress, behaviors, and reactions, may be affected.
5. The sample size for the given study may be too small to make proper inferences.

6. The driving simulator program is slightly outdated.
7. Some students may have had more driving experience, or driver's education than other students.
8. Many of the students have different disabilities, or the same form of a disability that varies to a certain extent.

Assumptions

Assumptions of the study include the following statements:

1. All students have the same cognitive ability to successfully pass the driving simulator program.
2. Each student is being observed while they are on the driving simulator.
3. All students who sign-up to partake in the study will finish the driving simulator course.

Definition of Terms

Terms of particular importance to the study include:

Autism Spectrum Disorder (ASD) - Autism spectrum disorder is a group of five pervasive developmental disorders: autistic disorder, Asperger's Disorder, Rett's disorder, childhood disintegrative disorder, and pervasive developmental disorder not otherwise specified (American Psychiatric Association, 2000).

Cognitive (Intellectual) Disability - Intellectual disability is characterized by both a significantly below-average score on a test of mental ability or intelligence and by limitations in the ability to function in areas of daily life, such as communication, self-care, and getting along in social situations and school activities (American Psychiatric Association, 2000). Intellectual disability is sometimes referred to as a cognitive disability or mental retardation (Batshaw, 1997; Smith, 1993).

Comorbidity - Comorbidity is two or more coexisting medical conditions or disease processes that are additional to an initial diagnosis (Mosby's Medical Dictionary, 2009).

Fixed-Base Driving Simulator - A fixed-base driving simulator provides no motion feedback on the driver and is solid with the ground. The dynamic effects of real life conditions are replicated only with sight and hearing of the driver (tesionline.com, n.d.).

Interrater Reliability - Intrerrater or interobserver reliability is the degree to which two or more independent observers or raters agree when rating the same subject or object (Kottner, Raeder, Halfens, & Dassen (2009). It can be affected by the measurement used, qualification, knowledge and training of observers, conditions of observation and population characteristics (Kraemer, 1979; Suen, 1988; Shrout, 1998).

Mental workload - Mental workload can be used to provide an indication of the cognitive demands placed on the driver (de Waard, 1996; deWaard & Brookhuis, 1997). There are several techniques available to measure mental workload; this includes subjective opinions, physiological measures, and task performance (Cantin, Lavaillere, Simoneau, & Teasdale, 2009).

Novice Driver - A novice driver is a driver who is learning to drive, but does not have a restricted license (Fisher, Pollatsek, and Pradhan, 2006).

Simulator - A simulator, according to Brock, McFann, Inderbitzen, and Bergoffen (2007), is an instructional method that requires students to interact with specific instructional events based on real-world scenarios; students must see or experience the consequences of their interaction. All interactions should result in similar real-world outcomes or effects. The primary learning outcome of a simulation should be the demonstration of a real-world process, procedure, or specific behavioral change (Brock et. al, 2007)

Virtual Reality (VR) - VR can be described as a computer-generated, interactive, three-dimensional environment that resembles the real world and promotes a sense of presence for the user (answers.com, n.d.). Mitchell, Parsons, and Leonard (2006) described VR as a combination of technologies, allowing creation and exploration of virtual environments (VEs), which are 3D computer-generated representations of environments that have realistic appearance. Additionally, Lewis and Griffin (1998) added that virtual environments may be displayed on a desktop monitor, a wide field-of-view display such as a projection screen, or on a head-mounted display.

Summary

The goal of this study was to evaluate the fixed-base driving simulator located in the Vocational Rehabilitation Center as a learning tool for those with autism spectrum disorder and cognitive disabilities. The evaluation of the driving simulator took into account the students overall perception of the simulator and its effectiveness as a learning tool. Additionally, the observer and teacher assessed its overall effectiveness as a learning tool for their students and whether or not they wanted to subsequently use it for other groups of students as part of a new curriculum. The next section will focus on the effectiveness of driving simulators as learning and assessment tools, the discrepancies associated with simulator systems, learning and intellectual difficulties defined by autism spectrum disorder and cognitive disabilities, and the use of simulation with autism spectrum disorder and cognitively disabled individuals.

Chapter II: Literature Review

The purpose of this literature review was to examine the following significant topics: the effectiveness of driving stimulation as a learning tool, the discrepancies associated with the use of simulation systems, the assessment of both autism spectrum disorder and cognitive disabilities as they apply to learning, behavior, and cognitive processing, and finally the evaluation of how the application of virtual reality (VR) and driving simulator systems have become effective learning and assessment tools for those with cognitive and autistic disabilities.

Driving Simulation as a Learning and Assessment Tool

Driving simulation, as previously alluded to, can be used as both a learning and assessment tool, as well as a range of other applications. Moreover, driving simulation has been widely used as a learning tool for novice drivers, as an assessment tool to test driver's abilities based on age group or disability, and as a tool for assessing various hazards that lead to increased accident rates, one example being cell phone use (Fisher, Pollatsek, & Pradham, 2006; Cantin, Lavalliere, Simoneau, & Teasdale, 2009; Cooper & Strayer, 2008). The following section will expand on the application and effectiveness of the driving simulator as a learning and assessment tool.

Driving simulators are widely used in driving schools to teach novice drivers critical skills and practice before entering onto the road. Kappe and Emmerik (2005) observed that many driving schools have started using simulators for training their students; it has been estimated that 100 low-cost simulators are now used in the Netherlands for initial driver training. Driving simulators are advantageous on many levels; the simulators can be used to train individuals in hazardous situations that would not be possible otherwise. Additionally, they act as a learning tool that can be self-paced based on the individual's learning needs. In addition, individual errors and overall progress can subsequently be reviewed by the individual and instructor. Vlakveld (2005) agreed (as cited in de Winter, Wieringa, et al., 2007), "that besides financial benefits, simulators offer great opportunities for carrying out objective measurements on the user's actions in a safe and purpose-developed virtual environment" (p. 138).

An excellent example of the use of a driving simulator as a learning and assessment tool is Fisher, Pollatsek, and Pradhan (2006) research study titled *Can novice drivers be trained to scan for information that will reduce their likelihood of a crash?* This study focused on combining PC-based learning, with driver simulation, and on the road training to teach drivers to recognize risks and hazards early on to prevent accidents. The study primarily used a PC-based program called "Risk Awareness and Perception Training Program" (RAPT). This program focused on three general areas to assist individuals in recognizing risks and hazards. First, it encouraged in depth processing of scenarios where risks are hidden by asking the novice driver to visualize where risks are located rather than simply presenting those risks. Secondly, RAPT assisted individuals in recognizing risky scenarios on the road that resembles, but never can be identical to, the ones they saw in training. Lastly, the RAPT program helped novice drivers to recognize risks in scenarios that are similar to ones that they might encounter on the open road (Fisher et al., 2006).

To determine the effectiveness of the first and second learning objectives, 48 novice drivers were put into a simulated driving environment to evaluate whether hazard detection training on a PC was effective (Fisher et al., 2006). Once the RAPT PC-based program was given to each novice driver, the individual's performance was evaluated on the driving simulator. The first study tested the effectiveness of the PC-based training on the driving simulator immediately after training, while the second study tested the effectiveness of the PC-based training 3-5 days later. Subsequently, the third RAPT study tested the individual's transfer of the PC-based training to the open road. The final conclusion of the novice drivers on the driving simulator and on the open road found that the RAPT PC-based program was an effective tool for assisting individuals to recognize risky and hazardous situations. Additionally, Fisher et al. (2006) found a substantial effect of the PC-based training program on novice and young drivers' awareness of where they should scan the roadway for information which will measurably reduce their likelihood of a crash on the PC, on a driving simulator, and on the road.

Driving simulators have been used on a large scale, not only as a learning tool to improve driving habits, but also as assessment tools. A relevant study that examines the use of driving simulators as assessment tools is the Cantin, Lavalliere, Simoneau, and Teasdale (2009) study *Mental workload when driving in a simulator: Effects of age and driving complexity*. This study used the driving stimulator to assess the mental workload on two different age groups, one younger and one older, while performing varying difficulties of driving tasks. Both groups consisted of all males, the younger group approximately 24 years of age, and the older group approximately 69 years of age. The main objective of this study was to assess the reaction times of the younger and older groups of drivers, focusing on the reaction times of the older adults to evaluate mental workload differences.

The study's research methodology consisted of having the subjects verbally respond to different auditory stimuli as quickly as possible while maintaining safe driving habits; therefore, the time it took to respond to the auditory stimulus was their reaction time. Reaction time according to Cantin et al. (2009) was defined as the temporal interval between the auditory stimulus and the onset of the corresponding verbal response detected from the microphone fixed on a headset. Driving the stimulator safely was considered the primary task, while responding verbally to the auditory stimulus was the secondary task. Cantin et al. (2009) stated that 36 auditory stimuli were given during three general driving contexts of increasing complexity: (a) driving on straight roads at a constant speed (b) approaching intersections for which the driver had to stop the car, and (c) when overtaking a slower vehicle. The results of the study showed that indeed the older drivers did have a higher mental workload than those of the younger drivers, which corresponded to longer reaction times. The older drivers had longer reaction times for all driving scenarios, especially the more complex driving tasks, such as overtaking a slower vehicle. Subsequently, Cantin et al. (2009) concluded that these results are important because they demonstrated that driving scenarios for simulator studies can be manipulated in such a way to mimic the mental workload imposed by similar on-road driving contexts. Although, simulation systems are becoming more popular and widely used nowadays for learning and as assessment tools, it is important to recognize that despite their positive persona, simulation systems do have some notable discrepancies.

Discrepancies with Simulation Systems

As previously portrayed throughout this paper, driving simulation and VR systems have been shown to be effective tools for learning and assessment; however, there are many discrepancies in the way of using these tools that need to be addressed. A few important discrepancies that need to be addressed with the use of simulation systems are whether or not the fidelity of a system matters, and how the fidelity might affect the outcome of learning. Also, evaluated is simulator sickness, research repeatability, and whether or not simulation systems provide a transfer of knowledge to real world applications.

Fidelity of simulator systems

Fidelity defined by Tarr (2006) is, "the degree to which a device can replicate an actual environment, or how real, the simulation appears and feels" (p. 8). Driving simulators can have varying degrees of fidelity which may directly affect the extent to which an individual finds the simulator an effective learning or assessment tool. Alexander, Brunye, Sidman, and Weil (2005) claimed that fidelity should be replicated, not only on a visual level, but also on a physical, functional, and psychological level. Physical in that the simulation looks, sounds, and feels like the portrayed environment; functional in a sense that it mimics the physics of the depicted environment or operational equipment, such as a steering wheel that vibrates or a car that shakes; and psychological in a way that stress and fear are incorporated into the simulation system so that real life situations and feelings are depicted.

The fidelity of a simulation system can range from low, medium, to high. The differences between each system are based on how accurate the representation of reality is. Low fidelity simulators typically are low cost and consist of basic entities such as a monitor with hearing and visual cues; this is comparable to the simulator used in this study. On the other end of the spectrum are high fidelity simulators which cost the most and represent realism the best. These systems usually have multiple cues such as a moving base, multiple screens, the best graphics, faster response times, and vibration. Simulators can be purchased for under $50,000 (low fidelity), from $50,000 to $250,000 (medium fidelity), and up to several millions of dollars (high fidelity) (Kantowitz, 2005).

While some believe that high fidelity systems are the only way to go because they present the highest degree of realism; other verdicts believe that high fidelity simulators are not worth the money because technology is continually being updated and thus systems are easily outdated. Furthermore, transfer of knowledge has not necessarily been proven to be significantly greater on high fidelity systems. de Winter, de Groot, et al. (2009) also agreed that high-fidelity is usually associated with high financial cost and the fact that the value of full motion cueing for training is still debated, the question also arises as to whether higher fidelity simulators always yield higher quality data (even though being more realistic). Kantowitz (2005) noted that medium fidelity simulators are typically the best choice for behavioral research studies, and that many important driver behaviors are studied successfully on medium-fidelity simulators, especially when driver cognitive behavior and decision making are objects of inquiry.

Moreover, the need of a certain fidelity level may depend on the degree of learning that is expected to occur. Depending on the training needed or the outcome of learning expected, a low fidelity simulator may work just as well as a high fidelity simulator. Alexander et al. (2005) noted that the appropriate levels of fidelity for training systems are dependent on the skills or behaviors that are to be trained. Additionally, they added if both the training system and the operational setting share properties with regards to the objectives of training, other aspects of the training system could tolerate lower levels of fidelity without compromising training effectiveness. Therefore, determining whether or not the fidelity of a system affects the outcome of learning depends on the training needed and the level of learning that is expected to result from the simulator system.

Simulator sickness

Use of simulator systems, such as driving simulators or VR, have frequently been associated with feelings of nausea or dizziness similar to motion sickness; these feelings can disrupt the learning process or assessment of individuals using the simulator. The correct terminology for this sickness is called Simulator Adaption Syndrome, and according to Mollenhaur (2004), simulator sickness is always an issue when using an immersive driving simulator. Additionally, VR has been known to cause extensive simulator sickness due to the fact that it is more of an immersive system; providing 3D images versus 2D imaging typically consistent with driving simulators. Lewis and Griffin (1998) found that VR systems can cause symptoms of simulator sickness which include ocular problems, disorientation and balance disturbances, and nausea. Furthermore, they indicated susceptibility to these side-effects can be affected by age, ethnicity, experience, gender and physical fitness, medication, as well as the characteristics of the display, the virtual environment, and the tasks. "The feelings of nausea and motion sickness among users of simulation systems can typically be ascribed to temporal and spatial distortions between actual motions of the user's body and corresponding movements of displayed images" (Lewis & Griffin, 1998, p. 3). While these side-effects can hamper the learning and assessment of an individual, not all individuals who use simulator systems are affected. In addition, strides have been made to reduce simulator sickness on newer and sometimes more expensive simulation systems. The National Advanced Driving Simulator at the University of Iowa claimed that their high fidelity simulators result in a much lower rate of simulator sickness; and that while other simulator facilities have reported frequencies of simulator sickness between ten and sixty percent, their average has been less than 2% over the previous two years.

Research repeatability

Simulation effectiveness, both on VR and driving simulator systems, has been identified throughout various studies; however it is important to recognize that it is difficult to repeat many simulator studies due to the high variability of simulation technology. Papelis, Ahmad, and Watson (2005) verified by concluding that repeatability of driving simulation experiments is a challenging process because of the wide range of simulator technology that is currently available. Additionally, they added depending on the simulator and the specific technology being used to implement the necessary scenes and scenarios, the effort needed to recreate an equivalent virtual reality testing environment can vary widely. Therefore, more work needs to be done to assure that similar protocols are being followed when conducting research so that the validity of simulator research is not being jeopardized.

Transfer of knowledge

The last discrepancy identified with simulator systems is the transfer of knowledge to real world applications. The transfer of learned information on systems such as driving and VR simulators is debatable. Some studies (Fisher, Pollatsek, and Pradhan, 2006; Hays and Vincenzi, 2000; Mitchell, Parsons, and Leonard, 2006) show a significant transfer of learning from simulated scenarios to real world applications, while others show limited correlational effects. Transfer defined means, "to pass or cause to pass from one person, place, or situation to another" (Merriam-Webster, 2004, p.759). For example, many studies claim that simulation should be used as an integrative part of an education curriculum to provide for higher levels of learning and knowledge transfer. Subsequently, Pardillo (2006) concurred that the transfer of knowledge on driving simulation systems is best achieved when combining simulation training into an integrative driving curriculum where simulation is not the only means of teaching. He further added that such integration requires a methodical approach and a detailed analysis of the training curriculum, learning goals, and training needs.

Moreover, the use of simulation systems alone is not always the best technique, especially when there is no replacement for the real world application. Tarr (2006) made a valid point in the context of transfer of learned simulation information by adding, "simulation is not a 'magic solution' that can be inserted into a typical content-based training program; it must be implemented for the additional advanced technology training it can provide" (p. 3).

Furthermore, he added it is not a cost-effective medium for presenting content or for those learning objectives that require the 'human touch' "(p. 3). Therefore, the transfer of simulated material is typically the greatest when the material portrayed represents the real life situation as closely as possible and is part of real world tasks. Alexander et al. (2005) concurred that simulator training is only valuable if the skills addressed and improved on in the virtual environment are required in the operational environment. Simulator systems that do not closely depict real world views or situations may create conditions where risk and hazards are not taken seriously by simulator users. On a physical level, the simulator should look, sound, and feel like the operational environment in terms of visual displays, controls, and audio, as well as the physics model driving each of the variables (Baum, Ridel, Hays, & Mirabella, 1982). Alexander et al. (2005) concluded that the best results of simulation transfer occur when fidelity, presence, immersion, and operator buy-in are utilized.

Despite the addressed deficiencies in simulator systems, they are still widely used and are being applied more than ever to new areas of research. Hence, the uses of simulator systems for learning and assessment have become increasingly popular tools for those affected by autism spectrum disorder and cognitive disabilities. However, it is first important to realize that the discrepancies associated with driving simulation and VR systems, or just the use of simulation systems in general, may affect individuals and persons with disabilities in different ways due to variations in learning, behavior, and cognitive processing.

Learning and intellectual difficulties defined by ASD and Cognitive Disabilities

The learning, behavior, and intellectual difficulties of those with autism spectrum disorder and cognitive disabilities will be defined to assess the problem areas these groups may have while using the driving simulator and executing different driving tasks presented throughout this study.

Assessing the learning, behavioral, and intellectual difficulties of individuals with autism spectrum disorder and cognitive disabilities is important bearing in mind these different disabilities may affect the overall evaluation of the fixed-base driving simulator as an effective or ineffective learning tool. Furthermore, two of the main objectives of this study are to assess the learning difficulties of those individuals with autism spectrum disorder and cognitive disabilities, as well as to determine how their disability may have affected their overall learning on the driving simulator. And additionally, to investigate how these behavioral and cognitive processing difficulties may affect the safety of their driving.

Autism spectrum disorder defined

Autism spectrum disorder (ASD) is currently the second most common developmental disorder after mental retardation (Self, Scudder, Weheba, & Crumrine, 2007). ASD is unique in that it can affect individuals in different ways and can range from mild to severe. Autism disorder is the most prevalent form of the spectrum disorders. Ozonoff, Goodlin-Jones, and Solomon (2007) agreed that studies that have broken down the rates by specific pervasive developmental disorder subtypes clearly show that the prevalence of classic autism itself is higher. Autism disorder is no longer considered a rare condition, its prevalence and diagnosis rate in society has increased dramatically as increased research and better diagnosing techniques have evolved. Chakrabarti and Fombonne (2001) reported a rate of 16.8 per 10,000 for autistic disorder, which is three to four times higher than the rate suggested in the 1960's and 1970's, and over 1.5 times the reported rate in the 1980's and 1990's.

Common symptoms associated with autism disorder typically present themselves before the age of three years old (Ozonoff, Goodlin-Jones, & Solomon, 2007). Symptoms of autism can include significant language delays, social and communication challenges, and unusual behaviors and interests (Lord & McGee, 2001). Additionally, Lord and McGee (2001) also agreed that many people with autistic disorder have intellectual disabilities as well. Individuals with autism disorder typically have trouble with language, attention, and cognitive processing, which has the potential to affect learning.

Learning difficulties associated with autism vary from individual to individual but most notably they consist of the inability to pay attention, communicate effectively with others, and use executive functions. Executive functions include the many skills required to prepare for and execute complex behavior, such as planning, inhibition, organization, self monitoring, and cognitive flexibility (Ozonoff, Goodlin-Jones, & Solomon, 2007).

Autism disorder commonly occurs with other cognitive ailments or disorders which can act in combination with some of the previously listed symptoms, and may contribute to decreased learning in an autistic individual. One example of this occurrence is the prevalence of attention-deficit/hyperactivity disorder (ADHD) in combination with ASD. Previous research by Tsai (2000) reported that 60% of individuals with ASD have poor attention and concentration and that 40% are hyperactive. Additionally, a study conducted by Goldstein and Schwebach (2004) found that almost 60% met the criteria for ADHD.

Nevertheless, it must be noted that those with ASD tend to express or manifest their inattentiveness differently than those with ADHD; those with ASD will focus too heavily on an object or function, whereas those with ADHD will not be able to focus on any one task for an extended period of time. (Hendren, 2003; Jensen, Larrieu, & Mack, 1997) also added that "overfocus" of attention and internal distractibility are said to be more characteristic of ASD's, whereas under focused attention and distractibility by external events are the hallmarks of ADHD. These finding correlate significantly with symptoms of autism, on a reverse level, which in turn may be correlated to similar learning and behavior difficulties among these two groups.

Consequently, due to a possible relationship of ASD individuals with ADHD individuals a study of ADHD was referenced to assess a possible speculative connection between ADHD drivers and potential autistic drivers. A study done by Parker, West, Stradling, and Manstead (1995) and Pless, Taylor, and Arsenault (1995) found that significant correlations between ADHD symptoms and driving risk have been reported. They also noted that some intuitive support exists for this idea to the extent that young people with ADHD and attentional problems may have deficits in key areas relating vigilance, impulse control, and decision-making that is deemed important for road safety. Another pertinent ADHD study found that ADHD is reliably associated with diminished executive functioning, particularly on measures of response inhibition, interference control, and working memory (Barkley, 1997). This finding is interesting because it correlates with Ozonoff, Goodlin-Jones, and Solomon (2007) who also claimed that those with autism disorder have deficiencies in executive functioning as well.

Subsequently, due to the fact that the previous two studies displayed ADHD symptoms similar to those of autism it may be possible to make an inference that if a study were done with a group of ASD individuals some similarities may arise that could predispose them to becoming a driving risk similar to several ADHD individuals.

Furthermore, many individuals that have ASD display variances in behaviors that may make them an increased risk on the road. Ozonoff, Goodlin-Jones, and Solomon (2007) noted that ASD can also co-occur with a variety of additional psychiatric and behavior disturbances. Identified behavioral warning signs that might have a negative impact on driving behavior include: trouble interacting in groups and following cooperative rules of games, not noticing when others are hurt or upset, unreasonable insistence on sameness and following familiar routines, need for advanced warning of even minor changes, and the tendency to become highly anxious and upset if routines or rituals are not followed (Ozonoff, Goodlin-Jones, & Solomon, 2007). These symptoms may have the potential to cause problems when driving in busy areas where there is a need for cooperative driving and patience. Additionally, Gillberg and Coleman (2000) noted that approximately 25% of individuals with ASD have a history of aggressive outbursts and irritability, these behavioral tendencies and other previously mentioned symptoms could possibly make those individuals with autistic disorder a high risk group of potential drivers. The next section looks at individuals with cognitive disabilities and how this disability may affect the learning, behavioral, and cognitive processing systems which are important while executing different driving tasks.

Cognitive disabilities defined

The exact definition of cognitive disabilities has been frequently changed and debated over the years; therefore, in this study intellectual disability, cognitive disability, and mental retardation are used in conjunction with each other and are meant to describe the same disability. Furthermore, Heward (2006) commented that "the definition of 'intellectual disability' has been revised a number of times during the past few decades as our understanding of the disorder has changed, and in response to various consumer, professional, political, and social forces" (p. 74).

The prevalence of intellectual disability in the United States has been estimated to be approximately 3% of the population (Heward, 2006). Individuals with cognitive disabilities also referred to as intellectual disability, or mental retardation refers to a particular state of functioning that begins prior to age 18, and is characterized by significant limitations in both intellectual functioning and adaptive behavior (AAMR, 2002). Adaptive behaviors according to Handen (2007) reflect an individual's ability independently to meet the needs and social demands of their environment. Furthermore, the decreased levels of intellectual functioning in individuals with cognitive disabilities are typically attributed to slower cognitive processing and decreased IQ levels.

Much like ASD, the severity of the disability and the symptoms associated with it can range from mild to severe. Measurement of IQ levels is typically the determining factor for diagnosing an individual with intellectual disabilities. Intellectual disability is typically defined using an IQ classification system which is subdivided into (mild, moderate, severe and profound mental retardation). The mild IQ range is 55-69, moderate 36-51, severe 20-35, and profound at less than 20, additionally the percentage of persons with mild mental retardation is 85%, 10 % moderate, 3.5 % severe, and 1.5 % profound (Handen, 2007).

As a result, learning, symptoms, behavioral, and cognitive processing can vary significantly depending on the level of cognition, or possible comorbidity. Those with mild mental retardation can typically become self-supporting productive individuals, however, as IQ loss or mental retardation increases the less functional that individual becomes. According to Handen (2007), most children with mild mental retardation can be expected to succeed within an academic curriculum, although most will remain below their typically developing peers in terms of reading and arithmetic levels; however, many of these children participate in vocational training and succeed in competitive employment, and live self-supporting lives. Additionally, the author added children with moderate mental retardation that comprise about 10% of the population typically have a curriculum that focuses on life skills and functional academics. These individuals as well can go on to become a productive part of society with support and training. Handen (2007) also noted that with support, individuals with moderate mental retardation may be able to manage competitive, or semicompetitive, employment situations. As for the severe and profound groups with mental retardation the main focus is teaching communication and self-help skills due to their severely low cognitive processing.

Similar to those with ASD, individuals with intellectual disability also have a higher than normal incidence rate of comorbid behavioral disorders. Children and adolescents with intellectual disability can experience the entire range of psychiatric disorders and appear to be at a greater risk than the general population for developing such disorders (Emerson, 2003; Quay & Hogan, 1999). Moreover, those individuals with mental retardation have also been found to exhibit symptoms of ADHD, similar to individuals with ASD. Furthermore, externalizing disorders, such as ADHD and conduct disorders appear to be among the most common behavioral disorders diagnosed in children with intellectual disability (Emerson, 2003). Similar to the inference made with autistic individuals, the combination of ADHD and cognitive disabilities may predispose this group as a high risk group of drivers. However, this may be too strong of an inference to draw considering, as previously stated, many of the mild to moderate individuals with intellectual disabilities may go on to lead normal lives.

Nevertheless, it is important to realize that driving is a highly cognitive task, and that those with cognitive disabilities or mental retardation typically have slower cognitive processing and delayed reactions times, which in turn could be a potential risk on the road. Baumeister and

Kellas (1968) explained that "such individuals respond much more slowly and display more marked intraindividual variability in speed of responding than those individuals of average intelligence" (p. 165). Furthermore, Kihira (2008) also commented "driving consists of very advanced and complicated tasks; diversified consideration of various cognitive functions is needed to judge driving competence" (p. 619). For instance, "when supposing an unforeseen emergency event, such as an obstacle appearing ahead, the driver must recognize the circumstances by direct sight and via mirrors, and must make decisions without undue delay to avoid the obstacle without error" (Kihira, 2008, 619). Additionally, Vanderbilt (2008) added when driving, approximately 20 decisions are made per mile. In conclusion, driving is a highly cognitive task with about 20 decisions made per mile, or more perhaps depending on the circumstances; therefore, it is critical to see how driving with a disability may be difficult, especially to this measure.

Even so, it is important to appreciate that the symptoms of ASD and cognitive disabilities can range from mild to severe, and that many individuals suffering from these disorders have the ability to improve their lives if given the proper support, education, and guidance. Consequently, a study done by Brewer and Smith (1984) reported that mildly and moderately retarded individuals are generally able to maintain accurate responding (i.e. virtually error-free performance), on experimental and vocational tasks that involve relatively simple perceptual judgments and motor responses.

Moreover, the use of simulator systems for learning and assessment have become an increasingly popular tool for those affected by ASD and cognitive disabilities, especially the use of virtual reality environments. The manipulations of different simulated environments, other than driving, have become an especially popular tool for motivating and measuring learning among those who have autism spectrum disorder (ASD).

Simulation use with ASD individuals and the Cognitively Disabled

For the past ten years virtual environments (VE's) have been successfully used for the assessment and treatment of a variety of important mental health problems (Wiederhold & Riva, 2004). Additionally, with increases in new technology and the inquisition of helping those with various mental disabilities, virtual reality (VR), as well as driving simulation have become popular tools for advancing the learning and assessment of those with autistic and cognitive disabilities. An advantage of simulation Parush, Hamm, and Shtub (2002) added was that "in contrast to the real world, which is being simulated to various degrees of fidelity, the students using a simulator are able to 'stop the world' and 'step outside' of the simulated process to review and understand it better" (p. 320). Furthermore, Wiederhold and Riva (2004) added VR can be considered a special, sheltered setting where patients can start to explore and act without feeling threatened. This section will look at how VR simulation research has been utilized as a learning tool to help those with ASD, as well as the use of driving simulation as a constructive evaluation tool for those with cognitive disabilities.

Simulator use and ASD individuals

"Parents and clinicians regularly report that children with autism are drawn to technological devices, and researchers have noted the importance of devising treatments that take advantage of this fascination" (Colby, 1973, 254). Consequently, VR has become an increasingly popular use of simulation to teach new skills and to assess those with ASD. VR simulation is being used with ASD individuals as a tool to create learning environments that feel non-threatening and conducive to learning. Several studies have been done using VR as a medium for teaching individuals with ASD. For instance, one study used VR to teach students tornado and fire safety skills in their school (Self, Scudder, Weheba, & Crumrine, 2007). A similar different study used VR to teach individuals fire safety and street crossing skills (Strickland, McAllister, Coles, & Osborne, 2007), while another created a VE of a cafe and a bus stop to teach social understanding (Mitchel, Parsons, & Leonard, 2006). These learning and assessment environments can create an atmosphere for ASD individuals to feel safe in while trying to overcome social and behavioral challenges. For instance, the VR simulator can create an environment where an individual may feel uncomfortable such as a busy bus stop. The individual can visit this bus stop through the VR simulation multiple times until the individual feels comfortable enough to go out into the real world and try it.

A research study done by Mitchel, Parsons, and Leonard (2006) titled *Using virtual environments for teaching social understanding to 6 adolescents with autistic spectrum disorder* revealed that VR simulation can have a positive learning affect on individuals with ASD. The objective of the study was to analyze the effectiveness of VE's, or VR simulation, and to teach social understanding to individuals with ASD. The study also focused on whether or not the use of the VE was an effective learning tool for those with ASD, and if so, what benefits the system may have provided. Mitchel et al. (2006) noted measures were taken in order to assess whether judgments and explanations changed in a way that indicated improved social understanding after using the cafe VE. Furthermore, Mitchel et al. (2006) explained that the study was significant because the skills of finding a place to sit and asking appropriate questions were identified as key learning objectives for these students, especially as they were already, or about to be, continuing their education by attending local colleges that were not specialized in catering for individuals with special needs.

The subject group consisted of six participants, three males and three females, ages ranging from 14-16 years of age. The methodology consisted of individuals with ASD watching three sets of video clips that consisted of a cafe and the inside of a bus. The video clips consisted of 15-30 second real life excerpts of people, two on a bus and three in a cafe. After the participants watched the video clips they were then expected to transfer the behaviors they had seen on the video clips to the VE, which consisted of a computer screen with a joystick and a mouse. The VE simulation consisted of four levels with increasing complexity of social interaction. As the participant navigated through the VE, the individual was expected to interact with the virtual characters similar to the real characters seen in the videos. The individual was also expected to reason out where they would sit in the bus or cafe. Mitchel et al. (2006) indicated that using a VE in this study was significant because it allowed participants to take a first-person role for skill-learning in a virtual social situation.

With the cafe simulation, the individual would start the simulation by getting food in the virtual cafe and then proceeding to find an appropriate place to sit by clicking on different seating areas. The seating arrangements varied depending on the complexity level. The easiest level started by having the participant find a seat in an empty cafe using no social interaction at all, while the hardest level exemplified a full cafe with large amounts of commotion. In this level the participant was expected to interact socially on a large scale by asking if there was room to sit at a busy table. However, if the student picked an inappropriate response such as, choosing to sit with a group of strangers when there were other empty tables open, the program would give verbal and visual feedback commenting on the decision of the individual. Additionally, the participant was given a set of three questions to choose from when interacting with a person, two of the questions that could be selected from were appropriate, while one was not. Subsequently, after choosing a question the individual was asked why they asked that question, or why they chose to sit in a particular location. This forced the participants to reason out their decision making processes throughout the virtual simulation. Essentially, the VE program was teaching the individuals appropriate etiquette and social skills while interacting within the simulated environment.

The results of the study according to Mitchel et al. (2006) was that the participants experience with the VE's led to improvements in judgments and reasoning about where to sit in some of the videos of real cafe's and real buses, at least in some cases. Furthermore, most of the participants showed the ability to transfer the context of social interactions in the videos viewed to the context of the VE. Mitchel et al. (2006) also stated that some participants at least some of the time used what they had learned in the VE to reason about how to behave in relation to videoed scenes of real-life cafes and buses, and that, their learning was not confined to a particular context of application (cafe), but was generalized to another context (bus).

In conclusion, this study allowed the participants to interact on a first person basis in a VE setting, receiving the aid of visual and verbal feedback from the simulation program as they interacted within different environments and social contexts. Mitchel et al. (2006) implied that the participants experienced first-hand what might happen when you behave in a certain way, and this might be considerably more potent and vivid than hearing a teacher merely state an abstract social rule. Moreover, it may be possible to infer that the positive results found from the use of the VR simulation system in this study, and others with ASD individuals, may transfer as well to the contexts of using a fixed-base driving simulator.

The use of driving simulation provides a different form of learning in that it is two-dimensional versus the three dimensionality of VR. Some have reported that this environment is not as conducive to learning or assessment because of its lack of fidelity compared to VR; however, it is still used quite successfully as stated earlier on. de Winter, de Groot et al. (2009) commented that one potential disadvantage of driving simulators is that they, by definition, provide only a presentation of reality, not reality itself. However, they concluded, driving simulators have proved to be excellent instruments in studies where relative comparisons are important. It can also be argued that VR also provides only a representation of reality and not reality itself. While most of the studies found identify the use of VR simulation as an effective means for teaching those with ASD, none, if any, spoke of using VR simulation with individuals that had cognitive disabilities. However, some studies have been found that use driving simulation to teach and assess cognitively disabled individuals.

Simulator use and the cognitively disabled

"Driving simulation has the potential to be useful in the clinical setting for testing and treating impairments of visual perception, cognitive functioning and driver safety across a wide variety of conditions and age ranges" (Rosen & Wachtel, 2004, p.69). A study that exemplifies the use of driving simulation as an assessment tool with cognitively disabled individuals is Rosen and Wachtel (2004) study *Driving simulation in the clinical setting utility for testing and treatment.* This study addressed the use of the driving simulator as a tool for evaluating impairments in vision and cognition among elderly populations, as well as other populations that may have cognitive and visual impairments. Rosen and Wachtel (2004) attested that the driving simulator is an efficient tool for the evaluation of driving ability in groups with both cognitive and visual impairment.

Additionally, they added because it is not widely appreciated that cognitive and visual impairments are closely linked, screenings for these conditions are not typically being conducted during the same visit or by the same clinician. The use of the driving simulator, however, has the ability to be used for screening and assessment of both cognitive and visual perception to test a driver's aptitude. "Driving simulation offers the advantages of testing performance, rather than function alone, because it integrates perceptual input, cognitive processing and behavioral output into a single dynamic, feed-forward and feed-back iterative loop" (Rosen & Wachtel, 2004, p. 69). The combination of testing not only function but also performance is what makes driving simulation and other forms of simulation great assessment and learning tools.

Rosen and Wachtel (2004) also commented that driving simulators provide a positive use as both an assessment and learning tool to test driver knowledge, and skills and abilities. They also contended that, "simulation can help to identify areas of needed improvement and as a teaching or learning device that might provide a compelling means of enhancing situational awareness, improving judgment and re-enforcing good driving habits and knowledge of rules of the road" (p. 70). The use of driving simulation is the perfect tool to test cognitive abilities of current and potential at risk driving populations. "As a performance test, driving simulation has the potential to be useful across a wide variety of conditions and age ranges, to evaluate impairments of perception and cognition, and to remediate deficits in knowledge, skills or abilities related to driver safety" (Rosen & Wachtel, 2004, p.73). This study provided some valid evidence that the use of the driving simulator may be an appropriate means to assess and teach individuals with cognitive disabilities.

Summary

In conclusion, this literature review has provided evidence of the effectiveness of the driving simulator based on its use as a learning and assessment tool. Furthermore, this review has also provided evidence as to why simulators may be ineffective learning and assessment tools based on deficiencies such as fidelity, simulator sickness, repeatability of studies, and transfer of learned information. The review also goes into depth focusing on how autism, or autism spectrum disorder, and cognitive disabilities can affect the learning, behavioral, and cognitive processing an individual may have when affected by these disorders. Subsequently, it is inquired exactly how these intellectual difficulties may correlate with driving, whether on the simulator or in real life. Finally, the last section focused on the use of virtual reality systems as learning and assessment tools for autism spectrum disorder individuals, and inferred that if virtual reality can have a positive learning and assessment outcome then maybe this can transfer to driving simulators as well. This section ended with reviewing driving simulations effectiveness as an assessment tool for those that may be visually or cognitively impaired.

Overall, the just of the chapter review was to provide evidence that driving simulators are effective learning and assessment tools, to point out that discrepancies are associated with simulator systems, to illustrate that autistic and cognitive disabilities may affect how well an individual will learn, behave, and cognitively perform on the driving simulator, or driving in general, and finally to provide evidence that virtual reality and driving simulator systems have successfully been used with these particular groups to show positive outcomes.

Chapter III: Methodology

The purpose of this study was to evaluate the effectiveness of the fixed-base driving simulator (*Simulator Systems International* S-2100/2300) as a learning tool for young adults with autism spectrum disorder and cognitive disabilities in the Vocational Rehabilitation Center. Furthermore, to determine if the simulator is an effective learning tool to help students to pass their permit or drivers exam, or alternatively to decide that driving may not be a task the student should readily pursue, and additionally to conclude if the driving simulator should be incorporated into a new learning curriculum for the students. This section will touch on the method of the study, the sample selection used, instrumentation used, procedures followed, and method of analysis.

Method of Study

The method of the study consisted of starting the students with a pre-interview questionnaire, given in Appendix C, to determine what experience they may have had with driving, or driving simulators, and also to establish what disabilities or uncertainties the students may reveal which might prevent them from completing the full course of the driving simulator program. The pre-interview questionnaire was given in one big room with each student waiting their turn to be interviewed.

The students were given as much time as needed to complete the full simulator program. Most students started the program in October of 2009 and finished in February of 2010. At first, the students were randomly scheduled for a two hour time block on the simulator; this was eventually dropped to one hour because the observer and teacher discovered that two hours was too long for most of the students to stay focused. Additionally, while using the driving simulator, each student was observed by the observer or the teacher. This was done to ensure that someone was available to answer the student's questions, and also to note the student's behaviors and progress while on the simulator.

To determine the effectiveness of the driving simulator, the observer, the teacher, and each student were given the opportunity to be interviewed using the post-interview questionnaire, also provided in Appendix C. The post-interview questionnaire was taped with an audio cassette and was conducted individually in a quiet enclosed room. Additionally, research was done to determine what disabilities the students may possess which could alter their performance while using the driving simulator.

To determine the disabilities of each student and how their disability may have affected their learning while completing the driving simulator program, consent forms were signed by each student, or guardian, so that the students full, verbal, and performance scale IQ's could be accessed. These scales are also known as the Wechsler Abbreviated Scale of Intelligence (1999) and are used to determine the cognitive functioning of an individual based on vocabulary, similarities, block design, and matrix reasoning. The vocabulary and similarities test make up the verbal IQ score, while the block design and matrix reasoning tests comprise the performance IQ score. The two IQ scores are then combined to make up the full-scale (FS) IQ score.

In addition, the students Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) diagnoses records were accessed to get an overview of each student's disability. The DSM-IV is the standard classification of mental disorders used by mental health professionals in the United States (American Psychiatric Association, 2000). These records helped to identify areas where each student may have had trouble using the simulator based on their disability and IQ scores.

Sample Selection and Description

Eleven students, one observer, and one teacher participated in the study. The students given the chance to partake in the study were part of the Vocational Rehabilitation Centers Transitional Partnership School. Some of the students who partook in the study were enrolled at Menomonie High School, while others were from different area school districts. Students were allowed to participate no matter what level they were at with their driving abilities. Consent forms were signed by each student, and/or guardian, to demonstrate that they understood the scope of the study, and to additionally inform the students that they could opt out of the experiment at anytime. Furthermore, the consent forms were signed to obtain student disability information.

The eleven students who decided to take part in the study had varying levels of disabilities; the most common were autism and cognitive (intellectual) disability. Two out of the eleven participants had another co-morbid disability. Moreover, each of the individuals had different levels of learning and performing abilities. Furthermore, it was unknown what medications, if any, the participants were using throughout the study that may have affected their performance level.

Driving experience varied somewhat among students; most had little to no driving experience, if a student had driven even once they were considered to have had experience. Of the eleven students who decided to participate, one had their driver's license previous to starting the simulation, and one had their learner's permit with the intention of taking their drivers test while participating in the study. The observer and the teacher who participated in the study consisted of one female and one male, all with previous driving experience.

Furthermore, none of the participants involved in the study had ever used a driving simulator before. All eleven students, plus the observer and the teacher participated in the *Simulator Systems International* S-2100/2300 driving simulation curriculum. Of the eleven participants, two were females and nine were males. The range of ages varied from 19-25 years of age.

Table 1

Characteristics of Participants including, sex, age, and driving experience

Participant	Sex	Age	Driving Experience
P1	M	26	Y
P2	M	21	Y
P3	M	20	Y
P4	F	20	N
P5	M	20	Y
P6	F	21	N
P7	M	21	Y
P8	M	21	N
P9	M	20	N
P10	M	21	Y
P11	M	21	N

Instrumentation

The primary instrumentation used was one low fidelity fixed-base driving simulator, manufactured by *Simulator Systems International*; model S-2100/2300, distributed during the time frame of 2006-2008. The computer program that went along with the simulator was FAROS 2002, version 4.03 beta 1. The setup consisted of a fixed-base driving simulator with an automatic style transmission, three 19" Dell LED computer screens (E198FP) with 1280 x 1024 pixels of resolution, and two FOX CONN TWO1 hard drives.

The fixed-base driving simulator consisted of an automatic style transmission which had park, reverse, neutral, drive, second, and first gear. Additionally, the dashboard had a headlights switch, hazard lights, a tachometer, a speedometer, an ignition with key, speakers with volume control, two toggle switches that were used for the mirror functions, and one control on the left side of the steering wheel which included the left and right blinker control, the windshield wipers, a horn, and hi-beams all in one. The seat had an adjustment to move the seat forward and backward, as well as a seatbelt, and a parking brake that was located on the right side of the seat. Additionally, the simulator had a brake and gas pedal similar to that of a real vehicle. The simulator system was open and consisted of three Dell LED computer screens stationed in front of the driver, set up similar to viewing out of a car windshield. See Appendix A for a picture of the simulator set-up.

The computer program consisted of four blocks of training, starting with "Getting Started", "Basic Training", "Intermediate Training", and "Advanced Training". Additionally, each block consisted of several supplementary sessions within a block. The getting started block helps to get individuals acquainted with the simulator and its controls, as well as teaching simple driving rules and maneuvers. The basic training block adds more driving maneuvers, while allowing the student to practice without the worry of other traffic. Subsequently, the intermediate training block builds on the last session but now allows individuals to start interacting with other drivers, and last, is the advanced training block which gives individuals a chance to drive in adverse weather conditions and risky situations. See Appendix B for the layout of each block and the session contained within.

The computer program was designed to create a log-in for each student, with a password, and an instructor logging function to track the progress of each student. This logging function consisted of completion rate of sessions, the number of attempts per session, and the duration spent on each session. The simulation program consisted of a series of videos and voice activated prompts. The videos were provided before most simulation activities to give instruction by showing real drivers participating in the activity.

Voice activated prompts, along with the use of a mouse, were used to navigate from block to block and session to session. The mouse was mainly used to log-in by clicking on one's name and then clicking the letters or numbers to enter in the student's password. The mouse was also used to click "next", "start over", or "watch video" within sessions or between blocks. Voice activated prompts and/or videos, and written instructions were given throughout blocks and sessions to inform the driver what to do. During the simulation based training, the voice activated instructor would provide route instructions and give task feedback in a written form, and by video, if the individual chose to watch how they drove throughout the session. If the participants failed a session, they were given the option to start over and/or watch a video showing the mistakes they made during the simulation. The participants were not able to move onto the next block or session until they had successfully passed each task.

Procedures

When the students agreed to take part in the study and had their consent forms signed, each student was initially given a pre-interview questionnaire to assess their age, previous driving experience, etc. The pre-interview questionnaire is given in Appendix C. Each student was required to create their own log-in on the *Simulator Systems International* S-2100/2300 driving program so that they could individually log-in using their date of birth as their password. Date of birth was chosen as a requirement for their password so that it was easy for the student to remember, and so that the teacher or observer could easily log-in to the student's file to look at their progress. Moreover, the logging function that tracks the progress of each student only works if each person has their own log in.

A sign-up sheet was posted so that the students could sign up for hour blocks of time throughout the week in which they could come in and use the simulator. An observer or teacher was present in the room throughout every session with every student so that their progress, reactions, and behavior could be documented, along with any malfunctions encountered with the simulator program. The observer or teacher was also present in case the students had questions about the simulator. Handwritten observation files were kept on each individual student. These files contained information on each student's progress, behavior, and reactions. Interrater reliability was not taken into consideration for this study, therefore, each observer or teacher was not trained to document or record information in a certain manner.

At the conclusion of the simulation program, the students, observer, and teacher were given a post-interview questionnaire to evaluate the simulator as a learning tool. Throughout the interview process the students, teacher, and observer were given a chance to express their opinions about the effectiveness or ineffectiveness of the *Simulator Systems International* S-2100/2300 driving program.

Method of Analysis

The observational, medical, and logging files of each individual student were evaluated to note their progression throughout the *Simulator Systems International* S-2100/2300 driving program. Overall learning progression, behaviors, and reactions to the program were evaluated to assess each student's completion rate based on gender, age, the Wechsler Abbreviated Scale of Intelligence (1999), hours spent on the simulator, sessions completed (basic, intermediate, and advanced training), and previous experience. Previous experience was gathered through the pre-interview questionnaire. Subsequently, the study assessed the students completion rate based on their DSM-IV (American Psychiatric Association, 2000) diagnoses, the Wechsler Abbreviated Scale of Intelligence (1999), hours spent on the simulator, and observed behaviors while using the simulator. Lastly, the post-interview questionnaires were evaluated to assess the simulators overall effectiveness as a learning tool.

Each interview questionnaire was considered in assessing the use of the *Simulator Systems International* S-2100/2300 driving program. The interview questionnaire responses were evaluated to determine if the students, teacher, and observer felt that the driving program was an effective or ineffective learning tool. All interview questions were compared to make a decision on the effectiveness or ineffectiveness of the simulator system. This decision was used to help determine if the system was worth incorporating into a standard curriculum for the students, or possibly determining if the system should be sold, or updated.

Limitations of the Methodology

Limitations of the methodology include:

1. Time was a limitation because the simulator can only be used in hour blocks and an observer or teacher needs to be present to assist each student.
2. It was unknown what medications, if any, the participants were using throughout the study that may have affected their performance level.
3. Observational documentation of the student's progress, behavior, and reactions could vary; interrater reliability was not taken into account when documenting each of the student's progress, behaviors and reactions while using the driving simulator.
4. Individuals may feel uncomfortable being watched, especially the autistic students, therefore, their progress, behaviors, and reactions, may be affected.

5. The sample size for the given study may be too small to make proper inferences.
6. The driving simulator program is slightly outdated.
7. Some students may have had more driving experience, or driver's education than other students.
8. Many of the students have different disabilities or the same form of a disability that varies to a certain extent.

The following section will talk about the results of the study.

Chapter IV: Results

The purpose of this study was to determine if the fixed-base driving simulator (*Simulator Systems International* S-2100/2300) was an effective learning tool based on the results of the pre and post-interview questionnaires given to the students, the observer, and the teacher. The learning effectiveness of the driving simulator was also assessed based on student observational notes taken by the observer, and the teacher. Additionally, the potential for using the driving simulator as a learning tool to help students obtain their permits and/or drivers licenses, or successfully progress through the simulator program, was assessed based on the students behaviors and reactions while using the simulator. Furthermore, each student was evaluated based on the Wechsler Abbreviated Scale of Intelligence (1999), as well as, the DSM-IV (American Psychiatric Association, 2000) records.

This section covers the collection of data, starting with the participants' progress throughout the simulator course. The study focused on each student's rate of completion based on gender, age, the Wechsler Abbreviated Scale of Intelligence (1999), hours spent on the simulator, completed sessions, and previous experience. Previous experience was gathered through the pre-interview questionnaire. Subsequently, the study assessed the students completion rate based on their DSM-IV diagnoses, the Wechsler Abbreviated Scale of Intelligence (1999), hours spent on the simulator, and observed behaviors while using the simulator. Lastly, post-interview questionnaires were evaluated to assess the simulators overall effectiveness as a learning tool.

Presentation of Collected Data

To determine the disabilities of each student and how these disabilities may have affected their learning on the driving simulator, the Wechsler Abbreviated Scale of Intelligence (1999) and the DSM-IV records were accessed so that they could be used as a means to evaluate an individual's progress throughout the driving simulator course.

The sex, age, full-scale (FS), verbal (V), and performance (P) IQ's (Wechsler Abbreviated Scale of Intelligence, 1999), hours spent on the simulator, sessions completed (beginners, intermediate, and advanced training), completion rate, and previous driving experience are given in Table 2 to give an indication of the participant's possible learning deficiencies and how they may have affected the students progression, or completion rate, throughout the simulator course.

Table 2

Participant's sex, age, IQ values, participation hours, sessions completed, completion rate and previous driving experience

Participant	Sex	Age (yrs.)	FSIQ	VIQ	PIQ	Hours	Sessions Completed B, I, A	Completion Rate	Driving Experience
P1	M	26	48	NA	NA	11	22, 33, 26	Y	Y
P2	M	21	75	72	83	13	32, 35, 27	Y	Y
P3	M	20	56	71	63	8	30, 22, 0	N	Y
P4	F	20	66	70	72	21	33, 34, 25	Y	N
P5	M	20	68	80	60	14	28, 32, 0	N	Y
P6	F	21	62	64	65	20	28, 34, 18	Y	N
P7	M	21	NA	NA	NA	25	33, 32, 19	Y	Y
P8	M	21	60	60	NA	16	0, 0, 0	N	N
P9	M	20	58	65	57	16	16, 0, 0	N	N
P10	M	21	90	76	107	17	32, 35, 19	Y	Y
*P11	M	21	NA	NA	NA	2	NA	N	N
Average		21.1	64.8	69.8	72.4	16.1	28.2, 25.7, 13.4		

*P11 was unable to continue with the study
Sessions completed (Block) (Total Sessions): (Basic Training (B)) (33), (Intermediate Training (I)) (35), (Advanced Training (A)) (28)

Of the four blocks (getting started, basic, intermediate, and advanced training) data was gather from the latter three due to a malfunction of data logging with the first. The basic training block consisted of 33 sections with sessions 1.1-1.3 (chapter lessons) absent from the program. Next, the intermediate training block consisted of 35 sessions with sessions 1.1-1.5 (chapter lessons) absent, and finally the advanced training block consisted of 30 sessions with malfunctions in both the "Rain" and "Ice" sessions, therefore, none of the students passed these two sessions. Furthermore, missing from the advanced training block was 1.1-1.7 (chapter lessons).

P11 was unable to complete the full study, he participated for the first day and decided he did not want to continue on with the program; therefore, he will not be included further in the presentation of the data. Previous to the study, P3 had his license, while P5 had had his drivers permit for the last three months. P3 and P5 did not complete the simulator program in succession with the others because they were told to limit their time on the simulator so that the other individuals with less experience could use it. Lastly, P8 and P9 were still in progress of completing the driving simulator program at the conclusion of the study and still had a significant way to go. Students may not have completed all of the sessions due to simulator malfunctions, or because of the "instructor override" option which allows a student to skip a session. The observer or teacher should have been the only ones able to do the override, however, it was noted that P1 may have overseen this being done and thus may have over rid sessions when the teacher or observer was momentarily out of the room. Other students may have been given the option by the teacher or observer to skip a session if the student had increased difficulties and could not pass the session after several attempts.

Referring to Table 2, there seems to be no relationship between gender, age, hours on the simulator, sessions completed, completion rate and full-scale, verbal, or performance IQ's. There does, however, seem to be a relationship between completion rate and previous driving experience. Generally, those with previous driving experience showed reduced completion times, excluding

P7, P3 and P5. However, some of the students with reduced completion hours and previous driving experience showed a lower completion of sessions, P1.

To determine the strengths and weaknesses of each student, and how these weaknesses may have affected their overall ability to progress through the driving simulator course, and perhaps the safety of their driving, Table 3 is presented. Table 3 presents the breakdown of each of the participant's completion rates which is based on hours spent on the simulator, full-scale (FS), verbal (V), and performance (P) IQ, DSM-IV diagnosed disability, and observed strengths and weaknesses while using the driving simulator. Consequently, seven of the ten students participating in the study were assessed as being cognitively disabled, one student was assessed as being autistic, and the other two were assessed with comorbid disabilities (cognitively disabled/autistic and cognitively disabled with ADHD), according to the DSM-IV classification.

Based on the individual's disability, each student had some slightly differing learning difficulties while using the driving simulator. One of the most noted difficulties, based on the observational notes, was trouble executing multifunctional tasks. For example, when merging or pulling off the side of the road, students had trouble remembering to check their blind spots, turn on their blinker, etc. Other noted difficulties included speeding, trouble with written instructions, following directions (comprehension of the task), difficulty remembering how to execute different tasks, and assistance or prompting in completing tasks. Prompting included keeping the student focused, as well as, reminding the students when certain driving procedures were not being properly followed, such as checking blind spots, turning on the blinkers, or checking their speed, etc.

Table 3

Participant's disabilities and observed strengths and weakness (behavioral and learning) noted while using the driving simulator

Participant	Completion	Hours	FSIQ	VIQ	PIQ	Disability	Strengths	Weaknesses
P1	Y	11	48	NA	NA	CD	WI, CM, FI, SI	RD
P2	Y	13	75	72	83	CD/ADHD	WI,CM, FI, SI	RD
P3	N	8	56	71	63	CD	WI,CM, FI, SI	RD, DC
P4	Y	21	66	70	72	CD	WI,CM, FI, SI	RD, PN
P5	N	14	68	80	60	CD	WI,CM, FI, SI	RD, AE, ES, PN
P6	Y	20	62	64	65	CD	CM, SI	RD, DC, DR, PN
P7	Y	25	NA	NA	NA	A	WI,CM, FI, SI	RD, DC, AE, ES, PN
P8	N	16	60	60	NA	CD		RD, DC, PN
P9	N	16	58	65	57	CD		RD, DC, AE, ES, PN
P10	Y	17	90	76	107	CD/A	WI,CM, FI, SI	RD, ES, PN

Disability Coding: Cognitively Disabled (CD), Autistic (A), Attention-Deficit/Hyperactivity Disorder (ADHD)
Strengths and Weaknesses Coding: Worked Independently (WI), Corrected Mistakes (CM), Followed Verbal and Written Instructions (FI), Shows Improvement (SI), Retention Difficulties (RD), Difficulty Comprehending Written and/or Verbal Information (DC), Difficulty Reading (DR), Prompting (to focus, change behavior) Needed (PN), Angered Easily (AE), Excessive Speeding (ES)

Table 3 indicated that all students had observed retention difficulties. Of those students that completed the simulator course, those that needed prompting typically took longer to complete the simulator program, except for P10. Additionally, 4 out of the 5 students that had difficulty comprehending also needed prompting. And lastly, of the three students that were angered easily, all three excessively sped and needed prompting while using the driving simulator.

With regards to observed strengths, those students that worked independently, corrected their mistakes, followed written and verbal instructions, and showed improvement, completed the driving simulator course, excluding P3 and P5. Again, P3 and P5 did not complete the simulator program in succession with the others because they were told to limit their time on the simulator so that the other individuals with less experience could use it. However, these two participants showed the same qualities as those that did pass; therefore, it could be assumed that these two students would have completed the simulator course in its entirety as well. Additionally, P6 corrected her mistakes, and showed improvement, however, she required assistance with most reading tasks, and therefore, at times, it was difficult for her to work independently. P8 and P9 failed to show much improvement, and therefore had trouble completing the driving simulator course in its entirety. Lastly, again IQ did not seem to be a contributing factor to the progression of each student throughout the course.

On a final note, when reviewing Table 3 it may be noted that some of the weaknesses observed could potentially cause safety issues for that individual and others if the student were to be driving. The two observed behaviors of most concern may be excessive speeding and anger related behaviors.

To determine the completion rate of each student throughout the course, as well as, the contributing factors that may have hindered or helped students to finish the driving simulator course, the pre-interview questionnaire, and the observational notes were referenced to answer this objective. The pre-interview questionnaire was conducted prior to the students using the driving simulator to assess if the students had any prior driving experience on the road or with a driving simulator, and also to establish what disabilities or uncertainties the students may reveal which might prevent them from completing the full course of the driving simulator program. Moreover, it was found that none of the participants, including the observer and teacher, had ever had any prior training on a driving simulator.

Referring to Table 2, six out of the ten students who participated in the study had previous driving experience; of these six, four completed the driving simulator program completely. P3 had his license prior to starting, while P5 had his permit three months prior to starting the simulator study; therefore, P3 and P5 were told to let those students who did not have their permit or license the allotted time slots, and if they wanted to continue the simulator program they may do so while on break. This lack of time on the simulator may have hindered P3 and P5 from completing the study.

P5 and P1 were getting additional help through a driving school; both obtained their licenses while participating in the simulator study. Additionally, P2, 7, and 10 received their permits while participating in the simulator program. Therefore, contributing factors that may have helped some students to progress through the driving simulator at a quicker pace could have been a combination of several factors such as previous driving experience, the use of the driving simulator, and/or the attendance of a driving school. Consequently, factors that may have hindered some students from progressing to completion, or at a quicker rate, may have been due to the availability of the simulator, or learning or behavioral difficulties associated with the participants' disability. Two of the students had so much trouble with the progression of the simulator course, most likely due to their disability, that they probably will not complete the program.

Referencing Table 3, one can see the different observed strengths and weaknesses of each student which may have hindered or helped the learning or progression process. To reiterate, the most common weakness was retention difficulties, all students had some trouble in this area. Seven out of the ten students had difficulties with needing prompting during the study, followed by five out of the ten students showing difficulties comprehending the material. Lastly, three out of the ten were easily angered by using the simulator; moreover, it was these three students that had issues with excessive speeding as well.

To restate, the observed strengths that may have helped students successfully progress through the program are presented in Table 3. Table 3 illustrates that those students able to work independently, follow verbal and written instructions, correct their mistakes, and show improvement, all had high completion rates. Furthermore, five out of the six students that completed the simulator course had strengths in all of these four areas. All students except for P8 and P9 showed improvement and correction of mistakes during the simulator program. P6 was able to complete the full simulator course by showing improvement and correction of mistakes, however, she did require assistance with reading the written instructions.

The last two objectives focused on determining the effectiveness of the driving simulator as a learning tool to prepare the students for their driver's or permit exam based on the students, the observer, and the teachers interview results. To gather these results each student was given the post-interview questionnaire. Additionally, to determine if the driving simulator was a good learning/assessment tool for the students the observer and teacher were given a separate post-interview questionnaire. The students were interviewed on January 28, 2010, while the observer and the teacher were interviewed on February 3, 2010, and February 4, 2010, respectively.

The only questions that will be presented from the post-interview questionnaire are the ones that revealed results significant to the study. Some of the questions presented in Appendix C may not be addressed because they were either redundant or provided information that was not pertinent to the studies final results. Each question is presented with either a table and explanation of the results, or just an explanation of the personal interview results. This next section will contain post-interview questionnaire results from the observer, teacher, and students.

The questions focus on all three of these groups combined responses, and touch on the simulators effectiveness by looking at completion rate, recommendations, likes and dislikes, the realism of the simulator, as well as, the consensus on providing the simulator course in conjunction with a drivers education program, and lastly, touching on the presence of simulator sickness.

Examining Table 4 shows that, six individuals did finish the driving simulator course, while six others did not. The six individuals that completed the driving simulator course were all students, while the six that did not complete the entire course consisted of four students, the observer, and the teacher. Three of the four students that did not complete the driving simulator course commented that they, "would still like a chance to finish the program", because as each of them noted, "it was a good learning experience."

The observer and the teacher did not complete the simulator course from beginning to end. For the most part, they simply participated on the simulator when it was having malfunctions, to troubleshoot, or to try and provide an explanation, or example, if students were having trouble with a particular part of a session.

Table 4

Did you finish the complete driving simulator course?

Response	Frequency (n=12)	Percentage
Yes	6	50%
No	6	50%

Ten out of ten students recommended the driving simulator course for other students that were thinking about potentially wanting to get their drivers' permit or license. Additionally, all students agreed that the driving simulator program provided a good learning experience. One student commented that he recommended the driving simulator course because, "it was a good tool to teach students the rules of the road." Another commented that he recommended the driving simulator for students that have never driven before and do not know what to do; he also added that, "it would have been helpful for me while I was learning to drive because it gives you a feel for driving, the gas, brake, steering, etc." Lastly, another student stated that, "even though I already have my license, the simulator helped to reinforce what I need to know about driving safely." The observer also said he would recommend the driving simulator because, "it provided a safe way to teach students the basics of driving, and there is a lot of good information for teaching students the rules of the road." The teacher recommended the simulator as well; she explained that, "the simulator was a good way to show certain situations specifically as a person was learning; situations that may not always be possible otherwise."

Table 5

Do you recommend the driving simulator course for other students?

Response	**Frequency (n=12)**	**Percentage**
Yes	**12**	**100%**
No	**0**	**0%**

Every participant complained about the simulators malfunctions, and noted that they should be fixed before another group of students use the simulator. The simulator program had at least ten recorded glitches, as well as fifteen incomplete sessions. The students, teacher, and observer claimed that, "the malfunctions added frustration and complexity to finishing sessions, repeating sessions and wasting time only to find that there was a glitch in the system." The observer and one student also claimed that some of the sessions were overly long. The observer also commented that he would change the length of some of the sessions, or have the computer software create locations within sessions in which information could be saved. That way he contended, if a student made a mistake half way through a session, for instance, he/she would not have to repeat the entire sequence. Furthermore, the teacher and one student commented that the graphics and the simulator program overall seemed slightly outdated compared to current available technology.

Table 6

What did you dislike, or what would you change about the driving simulator?

Response	Frequency (n=12)	Percentage
Malfunctions	**12**	**100%**
Graphics	**2**	**16.7%**
Sessions	**2**	**16.7%**
Outdated	**2**	**16.7%**
Nothing	**2**	**16.7%**

Half of the participant's found the simulator to be outdated; outdated as in the quality of the graphics and videos presented throughout the sessions. Those that found the simulator program unrealistic mentioned that it was nothing like driving a real car, the controls (gas, brake, steering wheel, emergency brake) were similar, but it still did not replace the actual experience of driving in a real car on the open road. Furthermore, others mentioned, that the simulator program did not provide the adverse consequences to driving like the real world does. One student mentioned she often had trouble with speeding on the simulator because it was not realistic enough, "you don't feel like you are going faster or slower like in a real car." Moreover, some complained that the images were outdated, there were not enough pedestrians to interact with, and when driving in the country setting there were no animals presented in any parts of the session. The observer and the teacher both found the simulator to be somewhat unrealistic, as well. The observer asserted that the European roads were not realistic when compared to those in America and were many times too narrow. The teacher found the simulator to not be very realistic, but said, "it was good for learning the basic principles of driving." One other student commented similarly by saying, "some parts of the simulator are realistic (looking into the review mirror, the gas pedal, the brake), while other parts are not realistic at all. However, the student asserted, "I believe the simulator more or less was just trying to teach one about driving." Finally, the last student commented that the "Adverse Weather", "Ice Session", was very unrealistic in that the simulator told you to drive at 20 miles per hour, but yet other cars around were whizzing past at rates well over twenty."

Table 7

Do you find the driving simulator realistic enough?

Response	**Frequency (n=12)**	**Percentage**
Yes	**6**	**50.0%**
No	**6**	**50.0%**

The information presented below in Table 8 shows that over half of those that participated on the driving simulator agreed that it would be more effective if it was used in conjunction with a driver's education course. The observer and teacher both agreed that the driving simulator course would be a great asset to a driver's education program. The observer also claimed, "the simulator was realistic enough to be effective if it was to be in conjunction with a driver's education program, where students could get hands-on experience behind the wheel of an actual car." Additionally he commented that, "the driving simulator would be a good addition to a driver's education course due to the fact that basic driving techniques can be practiced on the simulator, as well as students obtaining additional driving time."

Table 8

Do you feel the driving simulator program would be more effective in conjunction with a driver's education course?

Response	**Frequency (n=12)**	**Percentage**
Yes	**9**	**75.0%**
Maybe	**2**	**16.7%**
No	**1**	**8.3%**

When referring to Table 9, one can see that most of the participants experienced dizziness or nausea only some of the time, while most of the others reported no symptoms at all. Throughout the study, the observer recorded only one instance in which a student had to take a break due to dizziness from the simulator. Additionally, both the observer and the teacher noted they had perceived feelings of dizziness and/or nausea every time they used the driving simulator.

Table 9

Did the driving simulator cause symptoms of dizziness or nausea?

Response	**Frequency (n=12)**	**Percentage**
Every time	**3**	**25.0%**
Sometimes	**5**	**41.7%**
No	**4**	**33.3%**

This next section will contain the post-interview questionnaire results from only the students, which indicates how effective of a learning tool they felt the driving simulator to be. The questions focused on whether or not the simulator provided a positive experience, if it increased their confidence, and what areas they believe they still need to work on.

All of the students noted that the driving simulator provided a positive overall learning experience. When asked why the driving simulator was a positive learning tool, students added various responses which included, "it provided a safe environment in which to learn in that seemed to be less stressful than driving on an actual road." Another student added, "it was a positive experience because it gives someone the hands-on experience needed, while also giving those that use it a proper understanding of driving." Lastly, another participant explained, "it makes driving for someone with a disability a little easier, not much though." Others students also mentioned that they liked the option of being able to repeat a session if a mistake was made, as well as being able to watch a replay video to pinpoint exactly what it was that they did wrong.

Table 10

Did you have a positive experience using the driving simulator?

Response	Frequency (n=10)	Percentage
Yes	10	100%
No	0	

Overall, most of the students who participated in the driving simulator program agreed that the driving simulator helped increase their over all confidence in driving. One student commented that the driving simulator increased his confidence because he knew if he made a mistake he could try over again. Another explained that the simulator increased his confidence in driving because he was able to get more driving practice. As a final point, one student explained, "now that I have my license driving on the actual road is really what builds my confidence, not the simulator."

Table 11

Did the driving simulator increase your confidence in driving?

Response	Frequency (n=10)	Percentage
Yes	**8**	**80.0%**
No	**2**	**20.0%**

Table 12 refers to common driving tasks that the students identified as areas they needed to work on, or were not confident in, while using the driving simulator, or if they were to be driving an actual car. Several students mentioned they needed to work on parking, backing up, coming out of a skid, and driving in the snow because they were not covered in the driving simulator program. Interestingly enough, only 30 % of the students commented that speed was an issue; however, this was one of the most noted problem areas by the teacher and the observer. Additionally, many students remarked that they needed to work on remembering to check their blind spots, and to use their blinkers before merging or pulling out of a parking area. These similarly were also some of the most noted mistakes. Lastly, one of the students with a noted anger issue did surprisingly admit this was one area that he needed work on. Two out of the three students admitted they needed to work on paying attention similarly had "needed prompting" written in their observational file. Consequently, there seemed to be somewhat of a relationship between students realizing, or being aware, of the areas they needed to work on and what behaviors were actually being recorded by the teacher and the observer.

Table 12

What areas do you feel you still need to work on?

Response	Frequency (n=10)	Percentage
Paying Attention	3	30.0%
Checking blind spots	4	40.0%
Turning on blinkers	2	20.0%
Driving in adverse weather	5	50.0%
Driving at night	3	30.0%
Driving around other cars/ pedestrians	2	20.0%
Maintaining the speed limit	3	30.0%
Controlling the vehicle	1	10.0%
Parking	3	30.0%
Backing up	1	10.0%
Staying in own lane	2	20.0%
Controlling Anger	1	10.0%

The last section will contain the post-interview questionnaire results from only the observer and the teacher, which covers whether or not they found the simulator to be an informative learning tool, if they felt it increased the students confidence, and what difficulties the students had while using the driving simulator.

Do you feel the driving simulator provided an informative learning tool for the students?

Both the teacher and the observer indicated that the driving simulator program provided an informative learning tool for the students. The observer also added, "the one thing I liked about the simulator was that there was a lot of good information on it, and it also provided a safe way to teach students the basics of driving." In addition, the teacher noted, "the simulator was an informative learning tool because it provided a good basis, or starting point, for students that have had little to no driving experience." Lastly, the teacher indicated that due to the positive perception of the driving simulator thus far by the students, plans have been set forward to incorporate the driving simulator into different sets of programs for individuals with varying disabilities.

Do you feel the simulator helped to increase the student's confidence level in driving?

Both the observer and the teacher indicated that the driving simulator increased the student's confidence and self-esteem, especially as students showed improvement in their driving abilities. Moreover, the observer noted increased confidence in five out of the six students that completed the simulator course. The other of the six had noted overconfidence. The observer stated that, "the student appeared overconfident during some exercises, causing errors in their driving."

Table 13 refers to the observed difficulties students had while using the driving simulator. The most noted observed difficulties that both the observer and the teacher recorded while working with the students was speeding, checking of blind spots, use of blinkers, and multitasking. Multitasking was considered to be any process where the student had to carry out more than one task simultaneously. Some of the multitasking difficulties the observer referred to were the "start/stop" sequence, and properly merging into traffic. Initially, all students had trouble with the "start/stop" procedure (putting seat belt on, ignition on/off, parking brake, and selecting the proper gear), as well as remembering to execute all of the steps before merging (checking of blind spots, turning on blinker, maintaining a proper speed, etc.). Contrasting,

Table 12 and 13 shows that while the observer noted speeding as the number one difficulty among students; the students believed that they still need to work on driving in adverse weather the most. However, both the students and the observer noted "paying attention" was an area of needed improvement, at 30%.

Table 13

What did you observe to be the biggest difficulties the students had while using the driving simulator?

Response	Frequency (n=10)	Percentage
Paying Attention	3	30.0%
Checking blind spots	6	60.0%
Turning on blinkers	6	60.0%
Driving in adverse weather	1	10.0%
Driving at night	2	20.0%
Driving around other cars/ pedestrians	4	40.0%
Maintaining the speed limit	7	70.0%
Controlling the vehicle	4	40.0%
Staying in own lane	4	40.0%
Controlling Anger	3	30.0%
Parking	0	0%
Backing up	0	0%
Multitasking	5	50.0%

The teacher and the observer noted a higher percentage of difficulty areas than the students tended to; parking and backing up were not noted as difficulty areas for the students because they were not included in the driving simulator program.

Summary

The concluding results found that most of the students that participated in the study completed the driving simulator course. The results showed that the sex, age, full-scale, verbal, and performance IQ did not affect the completion rate, however, previous driving experience tended to. Furthermore, various observed strengths and weaknesses did affect the completion rate of some students. Those students that had noted strengths of working independently, correcting their mistakes, following verbal and written instructions, and showing improvement had better completion rates, while those that had difficulty comprehending often needed more prompting, which typically entailed more hours on the driving simulator.

The post-interview questionnaire indicated that 50% of all students completed the driving simulator course. Additionally, the students, the observer, and the teacher recommended the driving simulator for other students; however, the noted malfunctions of the program would first need to be fixed. All students found the simulator to be a positive experience, with 80% of the students expressing increased confidence. Subsequently, both the observer and the teacher found the simulator to be a positive informative teaching tool, and additionally commented that the simulator increased student's overall confidence. Interestingly enough, half of the participants found the simulator to be realistic enough, while the other half complained it was not. Furthermore, 75% of those that participated agreed that the simulator would be a great asset to a driver's education program; however, it was shown to cause symptoms of dizziness and nausea in some individuals.

Finally, 50% of the students admitted that one of the areas they still needed to work on was driving in adverse weather conditions, while the observer and teacher felt the areas with the most needed improvement was maintaining a proper speed while driving, as well as multitasking. The next chapter will provide the summary of the study, conclusions found, and any noted recommendations.

Chapter V: Summary, Conclusions, and Recommendations

This study measured the effectiveness of the fixed-base driving simulator as a learning tool for young adults with autism spectrum disorder and cognitive disabilities. The study focused on determining the disabilities of individual students, and determining how these disabilities may have affected their learning and perception of the fixed-based driving simulator located in the Vocational Rehabilitation Center at UW-Stout. This chapter will provide a summary of the entire study, a synopsis of major findings, conclusions drawn from the findings, recommendations based on the conclusions, and recommendations for further study.

Statement of the Problem

No assessments have been done to evaluate the effectiveness of the fixed-base driving simulator as a learning tool for young adults with autism spectrum disorder or other cognitive disabilities.

Methods and Procedures

Students from the Transitional Partnership School were asked if they would like to partake in a study using a fixed-base driving simulator located in the Vocational Rehabilitation Center at UW-Stout. Eleven students came forward to participate in the study. Most of the students started the study in October 2009 and finished in February of 2010. The students that were willing to participate signed a consent form to partake in the study, as well as to allow access to medical records. Students DSM-IV records were accessed along with the Wechsler Abbreviated Scale of Intelligence (1999) for full-scale, verbal, and performance IQ levels. This was done to assess each student's disability, and how the disability may have affected their performance on the simulator, as well as their perception of it.

Before the students started the study, they were given a pre-interview questionnaire which assessed the students previous driving and simulator experience, as well as any misconceptions, disabilities, or uncertainties that students may have revealed which might have prevented them from completing the full course of the driving simulator program. The students signed up for hour blocks of time on the driving simulator. While on the driving simulator the students were observed by an observer or teacher. Notes were taken throughout the time period, and were based on the students' progression throughout the course, as well as learning and behavioral reactions while using the simulator. At the conclusion of the study, the students, the observer, and the teacher were given a post-interview questionnaire to assess the overall effectiveness of the driving simulator as an informative learning tool.

The focus of the study was to determine:

1. The disabilities of each student and how these disabilities may have affected their overall learning on the driving simulator program.
2. The strengths and weaknesses of each student, and assess how the weaknesses may have affected the safety of their driving.
3. The completion rate of each student throughout the course, as well as the contributing factors that may have helped or hindered the students from finishing the driving simulator program.
4. How each student evaluated the use of the simulator as a learning tool to prepare them for their driver's or permit exam.
5. How the observer and the teacher felt about the driving simulation program, and if it was a good assessment/learning tool for their students.

Major Findings

The major findings of the study are based on the five objectives listed above. Finding are based on the students Wechsler Abbreviated Scale of Intelligence (1999), DSM-IV records, observational notes taken by the observer and the teacher, as well as logging information provided by the driving simulator, and the pre and post-interview questionnaire.

1. Determine the disabilities of each student and how these disabilities may have affected their overall learning on the driving simulator program.

    When the cognitive disabilities of each individual student was examined it was found that the Wechsler Abbreviated Scale of Intelligence (1999) was not a determining factor of completion rate, or hours spent progressing through the driving simulator course.

    The DSM-IV records indicated that the cognitive disability of each individual varied slightly, there was no significant difference in completion rate, or hours spent on the simulator from one disability to another, considering more than half of the students had the same disability. However, it is important to note that even though more than half of the individuals participating in the study had the same disability, indicated by the DSM-IV, they did not have the same exact learning abilities. When comparing those with disabilities, differentiation can be seen between each individual by comparing a persons full-scale, verbal, and performance IQ's.

2. Determine the strengths and weaknesses of each student, and assess how the weaknesses may have affected the safety of their driving.

- The strengths and weaknesses of each student were found by the observer and teacher taking observational notes during each session that the student was on the driving simulator. It was found that the most common strengths that correlated with completion rate of the student were: working independently, correction of mistakes, following verbal and written instructions, and showing improvement.
- The most common weakness recorded was retention difficulties, which occurred in all students. Students that had more hours into completing the simulator course all had common weaknesses of needing prompting.
- The observed behaviors that may be of a safety concern while driving, was the noted occurrence of being easily angered and excessive speeding.

3. Determine the completion rate of each student throughout the course, as well as the contributing factors that may have helped or hindered the students from finishing the driving simulator program.
   - There seemed to be a relationship between completion rate and those students who had had previous driving experience.
   - The Wechsler Abbreviated Intelligence Scale (1999) had no influence when considering completion rates.
   - Contributing factors that may have helped some students to progress through the driving simulator at a quicker pace could have been a combination of several factors such as previous driving experience, the use of the driving simulator, and/or the attendance of a driving school.

Factors that may have hindered some students from completing the driving simulator course could have included: time limitations on the driving simulator, lack of previous driving experience, and differences in learning abilities between individuals.

4. Determine how each student evaluated the use of the simulator as a learning tool to prepare them for their driver's or permit exam.

- Sixty percent of the participating students completed the driving simulator course.
- All students found the simulator to be a positive experience, with 80% of the students expressing increased confidence.
- Every student that participated in the study recommended the driving simulator as positive learning tool, whether they completed the entire course or not.
- More than half of the participating students agreed that the driving simulator course should be incorporated into a driver's education program because it was an informative learning tool.

5. Determine how the observer and teacher felt about the driving simulation program, and if it was a good assessment/learning tool for their students.

- Both the observer and the teacher recommended the driving simulator as a positive informative learning tool for students, as well as a good assessment tool for determining driving abilities.
- Both the observer and the teacher noted increased confidence in the students that showed improvement throughout the driving simulator program.

The most noted difficulty areas the observer and teacher noticed were excessive speeding and trouble multitasking.

Conclusions

The conclusions of the study found that the Wechsler Abbreviated Intelligence Scale (1999), and the DSM-IV diagnoses were not a determining factor of whether or not a student completed the driving simulator course. Additionally, it is remarkable that one of the students with the lowest full-scale IQ was actually one of the students with the lowest amount of hours on the simulator, and also one of the students that received his drivers' license while participating in the driving simulator study.

Six out of the ten participating students completed the driving simulator course. One of the determining factors that seemed to influence a student's progression or completion through the course was previous driving experience; four of the ten students that completed the simulator course had previous driving experience. Furthermore, two of the ten students that partook in the study and had gone on to receive their licenses had had previous driving experience, were currently participating in driver's education classes, as well as, participating on the driving simulator. Also, two of the six that completed the entire driving simulator course and had received their permits while participating in the study had had previous driving experience as well.

Another determining factor that seemed to show a positive relationship with completion rate was the possession of four observed strengths which included working independently, correction of mistakes, following written and verbal instructions, and showing improvement. Students that failed to correct their mistakes did not complete the driving simulator course; this, however, excludes the two students that were not given the full opportunity to finish the driving simulator program.

Overall, the driving simulator was perceived as an informative learning tool that did help most students to increase their confidence and driving skills. However, 50% of those that used it said that it was not as realistic as driving on the actual road, which is maybe why 75% of the participants indicated that the driving simulator would be more effective if incorporated into a driver's education course.

In conclusion, the most noted difficulties that the students had while using the driving simulator was speeding, and performing multitasking functions. All students had trouble initially with the "start/stop" procedure introduced in the beginning of the course, as well as the multi-step process of merging. Moreover, the students had difficulty with the simulator program because it had over ten noted glitches, as well as incomplete sessions throughout.

Recommendations

When comparing the disabilities of each student a more comprehensive scale of intelligence testing should be used, not just the Wechsler Abbreviated Intelligence Scale (1999). Also, determining the students' disabilities from just the DSM-IV is not comprehensive enough to compare students' progression throughout the simulator course. Other criteria's within the DSM-IV should be utilized for differentiating students' abilities, or disabilities.

Additionally, if this study were to be performed over again, there should be training provided for both the teacher and observer so that the effects of interrater reliability are taken into consideration while observing and noting students behavior and reactions. Also, the sample size, and the differences in disabilities and driving experience did not provide for a constant control group. There was quite a bit of variability between driving experience, levels of cognitive ability (IQ), and disabilities.

Recommendations for increasing the effectiveness of the driving simulator as learning tool include, updating the current program to the newest version. This would get rid of the problems associated with the current program which included it being outdated, full of malfunctions and glitches, and having incomplete sessions. Other recommendations may include, once the program is updated, marketing the simulator as an "add-on" to the current driver's education program at Menomonie High School, which would give the students the option of paying a little extra to take the full simulator course in conjunction with the driver's education class offered. Additionally, this fee for service would have the possibility of generating an extra profit for the Vocational Rehabilitation Center.

Areas of further study

Areas for further study could include the use of the driving simulator in conjunction with a driver's education program that incorporates a larger sample group of individuals with varying disabilities. It would be interesting to take individuals with varying levels of autistic spectrum disorder and assess how well they do with the driving simulator, as well as the driving simulator course in conjunction with a drivers' education program.

Additionally, researching students with varying levels of cognitive disabilities could also be done to assess their progress on the driving simulator, as well as the driving simulator in combination with a drivers' education course. This research could be important to helping those with learning disabilities by identifying the needs of these individuals, and the modifications necessary to make driving simulators and/or driver's education programs more suited for persons with particular learning styles and disability requirements.

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Appendix A: Picture of *Simulator Systems International* S-2100/S-2300 driving simulator

Owners Manual

S-2100/2300
Fully-Interactive Driving Simulator

Simulator Systems International
11130 E. 56th St.
Tulsa, OK 74146
Toll Free: 800-843-4764
Local: 918-250-4500
Fax: 918-250-4502

S S I

Appendix B: *Simulator Systems International* S-2100/S-2300 Curriculum

Getting Started	Notes	Did Not Complete	Completed with Assistance	Completed
1.Start Evaluation				
2. How to use the simulator				
1. Tool Box				
2. Icons				
3. Getting ready for the simulator				
1. Seat				
2. Mirrors				
3. Seatbelt				
4. Entering/Exiting				
5. Chapter Test				
4. Learning dashboard controls				
1. Ignition				
2. Instrument panel				
3. Lights				
4.Wipers				
5. Hazard lights				
6. Chapter Test				
5. Using hand/foot controls				
1. Pedals				
2. Gear Selector				
3. Handbrake				
4. Chapter Test				
6. Starting the engine				
1. Test				
2. Before starting the engine				
3. Starting the engine (gasoline)				

4. Starting the engine (dissel)				
5. Chapter Test				
7. Moving off				
1. Test				
2. Level surface				
3. Advanced training				
4. Uphill				
5. Downhill				
6. Chapter Test				
8. Master steering				
1. Test				
2. Steering Trail				
3.Slalom				
4. Circular course				
5. Winding course				
6. Chapter Test				
9. Mastering shifting gears				
1. Test				
2. Learning the basics				
3. Down shifting				
4. Advanced Training				
5. Perfecting				
6. Chapter Test				
10. Maneuving at slow speed				
1. Test				
2. Approaching				
3. Pulling out				
4. Maneuving				
5. Chapter Test				
11. Accelerating, breaking and stopping				
1. Test				
2. Mastering acceleration				
3. Braking with precision				
4. Chapter Test				
Basic Training				
1. Chapter Lessons				

1. Controlling your vehicle				
2. Turning and parking maneuvers				
3. IPDE- Hazord Identifaction				
2. Driving Exercises				
1. Entering the Road				
1. Leaving your parking space				
2. Merging using an acceleration lane				
3.Chapter Test				
2. Exiting the Road				
1. To pull over				
2. Practice using an exit ramp				
3. Chapeter Test				
3. Negotiating Narrow Lanes				
1. Narrow lanes				
2. Lanes narrowed by obstacles				
3. Lanes obstructed by poor visibility				
4. Chapter Test				
4. Negotiating Intersections				
1. Stopping				
2. Yielding				
3. Right of way				
4. Chapter Test				
5. Turning at Intersections				
1. Turning right				
2. Turning left				
3. Chapter Test				
Intermediate Training				
1. Chapter Lessons				
1. Negotiating intersections				
2. City streets				
3. Expressways				
4. Two-lane and Rural roads				
5. Distractions while driving				
2. Driving Exercises				
1. Merging into Traffic				

1. Leaving your parking space				
2. Practice using an on-ramp				
3. Chapter test				
2. Exiting Traffic				
1. Pulling over				
2. Using an exit ramp				
3. Chapter test				
3. Oncoming Traffic				
1. Oncoming traffic				
2. Chapter test				
4. Being Passed				
1. Being passed				
2. Chapter test				
5. Following Vehicles				
a. Following				
b. Chapter test				
6. Negotiating Intersections				
1. Intersections				
2. Chapter test				
7. Flowing with Traffic				
a. Flowing with traffic				
b. Chapter test				
8. Changing Directions				
1. Turning right, turning left				
2. Intersections and traffic circles				
3. Chapter test				
9. Passing Other Vehicles				
1. Learning the basics				
2. Perfecting				
3. Chapter test				
Advanced Training				
1. Chapter Lessons				
1. Dealing with Emergencies				

2. Handling Roadway Hazards				
3. Identifying and Avoiding Conflicts				
4. Avoiding Collisions				
5. Be on Alert 1 – Urban Congestion				
6. Be on Alert 2 – Adverse Weather				
Conditions				
7. Out of Control				
2. Driving Exercises				
1. Adverse Weather Conditions				
1. Fog				
2. Rain				
3. Night				
4. Ice				
2. Risky Situations				
1. 1				
2. 2				
3. 3				
4. 4				
5. 5				
6. 6				
7. 7				
8. 8				
9. 9				
3. Performance Tests				
1. reaction time				
4. Driving While Impaired				
1. How your driving is affected by				
drugs and alcohol				
5. Maintaining Your Vehicle				
1. Tire maintenance				
2. Brakes				
3. Engine				
4. Electrical components				
5. Summary				
6. Practice Driving				
6. City				

Other				
1. Free Driving				
1. City				
2. City (traffic)				
3. Expressway				
4. Expressway (traffic)				
5. Mountain				
6. Mountain (traffic)				

Appendix C: Pre and Post Interview Questionnaire

This research has been approved by the UW-Stout IRB as required by the Code of Federal Regulations Title 45 Part 46.

Methods of the research project:
I: Pre-Questionnaire Interview about driving experience
Questions included:

1. What experience do you have driving, if any?
2. What are some difficulties you may need to overcome while learning to use the simulator?
3. What are your overall strengths and weaknesses?
4. How much time will your parent or guardian have to spend with you if you get your permit?
5. If you passed your drivers license exam in the future where would you plan on driving?
6. Have you ever used a driving simulator? If so, where and how many hours did you spend on it?

II. Each student will be given the chance to learn how the driver simulator works during an orientation session.

III: Each student will go through varying levels of driving sessions to assess how well they do. The first level will start out easy; each level will progressively get harder, with varying distractions being added to see how well the student's reaction time is. The main test will look at how well does the student does in stressful driving situations, such as city driving, or situations where reaction time is important.

Attached is a PDF of what "Simulation Systems International" offers in their interactive driver simulator curriculum, along with a picture of the simulator, also attached is a print out of how the students progress will be recorded.

IV: The student's progress will be saved on the driving simulator program to track their improvement. Additionally, an observer or teacher will sit in with the student so they will be able to assess the student's difficulties and also be of assistance for questions.

V: Post-Questionnaire Interview
Concluding the end of the driving simulation course, the student, observer, and teacher will be asked to partake in an interview to assess how significant the driving simulator was as a learning tool. Questions include:

Questions for the students:

1. Did you have a positive experience using the driving simulator? Why or why not?
2. Did you finish the complete driving simulator course? If not, why did you decide not to complete it?
3. Do you recommend the driving simulator course for other students?
4. What did you like most about the driving simulator program?
5. What did you dislike most about the driving simulator program?
6. How did the driving simulator program increase your confidence with driving skills?
7. How did the simulator help you overcome the previous difficulties you listed in the pre-questionnaire?
8. What areas do you feel you still need to work on?
9. Do you feel you are more prepared now to attempt driving with a drivers permit with a parent or guardian?
10. Did you improve on your weaknesses/strengths listed in your pre-questionnaire?
11. What would you change about the driver simulation course?
12. Did the driving simulator cause symptoms of dizziness at all while driving?
13. How realistic do you find the driving simulator to be?
14. For those few students that have their license, describe if the driving stimulator program would have been helpful to you previous to learning how to drive.

Questions for the observers/teachers:

1. Do you feel the driving simulator provides an informative learning tool for the students? Please explain why or why not.

2. Do you feel the simulator helps to increase the student's confidence level in driving?

3. What did you observe to be the biggest difficulties the students had with the driving simulator?

4. Would you recommend the driving stimulator to other students as a positive learning tool?

5. What would you change about the driving simulator to improve it as an overall learning tool?

6. Do you find the driving simulator realistic enough to market it as a learning tool to prepare a student for on the road driving?

For the observer/teacher that participated in the driving simulation program:

1. How far did you get in the driving simulation program? Did you complete all levels of instruction?

2. What do like and dislike about the driving simulation program overall?

3. Did the driving simulator cause symptoms of dizziness at all while driving?
4. Do you think the driving simulator program would have been beneficial to you as part of your driver's education experience?