Integration Of Computer-based Virtual Check Ride System - Pre-trip Inspection In Commercial Driver License Training Program

2009

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INTEGRATION OF COMPUTER-BASED VIRTUAL CHECK RIDE SYSTEM –
PRE-TRIP INSPECTION IN COMMERCIAL DRIVER LICENSE TRAINING
PROGRAM

by

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B.E. Maharaja Sayajirao University of Baroda, 2002
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A dissertation submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy in Modeling and Simulation
in the College of Engineering and Computer Science
at the University of Central Florida
Orlando, Florida

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2009

Major Professor: J. Peter Kincaid
ABSTRACT

Pre-Trip Inspection of the truck and trailer is one of the components of the current Commercial Driver’s License (CDL) test. This part of the CDL test checks the ability of the student to identify the important parts of the commercial vehicle and their potential defects. The Virtual Check Ride System (VCRS), a computer-based application, is an assessment and feedback tool that mirrors the inspection component of the actual CDL. The VCRS has provided an after action review (AAR) via a feedback session that helps in identifying and correcting drivers’ skill in inspecting parts and for overall safety. The purpose of this research is to determine the effectiveness of the VCRS in truck driving training programs. An experimental study was conducted with truck driving students at Mid Florida Tech, located in Orlando, Florida. The students were divided into control and experimental groups. Students in the both groups received regular training provided by Mid Florida Tech. The experimental group received additional training by making use of the VCRS. A total of three paper-based tests were given to all subjects during first three weeks; one test at the end of a week. Both groups were given the same paper-based tests. A two-way analysis of variance was conducted to evaluate the effect of the VCRS in the experimental group. This analysis found a significant difference between control and experimental groups. This effect showed that the students in the experimental group increased their performance by using VCRS. Moreover, there was a main effect in the scores of each week. However, there was not an interaction between the two factors. Follow up Post Hoc tests were conducted to evaluate the pair-wise differences among the means of the test week factors using a Tukey HSD test. These Post Hoc comparisons indicated that the mean score for the third week’s test scores were significantly better than the first week’s test score in the experimental group.
was concluded that the VCRS facilitated learning for the experimental group and that learning also occurred for both groups as a result of repeated testing.
I dedicate my dissertation to my mother, Jasumati Makwana; father, Purshottam Makwana; aunt Kusumben (Dhirajben) Makwana; uncle Manubhai Makwana; and to all my family members who were instrumental and supportive while I achieved my academic goals. I wish to thank all those people who kept me in their prayers, showered me their blessings and their kindness. I also wish to thank my academic advisor, Dr. Peter Kincaid, for his advice, guidance, and support during my years of graduate study.
ACKNOWLEDGMENTS

I would like to thank Dr. Thomas Clarke, Dr. Lori Walters, and Dr. Oscar Martinez, who as my committee members gave me significant and valued guidance on my research. I wish to thank my supervisor, Ronald Tarr, for his support and guidance. I would also like to thank Carol Jones for her help on edits. I wish to thank the instructors at Mid Florida Tech: Derren Oaks; Tesro Price; Tom Witt, Dale Cowart, Keith Pence, and Jack LaRocca for conducting subject testing and using their classroom and lab facility. I would also like to thank all my friends, colleagues, and roommates for their kindness.
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<th>Acronym</th>
<th>Description</th>
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<td>AAR</td>
<td>After Action Review</td>
</tr>
<tr>
<td>CBA</td>
<td>Computer Based Assessment</td>
</tr>
<tr>
<td>CBI</td>
<td>Computer Based Instructions</td>
</tr>
<tr>
<td>CBT</td>
<td>Computer Based Training</td>
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<td>CDL</td>
<td>Commercial Drivers License</td>
</tr>
<tr>
<td>CMV</td>
<td>Commercial Motor Vehicle</td>
</tr>
<tr>
<td>CTBSSP</td>
<td>Commercial Truck and Bus Safety Synthesis Program</td>
</tr>
<tr>
<td>DCQ</td>
<td>Driver Coping Questionnaire</td>
</tr>
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<td>Department of Defense</td>
</tr>
<tr>
<td>DTDA</td>
<td>Driver Training and Development Alliance</td>
</tr>
<tr>
<td>FHA</td>
<td>Federal Highway Administration</td>
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<tr>
<td>FLHSMV</td>
<td>Florida Department of Highway Safety and Motor Vehicles</td>
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<tr>
<td>FMCSA</td>
<td>Federal Motor Carrier Safety Administration</td>
</tr>
<tr>
<td>IRB</td>
<td>Institutional Review Board</td>
</tr>
<tr>
<td>ISD</td>
<td>Instructional System Design</td>
</tr>
<tr>
<td>IST</td>
<td>Institute for Simulation and Training</td>
</tr>
<tr>
<td>MFT</td>
<td>Mid Florida Tech</td>
</tr>
<tr>
<td>PTDI</td>
<td>Professional Truck Driving Institute</td>
</tr>
<tr>
<td>TRB</td>
<td>Transportation Research Board</td>
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<td>UCF</td>
<td>University of Central Florida</td>
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<td>VCRS</td>
<td>Virtual Check Ride System</td>
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CHAPTER 1: INTRODUCTION

In 2000, large trucks accounted for 13% of fatal vehicle crashes (Federal Highway Administration, 2002). The damage that occurs with accidents involving large trucks is a major factor in the initiation of a variety of training programs. These training programs are offered to improve the knowledge and skills of Commercial Motor Vehicle (CMV) drivers. There are three primary sources that provide training programs: private schools, community and public colleges, and the commercial motor vehicle carriers themselves. Almost all commercial truck driver schools currently use conventional training, which consists of classroom instruction, off-road skills training, and on-road instructions.

The Commercial Drivers License (CDL) development was conducted in accordance with the Commercial Vehicle Safety Act of 1986 and the Federal rule by designing CDL testing system. The CDL license is federally mandated and this license is required to drive commercial vehicles throughout the United States. A comprehensive literature review of this sponsored research provided insight relating to the safety of commercial vehicle training practices including measurement of training effectiveness. Knipling, Hickman, and Bergoffen (2003) concluded that “the level of driving proficiency and knowledge required to earn a commercial drivers license (CDL) is widely required to be a safe and reliable in a full-time operational setting.”

The Commercial Truck and Bus Safety Synthesis Program (CTBSSP) was established by the Federal Motor Carrier Safety Administration (FMCSA) to carry out a study on current practices and areas of concern for bus and truck training programs. In Synthesis 5 (Staplin, Lococo, Decina, & Bergoffen, 2004,) a meta-analytical report from CTBSSP on Commercial Motor Vehicle (CMV) driver training tools and techniques for improving safety of CMV
concluded that computer-based technologies can improve the effectiveness of commercial driver training programs. Multimedia-based instructional material can be used in place of traditional classroom activities that rely on printed material and field trips.

A combination of classroom lectures and supervised driving is widely accepted as a sound method for training truck drivers. Those training organizations that used sophisticated technologies, such as simulation and CBI, however, typically improved student performance beyond the level provided by traditional training. Most training organizations use CDL test passing rate as the primary measure of training effectiveness. The training organization is considered successful if more than 70% of students pass the CDL test. The survey results of CTBSSP (Brock, McFann, Inderbitzen, & Bergoffen, 2007), Synthesis 13, also found that some organizations measured processes (time spent behind the wheel, classroom hours) for determining training effectiveness.

To integrate computer-based training into conventional training the curriculum of the Class-A truck driving training program at Mid Florida Tech (MFT) was examined. This training program teaches and trains students seeking the CDL. Classroom activities are used to teach truck and driving related concepts; psychomotor skills are taught by driving actual Class-A vehicles (Appendix J). This training method is essential and necessary. However, augmenting conventional training with computer-based training can improve the effectiveness effects of the overall training program (Brock 1997, 1998; Evans & Gibson, 2007). The review of literature for this dissertation highlights the various characteristics of computer-based instruction that are essential and can be used in commercial driver license training. The key requirements and guidelines for CBI, according to CTBSSP, for the Class-A driver license training is studied; the e-learning tool used for this study is explained in detail in the Chapter three and Appendix I.
This research study has investigated an e-learning tool, the Virtual Check-Ride System (VCRS) that can be used for training and evaluation of specific performance outcomes. The VCRS consists of CDL questions on general knowledge, air brakes, and combination vehicles. The VCRS can be used to teach and train the knowledge and skills associated with the CDL test. The virtual inspection simulates the actual walk-around inspection. The functionality of this system guides the driver in learning various parts of the truck/trailer, identifying important inspection points, and determining the overall condition of the truck/trailer for a safe ride.

1.1. Purpose of study

The purpose of this study is to determine the effectiveness of computer based diagnostic, remedy, and feedback tool on learning in the context of a commercial driver’s license training. To fulfill this purpose, the effects of the Virtual Pre-trip Inspection, a part of the Virtual Check Ride System, was investigated with students from (MFT) as subjects.

1.2. Research Questions

1. What are the performance effects of the VCRS on the CDL truck driving training students at MFT?

2. Does training occur with repeated use of the VCRS?
1.3. **Research Hypothesis**

1.3.1. **Hypothesis 1:**

Null Hypothesis H0: There will be no significant difference between the scores of truck drivers’ performance in the experimental group, who make use of VCRS, versus the control group, who do not use VCRS.

Alternate Hypothesis HA: There will be a significant difference between the scores of truck drivers’ performance in the experimental group, who make use of VCRS, versus the control group, who do not use VCRS. Scores of subjects receiving the experimental treatment are expected to be higher.

1.3.2. **Hypothesis 2:**

Null Hypothesis H0: There will be no significant difference between truck drivers’ performance in the experimental group’s test-1 and test-3 scores that make use of VCRS, versus the control group that do not use VCRS.

Null Hypothesis HA: There will be a significant difference between truck drivers’ performance in the experimental group’s test-1 and test-3 scores that make use of VCRS, versus the control group that do not use VCRS. Scores of subjects receiving the experimental treatment are expected to be higher.
1.4. **Research Design**

The experimental design reflects two factors: Groups - control and experimental groups; and Tests- three tests were given over a period of four weeks. The Experimental group received conventional driver training and training using the VCRS; whereas, the control group only received conventional driver training. The research design, test questionnaire, informed consent, and evaluation material used by the subjects were approved by the Institutional Review Board (IRB) at the University of Central Florida. More detailed information on research design is given in Chapter four.

1.5. **Significance of Study**

The results of this study investigated the effectiveness of the Virtual Inspection in learning and training CDL truck drivers. This study can be helpful to a) Information specialists b) Instructional designers c) Interactive tool builders, d) Simulation Engineer, and the like. The analysis of this study provides a comprehensive description of the two training environments: using and not using the VCRS. We have fully documented the settings of this training environment and size of the subject sample to make the results of this study applicable to other similar settings.

1.6. **Operational Definitions**

Simulation, refers to a collection of hardware and software systems which are used to imitate the actions of some entity or phenomenon.
Simulation-based training, refers to the type of education in which someone learns by using or participating in a simulated environment. Simulated environment can be constructed using computer, head mounted display, physical models, virtual models, and/or simulators.

Computer-based training, refers to the type of education in which someone learns by executing specific application software on a computer.

Computer experience, refers to the research participants’ skills and abilities in working with computer by using keyboard and mouse.

E-learning, refers to learning conducted in the electronic medium, particularly via internet.

CDL Class-A training, refers to truck driving program that teach operating and safety procedures of cargo and truck, as well as train driving of tractor trailer or a straight truck.

Virtual Check Ride System, refers to a computer-based application that includes inspection and identification of parts for Class-A and Class-B vehicle.

Pre-trip inspection, refers to procedure of inspecting truck-parts to determine if a truck is driving condition.

Virtual Pre-trip inspection, refers to computer-based application having assessment and feedback tool that mirrors the Pre-trip inspection component of the actual CDL.

Independent Variable (IV), refers to the variable that predicts the response.

Dependent Variable (DV), refers to the variable being predicted by independent variable(s) or a response variable.

Internet (World Wide Web), refers to the worldwide network of computers to facilitate exchange of information.
Instruction, refers to the structured activities that aim in describing how task is to be done.

Training, refers to the structured learning experiences provided to build up new skills and knowledge to be use on the job (Broad, 2005).

Commercial Drivers License, refers to a driving permit required to operate any type of vehicle with a gross vehicle weight rating (GVWR) of 26,001 lb (11,793 kg) or over for commercial use, including (but not limited to) tow trucks, tractor trailers and buses. These vehicles are designed to transport 16 or more people including the operator, or transporting hazardous materials (Wikipedia).

Commercial Motor Vehicle, refers to a vehicle with a net weight of 26,001 or more pounds. This vehicle is designed to sixteen or more passengers, including the driver (FLHSMV).

Crash, refers to “an event that produces injury and/or property damage, involves a motor vehicle in transport, and occurs on a traffic way or while the vehicle is still in motion after running off the traffic way” (FARS).

Fatal Crash, refers to “an event that produces injury and/or property damage, involves a motor vehicle in transport, and occurs on a traffic way or while the vehicle is still in motion after running off the traffic way” (FARS).

Virtual Pre-trip inspection, refers to a process of inspecting and identifying various components of the trucks on a computer-based application.
1.7. Assumptions

- The research participants responded to the survey honestly; and the participants’ responses were based on their own beliefs and knowledge and not influenced by the work context or social pressures.
- The validity and reliability of the questionnaire items was tenable to allow for accurate results.
- The research participants answered the questionnaire without the interference, influence and/or help of other individuals.

1.8. Organization of Proposal

This dissertation is organized into six chapters. This first chapter introduces the study by providing a description of the study, research hypothesis, research design, significance of this study, definitions, and assumptions made in this study. Chapter two provides statistical information on road accidents, particularly involving large trucks. Chapter three presents the literature-based background from the field of computer based instruction, commercial driver license training, significance of images in learning, description of VCRS, and vehicle control skills. Chapter four describes the methodology of the study and includes information about participants, research design, treatment, instruments, and procedures used for data gathering and analysis. Chapter five presents descriptive statistics, statistical evaluations and evaluation of the e-learning tool. Final chapter, Chapter six, discusses results, implication of results, limitations and future research suggested by this study.
CHAPTER 2: LARGE TRUCK - CRASH RELATED STATISTICS

This chapter provides detailed information including statistics on crashes that involves large trucks. There are various factors that may cause fatal accidents that lead to casualties and destruction of mass properties. The purpose of this statistical information is to provide a comprehensive overview on the number of accidents involving cars, small trucks, and large trucks, highlighting accidents which involve trucks.

![Figure 1: Fatalities per Annum, Fatality Analysis Reporting System, 2000 to 2007](image-url)
Referring to Figure 1: In the year 2007, 41,059 people were killed due to road accidents; in 2005 it was 43,510; 42,708 in 2006 and 41,059 in 2007. This is a substantial decrease in number of fatalities from 2005 through 2007.

Figure 2 shows the number of people killed in accidents that involved passenger cars, light trucks, and large trucks. The number of people killed in passenger cars is significantly larger as compared to number of people killed in light and large trucks, reflecting the fact that there are more cars on the road than trucks. Figures 1 and 2 show a trend toward safer driving from 2000-2007, taking into account all three types of vehicles. Figure 2 shows that this increase in safety (as measured by fatalities) was due mostly from a decrease in fatalities involving passenger cars. Fatalities involving trucks, both light and heavy, showed a relatively flat trend for the same period.
Figure 3: Accident rate per 100 million vehicle miles traveled, Fatality Analysis Reporting System, 2000 to 2007
As shown in Figure 3, trucks, both light and large, were involved in a greater number of crashes per 100,000 registered vehicles as compared with passenger cars. The rate of accidents for all types of vehicles has shown a steady decline throughout the reporting period (2000 – 2007).

To summarize, as measured by fatalities caused by crashes, large trucks have shown a relatively flat trend in recent years, while the number of crashed per 100,000 miles involving large trucks has steadily decreased over the same period. This apparent inconsistency is explained by the increasing number of miles per year which large trucks have been driven. Both crashes and fatalities involving large trucks remain a substantial problem on America’s highways.
Figure 4: Percentage of vehicle involved in crash per 100,000 registered vehicles, Fatality Analysis Reporting System, 2000 to 2007
Figure 4 shows the percent of vehicles - passenger cars, light trucks, and heavy trucks involved in crashes from 2000-2007. All of these types of vehicles showed a steady decrease in crashes indicating a trend towards safer driving for all of these types of vehicles.

The Table 1 shows the number of crashes due to the failure of part(s) in large trucks. The majority of these accidents were due to the failure of tires and braking systems. The information in this table does not necessarily relate to failure in conducting inspection; however, it seems logical that proper diagnosis of an entire vehicle and its components should reduce the number of accidents caused by failure of parts.
# Table 1: Number of Crashes by Vehicle’s Parts Failure, Fatality Analysis Reporting System, 2000 to 2008

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<td>Tires</td>
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<td>Steering System -- tie rod, kingpin, ball joint, etc.</td>
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<td>18</td>
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<td>Suspension, Springs, shock absorbers, MacPherson struts, axle bearing, control arms, etc.</td>
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<td>4</td>
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<td>1</td>
<td>5</td>
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<td>6</td>
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<tr>
<td>Body, Doors, Hood, Other</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>10</td>
<td>10</td>
<td>12</td>
<td>10</td>
<td>18</td>
<td>7</td>
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<tr>
<td>Trailer Hitch</td>
<td>3</td>
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<td>14</td>
<td>11</td>
<td>14</td>
<td>19</td>
<td>20</td>
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<td>14</td>
<td>9</td>
<td>14</td>
<td>12</td>
<td>14</td>
<td>12</td>
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<tr>
<td>Air Bags</td>
<td>5</td>
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<td>22</td>
<td>1</td>
<td>28</td>
<td>27</td>
<td>21</td>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>Other Vehicles Defects</td>
<td>39</td>
<td>48</td>
<td>38</td>
<td>46</td>
<td>62</td>
<td>47</td>
<td>54</td>
<td>73</td>
<td>82</td>
</tr>
<tr>
<td>Safety Belts</td>
<td>6</td>
<td>5</td>
<td>7</td>
<td>3</td>
<td>19</td>
<td>20</td>
<td>12</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td>771</td>
<td>879</td>
<td>931</td>
<td>912</td>
<td>1011</td>
<td>1034</td>
<td>942</td>
<td>1022</td>
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</table>
# Table 2: Number of Persons Affected by Vehicle Related Factors, Fatality Analysis Reporting System, 2000 to 2008

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
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<th></th>
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<tbody>
<tr>
<td>Tires</td>
<td>1245</td>
<td>1321</td>
<td>1506</td>
<td>1428</td>
<td>1293</td>
<td>1501</td>
<td>1170</td>
<td>1352</td>
<td>1476</td>
</tr>
<tr>
<td>Brake System</td>
<td>167</td>
<td>186</td>
<td>203</td>
<td>241</td>
<td>302</td>
<td>252</td>
<td>274</td>
<td>338</td>
<td>362</td>
</tr>
<tr>
<td>Steering System - tie rod, kingpin, ball joint, etc.</td>
<td>37</td>
<td>36</td>
<td>32</td>
<td>28</td>
<td>30</td>
<td>42</td>
<td>52</td>
<td>36</td>
<td>55</td>
</tr>
<tr>
<td>Suspension - Springs, shock absorbers, MacPherson struts, axle bearing, control arms, etc.</td>
<td>24</td>
<td>21</td>
<td>20</td>
<td>30</td>
<td>12</td>
<td>25</td>
<td>27</td>
<td>17</td>
<td>66</td>
</tr>
<tr>
<td>Power Train/Engine</td>
<td>25</td>
<td>28</td>
<td>58</td>
<td>42</td>
<td>36</td>
<td>44</td>
<td>43</td>
<td>52</td>
<td>37</td>
</tr>
<tr>
<td>Exhaust System</td>
<td>2</td>
<td>2</td>
<td>6</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Headlights</td>
<td>24</td>
<td>25</td>
<td>34</td>
<td>45</td>
<td>51</td>
<td>50</td>
<td>40</td>
<td>60</td>
<td>69</td>
</tr>
<tr>
<td>Signal Lights</td>
<td>4</td>
<td>12</td>
<td>14</td>
<td>6</td>
<td>12</td>
<td>5</td>
<td>15</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>Other Lights</td>
<td>20</td>
<td>15</td>
<td>26</td>
<td>32</td>
<td>19</td>
<td>34</td>
<td>39</td>
<td>26</td>
<td>34</td>
</tr>
<tr>
<td>Horn</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>0</td>
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</tr>
<tr>
<td>Mirrors</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Wipers</td>
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<td>5</td>
<td>2</td>
<td>0</td>
<td>9</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>Driver Seating and Control</td>
<td>5</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>8</td>
<td>3</td>
<td>12</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Body, Doors, Hood, Other</td>
<td>5</td>
<td>9</td>
<td>12</td>
<td>18</td>
<td>26</td>
<td>25</td>
<td>18</td>
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<td>13</td>
</tr>
<tr>
<td>Trailer Hitch</td>
<td>6</td>
<td>14</td>
<td>18</td>
<td>18</td>
<td>24</td>
<td>42</td>
<td>39</td>
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<td>Wheels</td>
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<td>34</td>
<td>1</td>
<td>67</td>
<td>58</td>
<td>28</td>
<td>7</td>
<td>21</td>
</tr>
<tr>
<td>Other Vehicles Defects</td>
<td>52</td>
<td>61</td>
<td>49</td>
<td>95</td>
<td>99</td>
<td>67</td>
<td>99</td>
<td>110</td>
<td>135</td>
</tr>
<tr>
<td>Safety Belts</td>
<td>7</td>
<td>13</td>
<td>13</td>
<td>4</td>
<td>38</td>
<td>37</td>
<td>22</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>1662</td>
<td>1801</td>
<td>2068</td>
<td>2032</td>
<td>2043</td>
<td>2217</td>
<td>1943</td>
<td>2128</td>
<td>2382</td>
</tr>
</tbody>
</table>
Tables 1 and 2 show (1) the number of crashes caused by parts failure and (2) the number of people affected due to the failure of part(s) in large trucks. The majority of these incidents were due to the failure of tires braking system, suspension and engine parts. The VCRS delivers the training on inspecting these vulnerable parts. As stated above, proper diagnosis of an entire vehicle and its components will likely reduce the number of accidents caused by the parts failure.
CHAPTER 3: LITERATURE REVIEW

In the last decade the use of technology, especially in online-learning, has had more impact on education than ever before. The increased computation power of computers and reduction in their cost has made it possible for most academic and training organizations to afford and use them. Computers, internet connection, and wireless communication technologies are found in more homes every year, and the youth of today are growing up with the latest technology. Large bodies of research studies have shown that, under the right circumstances, the use of technology has an educational effectiveness for students of all ages, skills, learning styles and regardless of the field of study.

Researchers, instructors, and practitioners have found that the delivery of instruction using technology can be effective if it is planned, designed, evaluated, and revised before making it available to the end users. Well designed instructional technology helps students study on their own, at their own pace and choice of place (Gagne, Briggs, & Wager, 1988). Gagne et al. (1988) stated that different types of learning, such as learning historical facts or mathematical formulas, required different instructional presentations. They proposed “events of instructions” and instructional strategies so that learning happens efficiently and effectively and is based upon organization of content, identification of type of learning, and proposed objectives. Students can still learn, without making use of any technology, by using well-designed instructional strategies (Bloom, 1984; Lysakowski and Walberg, 1982). However, there are instructional strategies that mandate the use of graphics (Winn, 1994) and sound (Hereford and Winn, 1994); and these strategies require students to play an active role by taking control of the material.
Computer-based simulation has been widely used for education and training for decades. Simulation is a collection of hardware and software systems which are used to mimic the behavior of some entity or phenomenon. Studies from the eighties demonstrated that guided feedback allowed students a measure of control and provided significant learning improvement (Carrier, Davidson, & Williams, 1985; Dwyer, 1985; Johansen & Tennyson, 1985; Tennyson, 1984). Moreover, simulation allows training in non-threatening environments. It allows students to practice skills that are difficult or impossible to do in the real world. Simulation-based learning environments support multiple perspectives of reality, and allow students to construct their knowledge and understanding in a contextually and visually rich environment by interacting with the learning information; this approach to learning has acquired the name “Constructivism” (Duffy and Jonassen, 1992). Instructional System Design principles are widely used in training and education for medics, soldiers, pilots, emergency and law enforcement officers, K-12 students, and general public (Harasim, Calvert, & Groeneboer, 1996; Ahmad, Piccoli, & Ives, 1998; Hall and Gordon, 1998; Lau, Curson, Drew, & Leigh, 1999; Roussou, 2004; Jia, Makwana, Dezhi, & Kincaid, 2008). In spite of the benefits on using instructional design methodologies, conventional training approach is widely accepted in training commercial driving students, especially in conducting the Pre-trip inspection. The VCRS used in this research study fulfills all of the requirements of a computer-based application to be used for training truck driving training students. All of these requirements are mentioned in Table 5 along with a description of the user-interface, how to use VCRS, and review and feedback.

Educational and training institutions are using computer-based training (CBT) and computer-based assessment tools in their introductory or entry-level courses. The exploratory research by Schneberger (2006) introduced various types of hybrid classes to determine the
efficacy and applicability of the training and education programs. This was achieved by proposing a research model based on Jarvenpaa’s (2001) research model that helps instructors select the best teaching method based on the following factors: students, instructor, syllabus, and available technology.

According to Leidner and Jarvenpaa (2001), sometimes classroom based learning cannot be effectively used and in such circumstances computer-based teaching can be useful. However, the challenge lies in using hybrid courses. Hybrid courses integrate computer-based technology with conventional lecture pedagogy. Strother (2002) identified advantages of using CBT and they are as follows: scalability in terms of class rooms and instructors, type of available content, ease of time and convenient place for students and instructors, self-paced learning, and automated feedback. The statistical data of Computer-based Assessment (CBA) can be used to make analysis in improving course personalization, content, and delivery.

![Figure 5: Computer-based training and assessment. Reprinted from “Computer-Based Training and Assessments: An Exploratory Study of Social Factors” by Schneberger, S., 2006. Proceedings of the 39th Hawaii International Conference on System Sciences, 8.](image-url)

Schneberger (2006) reviewed two types of classroom information technologies: one used technology to improve students’ learning, and the other used technology to improve students’ performance. As a part of this assessment, as shown in Figure 6, the first group of technology
characteristic has the variables such as ease of use and navigation, understandability, and internet connection speed. The individual student characteristic has variables such as prior computer experience, self-efficacy, and current grade point average. In the second group, computer-based training includes variables such as place of using CBT, technical support, the way technical support is used. The classroom lecture has the variables of class size, instructor, and class meeting time. The results of this model suggests that organizations which make use of CBT and CBA can improve users’ knowledge and skill level.

Following the model shown in Figure 6, the technological characteristics and the functional requirements examined in this dissertation were: web browser, desktop computer, and VCRS software application. The nonfunctional requirements were ease of use and navigation. The characteristics of (MFT) ’s students were: prior computer experience, ability to read and write in English, and no vision, hearing, or listening disability. For the second group, as shown in the above model, computer-based training was conducted at the computer-lab at MFT using six desktop computers. All these computers were fully functional and had a web-browser, MS Office, anti-virus and other software applications. The students were not permitted to use any of these software applications, except VCRS, during their course of training.

Guidance for operating the computers and permission to create user accounts were administered by the instructors at MFT. During the course of their training, a principal investigator was present at all times. The driving training program at MFT operates from Monday to Thursday from 7:00 A.M. to 5:00 P.M. and had a lunch break for 45-60 minutes, and two breaks of 15 minutes each in the morning and in the afternoon. The class size varied from 4 to 15 students during the entire experimental phase of nine months. There were total of four full-time instructors as well as a maintenance engineer, who can also teach and train students when
the need arises; of these four instructors, one was a lead instructor and he approved the schedule for conducting experimental tests.

3.1. **Computer Based Instructions for Learning**

In 2000, approximately 35 percent of educational institutions reported that computers were frequently used as a hands-on instructional tool for on-campus mathematics, reading, writing, or remedial courses. Furthermore, approximately 41 percent of institutions occasionally used computers for instructions in on-campus mathematics, reading, writing, or remedial courses (Institute of Education Sciences). However, Computer-based instruction (CBI) is not by itself a panacea. Poorly designed instructional courseware might deteriorate student performance (Brock, 1997, 2003). CBI that is effectively designed by making use of graphics, video, and sound can meet the learning needs of each student in the training organization.

Swezey and Llaneras (1997) presented different instructional and learning models. Brock (1997) discussed how computers can help in utilizing human learning capabilities. CBI techniques have been used to train young novice drivers (Brock, 1998, 2005; Hodell, Hersch, Brock, Loerno, Clinton, and Black, 2001). The meta-analytic studies on CBI found that students learn more by using CBI than they do with traditional ways of teaching (Fletcher, 2006; Kulik, 1994).

3.1.1. **Media for Learning**

Liao (1998) found that hypermedia instruction had “moderately positive effects on student’s achievement over traditional instruction”. Hartley and Bendixen (2001) suggested that a hypermedia-based instructional environment leads to better understanding of how students learn.
By using the technology, access to instructional content increases and the effective contents’ design foster higher order thinking skills. Liaw and Huang (2000) provided evidence and examples that increased student’s satisfaction. Their research illustrated the processes in web-based environment that increased content interactivity and social interactivity. According to Berge (1999) interaction is not possible unless it is “intentionally designed into the instruction program”. Laurillard (1997) stated that current interactive media is not capable of providing genuine real discussion; however, media is certainly capable of delivering adaptive feedback to students on their performance. The quality of this feedback depends on instructional design.

3.1.2. Interactivity and Learning Activities

Interactivity is the process of learning activities that involve interactions between student-student, student-tutor, student-computer, or interaction between student and learning material (Moore, 1989; Schrum & Berge, 1997; Evans & Gibbons 2007). Learning methods that make use of computer-based system are either student initiated or computer initiated interaction (Schar & Krueger, 2000). A computer-based learning system can be called non-interactive if learning involves minimal or no interactions, for example, reading lessons from the computer screen. Evans & Gibbons (2007) defined an active-learning hypothesis and a passive-learning hypothesis to characterize types of learning interactivities. The authors also refer to a constructivist model of learning (Duffy & Jonassen, 1992), in which learners construct their own knowledge of the subject based on their prior experience or knowledge. According to this model, the learner plays an active role while interacting with the learning system by using a keyboard or mouse to retrieve the information, as a consequence, this effort should increase their learning. Passive-learning is merely an information transfer; according to this model the learner receives direct
information from subject experts via lectures or textbooks. A study by Rieber (1990) found that students scored better (upon receiving animation and simulation for learning Newton’s Laws of Physics) than those who received passive learning. Similarly, students practicing selection of plant design in a plant-biology lesson increased their performance. Furthermore, the effect of interactivity was found in increased scores in teaching the lessons about electric-motors which involved selection of time and its explanation (Moreno, Mayer, Spires, and Lester, 2001).

3.1.3. Learner’s Characteristics

Computer-based or multimedia-based interactive learning system utilizes various media such as sound, audio, video, text, images, and animation to gain users’ attention (Sun & Cheng, 2007; Asan, 2003). Such learning systems are not by themselves a panacea. Intuitive user interface that involve interactive graphics, rich environment, and dynamic buttons must be designed based on user center design principles such that novice, intermediate, and expert type computer literates can freely navigate and easily identify relevant content.

Learning preference differ from student to student. Hamada (2007) cited various learning models (Myers, 1980; Kolb, 1984; Silverman and Felder, 1988; Hermann, 1990) that have been created for the recognition of learning preferences of students. One of the learning from Felder-Silverman (1988) classified learners based on the following learning characteristics: Active, Sensing, Intuitive, Visual, Verbal, Sequential, and Global. An active learning approach uses learning-by-doing style; Sensing learning style tend to learn the factual information through their senses; Visual learner look for charts, diagrams, images, tables, etc.; Verbal learners learn from spoken and written words, Sequential learners learn from logistics and detail step-by-step processes; and Global learners learn an entire concept in large incremental steps.
Education or training courseware is generally designed around learning objects that function similar to instructional components. Guidelines and principles of effective instructional design should have an essential role in building the courseware (Rosenberg, 2000). Warren (2000) stated that instructional design strategy, technical architectures, and delivery systems are at the core of effective courseware design. While designing the user interfaces of the web-based applications, metaphors have been used significantly. According to Lafeoff and Johnson (1980), metaphors help in structuring the basic understanding of our experience; “metaphors can shape our perceptions and actions without our ever noticing them.” The challenge lies in designing the appropriate metaphors relevant to the contextual information. Balasundaram and Ramadoss (2006) proposed a method that serves as guideline objects in selecting metaphors while designing computer-based learning courseware. Some of the characteristics of such metaphors are as follows: reusable, well organized, user-friendly, interesting, means of assessment or evaluation, connected to course objectives, and appropriate visual aids.

### 3.1.4. Multimedia-based instructional material

The empirical evidence presented by Mayer (1997, 1999a, 1999b, 2001) found that instructions delivered only verbally does not always prove beneficial. Mayer’s research study found that students, who learned from verbal (or read) explanations that are delivered using text-only, are not able to understand the majority of the key ideas. Furthermore, students encountered difficulties in using these instructional materials to solve new problems. There is a need to design multimedia instructions that are coherent with the ways students learn. Research shows that students learn better from well designed multimedia instructional materials than from conventional verbal-only instructions; when students used well-designed multimedia
instructional material, the scores of problem-solving tests showed improved performance (Mandl and Levin, 1989; Schnozt and Kulhavy, 1994; Van Merrienboer, 1997; Najjar, 1998; Sweller, 1999; Mayer 2001, 2003). Mayer (2003) defined a multimedia instructional message as “the presentation contains words and pictures, and the presentation is designed to foster meaningful learning. The words can include printed or spoken text and the pictures can include static graphics (such as illustrations, maps, charts, and photos) and dynamic graphics (such as animation and video)” As per this definition, the VCRS is a multimedia-based instructional system.

3.1.5. Role of context in learning

Context has a significant influence on performance-based learning. The study by Tessmer and Richey (1997) examined the role of context in learning and proposed a model for the instructional design process. This model assumed three contexts that need to be investigated: the orienting, instructional, and transfer contexts. Each of these contexts has several different contextual factors that create levels among context. The orienting context has the factors that influence student’s motivation and cognitive preparation to learn. The factors and environment of the instructional context focuses on delivery of instruction, symbolic, social and physical resources outside the person (Perkins, 1992; Tessmer and Richey, 1997). The transfer context is the payoff context that specifies the application environmental in which the learning will be applied.
3.2. **Use of pictures in facilitating learning**

In academic organizations, many instructors, teachers and professors make use of software application like Microsoft PowerPoint to include relevant pictures, video, and audio for their classroom or web-based presentations. Many times these pictures are used as adjuncts to textual material. Fang (1996) listed the following six roles that pictures can play in his discussion of storybooks used for learning:

1. Establish the setting
2. Define or develop the characters
3. Extend or develop the plot
4. Present different viewpoints
5. Provide text coherence
6. Emphasize the text

The above list describes the benefits the processes listed above, such as motivation, creativity, aesthetic appreciation, promoting language learning in children, and mental scaffolding in learning new things. The early research on the effect of pictures on students’ text processing (Levin, Anglin, & Carney, 1987) provides four conventional functions: decorational, representational, organizational, and interpretational. Decorational pictures have little or no relationship to textual material; for example, drawing a flock of birds adjacent to a road or bridge. Representational images mirror some part or all of the parts of the textual information and they are widely used in presentations or illustrations; for example, a picture that provides a synopsis for a novel or magazine. Organizational pictures provide a structural framework for textual material; for example, a map of an interstate or highway road. Organizational pictures are widely used in instructional or operating manuals for hardware, software, and kitchen appliances.
An interpretational picture helps to understand complicated text; for example, blood pressure in terms of a pump system.


Table 3: Seven “C” – Use of Picture

<table>
<thead>
<tr>
<th>Concentrated</th>
<th>Directs reader’s attention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compact/Concise</td>
<td>A picture is worth a thousand words</td>
</tr>
<tr>
<td>Concrete</td>
<td>Representation function</td>
</tr>
<tr>
<td>Coherent</td>
<td>Organization function</td>
</tr>
<tr>
<td>Comprehensible</td>
<td>Interpretation function</td>
</tr>
<tr>
<td>Correspondent</td>
<td>Communicating unfamiliar text to reader’s prior knowledge</td>
</tr>
<tr>
<td>Codable</td>
<td>Mnemonic transformation function</td>
</tr>
</tbody>
</table>

Peeck (1993) lists various reasons for pictures facilitating learning: pictures increase motivation, attention, depth of processing, elucidation of textual content, dual-coding theory, distinctive encoding, and decreased interference. However, there are other factors that account for learning and Peeck (1993) refers to Barnsfor’s Model: Learner’s characteristics such as age, ability to read, ability to read or distinguish pictures, and their learning activities. Peeck asserted those students are less likely to learn more by simply asking them to pay more attention; he refers to the suggestion that learning from text illustrations are improved when appropriate cues or instructions are provided. (Bernard, 1990; Reinking, 1988; Weidenmann, 1989)

3.3. Organizational Pictures

Carney and Levin (2002) refer to a research study by Betrancourt and Bisseret (1998) explaining different ways of presenting textual information using pictures. As a part of this research study, pictorial information was displayed on a computer screen via pop-up windows in three different ways:
a) Split Display: Picture and Text Material displayed in separate parts of the computer screen

b) Integrated Display: Picture and Text appeared in close vicinity

c) Pop-up Display: Picture appeared only when the user clicked on a hyperlink on the screen

Betrancourt and Bisseret (1998) noted the following results:

The integration of text information via pop-up fields increased the learning efficiency compared with a split format, but this advantage is significant only with regard to the integration of text-picture information, as opposed to either pictorial or textual information alone. Second, the information was more quickly retrieved from memory when the material was integrated (spatially or in pop-up fields) as compared to a split display. These results support the hypothesis that an integrated display (either spatially or in pop-up windows) improves subjects’ performance in memorizing a labeled schema. (p. 268)

Betrancourt and Bisseret (1998) give the following three reasons for using the pop-up approach:

a) Pop-up is displayed only when required, hence it saves the computer screen space

b) It gives an option of displaying either picture or text in the foreground

c) This approach requires interaction with the learning content. Therefore, it enhances users’ motivation and performance.

Betrancourt and Bisseret (1998) further stated that:

The integrated format helps the learners mentally integrate the two sources of information and allows the learners to avoid splitting their attention between the two
media. Therefore, fewer cognitive resources would be required to process the document, thus increasing the remaining working-memory capacity allocated to learning. (p. 268)

The functionality of the After Action Review in VCRS has the feature of a pop-up-window that shows an enlarged magnified image of the truck part(s) when a student clicks on the picture on the main-window. When students are confused and want to compare their answers, or learn more details, they often used this feature. The pop-up-window maintained the context and had integrated the parts labels, thus supporting or matching the content of a main-window to a pop-up-window. Some students immediately closed the pop-up window when it was not required or when they proceeded to subsequent questions; however, most of the students simply proceeded to the next question without closing the pop-up window which leads the pop-up window to get automatically minimized onto the task-bar. By doing so, students compared the pictures of multiple parts or similar parts taken from different angles.

3.4. Commercial Drivers License training

According to Synthesis 13, Brock et al. (2007), a Commercial Drivers License (CDL) is federally mandated and this license is required to drive commercial vehicles throughout the United States. CDL tests determine whether the:

1) Applicant had an adequate understanding of how to ascertain the condition of key operational and safety systems of the vehicle. 2) Driver had the fundamental psychomotor and perceptual skills necessary to control and maneuver heavy vehicles. 3) Driver was capable of safely driving the vehicle in a variety of road environments and traffic conditions. (p. 12)

The design of these tests is adaptable; therefore, they can be used for various vehicle sizes and configurations. CDL development has been conducted in accordance with the
Commercial Vehicle Safety Act of 1986 as well as Federal design guidelines. The CDL knowledge test covers the following topics: general knowledge test of safe driving principles, air brakes, combination vehicles, tankers, doubles/triples, passenger transport, and hazardous materials.

FMCSA sponsored a research project that was beneficial to federal and state agencies, bus and commercial truck operators and other organization interested in improving vehicle safety. The comprehensive literature review of this sponsored research provided ways to assess the safety of commercial vehicle training practices and to measure training effectiveness. This report by Knipling, Hickman, and Bergoffen (2003) concluded that “the level of driving proficiency and knowledge required to earn a commercial drivers license (CDL) is widely required to be a safe and reliable in a full-time operational setting.”

The Professional Truck Driving Institute (PTDI) established in 1986, is the only organization that certifies quality-level training to students and carriers. This organization has developed a standard for entry-level truck drivers. PTDI is not a training school and does not offer any courses; PTDI certifies courses at truck driving schools. PTDI-certified courses are widely accepted, and currently these courses are offered in 61 schools in the United States and Canada. The Table 4 below was created by the Driver Training and Development Alliance (DTDA). This table was created by using the content of PTDI. This table shows the topics required for any entry-level driver training program.
3.4.1. Driver training methods

According to CTBSSP, Synthesis 1 (Knipling, Hickman, Bergoffen, & Truck, 2003), “The level of driving proficiency and knowledge required to earn a commercial drivers license (CDL) is widely regarded in industry as well below the level required to be a safe and reliable driver in a full-time operational setting.” Truck driving training institutions believes that the training reduces accidents. Counting the number of students that pass the CDL test is a widely accepted standard for determining the effectiveness of driver training programs. A training school is considered successful if it graduates more than 70% of its students. These training institutions measure training effectiveness by calculating the number of hours spent in the classroom training and the total time spent behind the wheel driving rather than specific performance measures.

<table>
<thead>
<tr>
<th>Introduction to Trucking</th>
<th>Control Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle Inspection</td>
<td>Basic Control</td>
</tr>
<tr>
<td>Backing</td>
<td>Coupling and Uncoupling</td>
</tr>
<tr>
<td>Fifth Wheel and Sliding Tandems</td>
<td>Special Rigs</td>
</tr>
<tr>
<td>Night Driving</td>
<td>Extreme Driving Conditions</td>
</tr>
<tr>
<td>Hazard Awareness</td>
<td>Emergency Maneuvers</td>
</tr>
<tr>
<td>Skid Control</td>
<td>Vehicle Systems</td>
</tr>
<tr>
<td>Braking Systems</td>
<td>Driver Wellness</td>
</tr>
<tr>
<td>Pre-trip Inspection</td>
<td>Product Handling</td>
</tr>
<tr>
<td>Cargo Documentation</td>
<td>Hours of Service/Fatigue Management</td>
</tr>
<tr>
<td>Accident Procedures</td>
<td>Trip Planning</td>
</tr>
<tr>
<td>Public Relations</td>
<td>Employer/Employee Relations</td>
</tr>
<tr>
<td>CDL Requirements</td>
<td>Visual Search</td>
</tr>
<tr>
<td>Communications</td>
<td>Space Management</td>
</tr>
<tr>
<td>Speed Management</td>
<td>Recognizing and Reporting Malfunctions</td>
</tr>
<tr>
<td>Preventive Maintenance and Servicing</td>
<td>Diesel Engines</td>
</tr>
<tr>
<td>Drug and Alcohol Abuse</td>
<td>Continuous Career Development</td>
</tr>
</tbody>
</table>

Factors that affect the students’ performance in transfer of training are systematic training design and the operator’s ability in training students.

### 3.4.2. Instructional Methods

According to CTBSSP (Brock et al., 2007), Synthesis 13, the use of instructional technology has not been integrated significantly in the majority of commercial driving training organizations. The common method for training commercial drivers makes use of classroom-based learning and supervised driving. Driving training organizations that make use of advanced technologies such as simulation and well-designed Computer Based Instruction (CBI), however, demonstrated improved student performance.

### 3.4.3. Train the Trainer

There is a common practice of using experienced drivers as instructors. However, there is no empirical data that determines job experts are good teachers. According to CTBSSP, Brock et al. (2007), Synthesis 13, the essential qualities of a good driver training instructor are the following: presentation of fundamentals, using classroom equipment, listening to students, observational fundamentals, capability to explain activities in lucid and behavioral terms, and calm attitude.

According to CTBSSP, Brock et al. (2007), Synthesis 13, in the last 50 years, the Department of Defense (DOD) funded research and development projects for the field of instructional technology. DOD has also developed a general approach in curriculum development that focuses on training students with the specific skills that are required in accomplishing the tasks at the job site. Unfortunately, most of the bus and truck operator training has not been approached this way.
3.5. Computer-based driver training

Driving a vehicle effectively without accidents is a learned skill that requires multitasking including information processing. While driving and maneuvering the vehicle, the driver has to effectively guide the vehicle and identify potential hazards. This multitasking driving environment requires simultaneous processing of multi-sensory information. Practicing these skills in a real-life environment could be extremely dangerous, especially while driving in public. However, using driving simulators, high fidelity and functional driving environments can be scripted to imitate real world environments (Klein 1999).

3.5.1. Computer based instructions in driver training

In 2005, more than 35,000 people lost their lives in privately owned vehicles (FARS, 2002). Contributing factors to fatal accidents are speed, fatigue, and not using seatbelts. Moreover, there is a high crash risk among young novice drivers during the initial months of driving due to limited skills pertaining to visual search and attention errors (Preusser, 2006; McKnight, 2006; Mayhew, 2007). Research prior to the 1990s does not provide any evidence that either driver education or conventional licensing systems has had a positive impact on safety (Mayhew, 2007). Driver education should not be a substitute for supervised practice. Consequently, best teaching practices for computer-based instruction and driving simulation should be incorporated in driver education. This will give students the opportunity to experience, identify, and reduce behaviors that lead to accidents. This training should deliver more effective transfers of knowledge, attitude and skills practice than lectures and safety videos (Brock, 2006; Mayhew, 2007).
The research on these three topics: CBI, Driver training, and Commercial vehicle operations) proposes 10 minimum characteristics required in CBI programs for commercial vehicle operators. The research was accomplished by: CBI (Eberts and Brock, 1987; Brock 1997; Brock 2006); Driver training (Brock 1998; Hodell, Hersch, Brock, Lonero, Clinton, & Black, 2001; Brock 2006); and Commercial vehicle operation (Llaneras, Swezey, Brock, Rogers, and Van Cott 1998; DTDA; Brock, Krueger, Golembiewski, Daecher, Bishop, and Bergoffen, 2005).

Below are the 10 characteristics identified as required for commercial driver training:

1. Interactive learning
2. Students can freely enter and exit as needed
3. Easy to use
4. Visually rich
5. Customizable to include company policies, vehicles and drivers;
6. High retention by students
7. Information collected on a common database
8. Students set their own pace
9. Criteria testing
10. Model consistency.

Table 5 analyzes the compliance of VCRS in accordance to these characteristics.
<table>
<thead>
<tr>
<th>Required characteristics of CBI</th>
<th>VCRS Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Interactive Learning</td>
<td>Use of control buttons such as next, checklist, and radio buttons. Provide feedback, analysis, and numerical score.</td>
</tr>
<tr>
<td>b) Students Enter and Exit as Needed</td>
<td>User login and password stores users’ inputs which can be accessed at anytime.</td>
</tr>
<tr>
<td>c) Easy to Use</td>
<td>User friendly and minimum information required for signing up new login and password.</td>
</tr>
<tr>
<td>d) Visually Rich</td>
<td>Colorful images with arrows pointing at parts.</td>
</tr>
<tr>
<td>e) Can be Customized to Include Company Policies, Vehicles and Drivers</td>
<td>Images of the vehicle and its parts, questions, answers, etc., can be customized by updating the database.</td>
</tr>
<tr>
<td>f) High Retention by Students</td>
<td>Use of red, green, and yellow colors for wrong, correct, and missed answers respectively. These color codes are self explanatory. Regular use may result in increased knowledge and performance.</td>
</tr>
<tr>
<td>g) Information Collected on a common Database</td>
<td>Using the internet to access VCRS offers the ability to store information in centralized repository.</td>
</tr>
<tr>
<td>h) Students Set Their Own Pace</td>
<td>There is no time limit to complete the exercise.</td>
</tr>
<tr>
<td>i) Criteria Testing</td>
<td>Instructor can setup the minimum percentage required for a pass grade; VCRS can measure and store results. The final report shows how the user performed by providing a score on an individual question; set of related questions; and final cumulative score.</td>
</tr>
<tr>
<td>j) Modal Consistency</td>
<td>Pictures of an actual truck are used for: Questions on defects and identification of parts, feedback, and analysis.</td>
</tr>
</tbody>
</table>

According to CTBSSP, Brock et al. (2007), Synthesis 13, “activities such as decision-making instructional exercises and role-playing can be classified as simulations if the activity is based on a real situation or the students are required to apply a process that could be used in a real-life scenario”. Fifteen years of sponsored research by FMCSA found that “1) simulators may provide opportunities for improved training of commercial vehicle operators, and 2) provide a
technology for measuring the effectiveness of various operator training curricula and techniques.”

3.5.2. Simulation-based training in driving training in Europe

Simulation-based E-learning applications in Europe are widely used as a supplement to existing driver training programs (Larsen, 2006). These applications aimed to provide variety of driving scenarios, possibilities, rules and regulations on the existing curriculum. The target audiences range from novice to professional drivers and the length of using E-learning applications varies from few months to eight years. The majority of these applications focus on skills learning, i.e. good understanding of driving rules, signs, and regulations. However, there are applications that focus on defensive driving techniques.


<table>
<thead>
<tr>
<th>Country</th>
<th>Use of driving simulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vienna, Austria</td>
<td>Virtual driving License for novice driver. Computer-based test with questionnaire on existing driving curriculum.</td>
</tr>
<tr>
<td>Prague, Czech Republic</td>
<td>Training of voice drivers in traffic regulations</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>Training program for novice drivers and re-training for the final driving examination. Curriculum and test is based on traffic rules and situations at intersections</td>
</tr>
<tr>
<td>Prague, Czech Republic</td>
<td>Animation of intersections for training professional drivers in traffic rules</td>
</tr>
<tr>
<td>Germany</td>
<td>Training on theoretical driving test for novice and professional drivers</td>
</tr>
<tr>
<td>Oorschot, Netherlands</td>
<td>Training novice and professional army drivers.</td>
</tr>
<tr>
<td>Crowthorne, United Kingdom</td>
<td>Training of professional truck drivers on hazard perception through examples.</td>
</tr>
</tbody>
</table>

These learning applications in Europe have proved cost-effective as they significantly reduce the total cost of the training. This was achieved by providing training tools that increase
specific knowledge and awareness and illustrate complex traffic situations, as well as reduce total training time.

According to Brock (2007), there are approximately 3,600 commercial truck driver training program in the United States. These training program coach entry level training, CDL, specific vehicle, and other license training. A research study by Brock (2007), survey of 42 training and carrier organizations, identified four types of skills training: range training, simulator training, skills demonstration by an instructor, and on road training. Range training involves driving a vehicle in limited space at the training institute or riding a vehicle with another student. The survey found that no school used all four training methods; however, these training institutions were rated at least satisfactory with the various training methods being used.

Table 7: Skills training Methods (Brock et. al, 2007)

<table>
<thead>
<tr>
<th>Skill Training Method</th>
<th>Driving Range (n=31)</th>
<th>Simulation (n=16)</th>
<th>Demonstration (n=22)</th>
<th>Over the Road (n=36)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range in Hours</td>
<td>6-220</td>
<td>1-20</td>
<td>2-100</td>
<td>9-1900</td>
</tr>
<tr>
<td>Medium (Hours)</td>
<td>40</td>
<td>3</td>
<td>10</td>
<td>42</td>
</tr>
<tr>
<td>Mode (Hours)</td>
<td>20</td>
<td>2</td>
<td>2</td>
<td>44</td>
</tr>
</tbody>
</table>

3.5.3. Virtual Check Ride System

The Virtual Check-Ride System (VCRS) is a web-based application to provide knowledge and train driving skills associated with the CDL. Initially designed as an alternative to the traditional CDL test, it can also be used as a training device helping students to evaluate their grasp of knowledge during the course of learning. To make use of VCRS, a user needs to login using a user name and password, refer
Figure 6. A new user registration can be created, as show in Figure 7, by submitting the following information: username, password, first name, last name, and license number.
The system includes the Knowledge Test, Endorsements Test and Virtual Inspection for all-class (Class A, B, C and E) driving license test. Figure 8 shows the entry page of the test. For the purpose of this study, students used Virtual Inspection test of Class A as a part of their training program.
The Virtual Inspection, like the real inspection carried out on the actual vehicles, consists of two different elements, part identification and potential defects. The Virtual ‘part identification’ test assesses the driver’s knowledge on part location and name by presenting a high definition digital photo and having a student identify the part in the photo from the associated list, refer Figure 9. To reduce the chance of guess work, the test offers more choices than parts in the photo. After the part identification is addressed, several questions on possible defects regarding to that particular set of parts are presented to the student (Figure 10). The test comprises 117 inspection points that the driver must identify correctly.
Figure 9: VCRS Part Identification

Figure 10: VCRS Defects Identification
CHAPTER 4: METHODOLOGY

This chapter provides the information on participants, test instruments used in this research study, experimental procedure and research design, and data analysis. The section on participants gives detailed information on how the participants participated, number of participants recruited, age, etc. The section on procedure describes the setting of control and experimental groups and the type of instruments used. The test instruments are also provided in Appendix A, B, C, D, N, O, and P.

4.1. Participants

A total of 21 participants were tested in the control group during first week and 20 participants during second and third week. A total of 25 participants were tested in the experimental group during the first and second week, and 20 participants in the third week. Dropping from a class or switching from the Class-A to Class-B program lead to this difference in number of participants in different weeks. Both the groups had 3 female. The participants were at least 21 years old and had a basic knowledge of operating a computer; i.e. ability to use a mouse, keyboard, and surfing the internet. The inspection at MFT last for the period of four weeks. After this four weeks, new batch of students are enrolled. The batches of students were systematically assigned into either control group or an experimental group. All of these participants were CDL license seekers at (MFT) . Upon arrival, the participants were asked to fill out the demographic survey form (Appendix A) and the informed consent form (Appendix B). After the completion of the experiment the participants were asked to fill out the questionnaire for evaluation of the Virtual Check Ride (Appendix C). The principal investigator for this study visited this training institute.
to: provide an overview of this research study to a new batch of students, deliver and collect the test material, and assist participants in using the VCRS. Participants in the both groups were asked to complete three paper-based take-home tests at weekly intervals during the course of their training.

4.2. Research Design

The experimental study used a mixed between-subject design with a repeated measure. The study was conducted to assess the combined impact of Virtual Pre-trip training with Conventional Pre-trip Training as it compared to conventional Pre-trip training only. Another purpose of conducting the study was to see if learning occurred in the experimental group over the course of three weeks during which three tests were administered. This study was conducted at Mid Florida Tech with truck driving students serving as participants. Only those students that fell into the experimental group made use of the computer based Virtual Check Ride System. The paper based tests were taken at the end of each week; control and experimental subjects were given the same test. The test material covered the study material taught during a particular week as well as the material taught during the preceding week(s). Tests scores for each group and for the three tests provided data for the statistical analysis.

4.3. Instruments

The data was collected using the following: Demographic survey (Appendix A), Consent form (Appendix B), and post-test questionnaire (Appendix C) and evaluation of virtual check ride (Appendix D). The instruments involved in this study are the following:
Demographic information helped in determining the education level, gender, work experience, and knowledge about using a computer. Test material covered the topics learned during the particular week of instruction. This testing material had check-list based choices to identify defects; whereas, radio button based choices were used in parts identification. The interface of radio-button and checklist based questions in paper-test is similar to the user interface of such questions in the VCRS. There were 56, 76, and 64 test questions in paper-based test-1, test-2, and test-3 respectively. Evaluation of the VCRS was based on usability, fidelity, accurate representation of information, and cognitive content. The questions in the Driver Coping Questionnaire dealt with driving in a difficult, stressful, or upsetting situation. This questionnaire do not relate to hypotheses addressed in this research question, therefore the participants information on this questionnaire is not mentioned in this dissertation. The questionnaire was approved by the UCF’s Institutional Review Board during the early phase of this research; hence this questionnaire is reported in the Appendix.
4.4. **Procedure**

Duration of drivers’ training program at (MFT) is eight weeks; and the Pre Trip Inspection test is carried out after the completion of four weeks. The last four weeks are dedicated for on road driving training. During the course of eight weeks, two instructors are involved for the entire batch of students. (MFT) delivers this service throughout the year. Two conditions were tested in this research: experimental group which used the VCRS, and control group which did not use the VCRS. The number of students available in any group depended on number of students getting admitted in a given eight week’s period. The same test material was used for control and experimental groups; however, different questions were asked in individual tests. Three take-home test materials were given weekly during the first half of the eight week course. Completed tests were usually collected the next working day after they were handed out to participants.

4.5. **Data Analysis**

This study used Microsoft Excel to tabulate the data and used statistical software, SPSS and Minitab, to complete the statistical analyses. We used a p-value of 0.05 as the criterion in determining statistical significance.
CHAPTER 5: RESULTS

Table 8 examines the descriptive statistics; the dependent variable is the weekly test score. As shown in Figure 7, for the experimental group, there is an increase of score from test-1 to test-3. A two-sample t-test was utilized to examine the performance effects on the experimental group. There was a significant difference in the scores for experimental group in test1 (M: 50.32, SD: 3.09) as compared to control group’s test-1 (M: 47.14, SD: 4.53); t(34) = (2.72), p = (0.01). There was a significant difference in the scores for experimental group in test-2 (M: 69.76, SD: 6.10) as compared to control group’s test-2 (M: 60.65, SD: 5.75); t(41) = (5.14), p = (0.00). There was a significant difference in the scores for experimental group in test-3 (M: 61.00, SD: 2.32) as compared to control group’s test3 (M: 54.05, SD: 5.19); t(26) = (5.47), p = (0.00); refer Appendix Q.
5.1. Descriptive Statistics

Table 8: Descriptive Statistics for Six Cells

<table>
<thead>
<tr>
<th>Tests</th>
<th>Group</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>84.18</td>
<td>8.091</td>
<td>21</td>
</tr>
<tr>
<td>Test1</td>
<td>Experimental</td>
<td>89.86</td>
<td>5.521</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>87.27</td>
<td>7.315</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>79.80</td>
<td>7.568</td>
<td>20</td>
</tr>
<tr>
<td>Test2</td>
<td>Experimental</td>
<td>91.79</td>
<td>8.024</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>86.46</td>
<td>9.805</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>84.45</td>
<td>8.103</td>
<td>20</td>
</tr>
<tr>
<td>Test3</td>
<td>Experimental</td>
<td>95.31</td>
<td>3.620</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>89.88</td>
<td>8.283</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>82.84</td>
<td>8.082</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td>Experimental</td>
<td>92.11</td>
<td>6.439</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>87.79</td>
<td>8.585</td>
<td>131</td>
</tr>
</tbody>
</table>
5.2. Two-way Analysis of Variance

Table 9: Two-way ANOVA test

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>0.341^a</td>
<td>5</td>
<td>0.068</td>
<td>13.816</td>
<td>0.000</td>
</tr>
<tr>
<td>Intercept</td>
<td>99.433</td>
<td>1</td>
<td>99.433</td>
<td>20141.698</td>
<td>0.000</td>
</tr>
<tr>
<td>Tests</td>
<td>0.037</td>
<td>2</td>
<td>0.018</td>
<td>3.713</td>
<td>0.027</td>
</tr>
<tr>
<td>Group</td>
<td>0.293</td>
<td>1</td>
<td>0.293</td>
<td>59.348</td>
<td>0.000</td>
</tr>
<tr>
<td>Tests * Group</td>
<td>0.025</td>
<td>2</td>
<td>0.013</td>
<td>2.574</td>
<td>0.080</td>
</tr>
<tr>
<td>Error</td>
<td>0.617</td>
<td>125</td>
<td>0.005</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>101.919</td>
<td>131</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>0.958</td>
<td>130</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

^a: R Squared = 0.356 (Adjusted R Squared = 0.330)

A two-way analysis of variance was conducted to evaluate the effect of the experimental treatment VCRS given to the experimental group participants. Findings indicated a significant difference between the test scores for the control and experimental groups F (1,
This effect showed that students in the experimental group outperformed students in the control group by using the VCRS. Moreover, there was a main effect in the three testing scores, F(2, 125) = 3.713, p ≤ .05. However, there was not an interaction between the two factors, F(2,125), p= 0.08. Follow up Post Hoc tests were conducted to evaluate the pair-wise differences among the means using a Tukey HSD test. These Post Hoc comparisons showed only one pair-wise difference, the mean score for the third week’s test score had a significant difference than the first week’s test. (Mean Difference: 0. 05455; SD: 0. 01842; p=0.012). An examination of Figure 11 shows that this difference is attributed to the rise in test scores only for the experimental group.

### 5.3. Evaluation of VCRS

#### Table 10: Evaluation of VCRS

<table>
<thead>
<tr>
<th>Question</th>
<th>Average Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall impression of VCRS</td>
<td>3.68</td>
</tr>
<tr>
<td>Effort required in using VCRS</td>
<td>3.32</td>
</tr>
<tr>
<td>Clarity of Images</td>
<td>3.86</td>
</tr>
<tr>
<td>Inspection Material Covered in VCRS</td>
<td>3.77</td>
</tr>
<tr>
<td>Quality of illustration</td>
<td>3.95</td>
</tr>
<tr>
<td>Instructional material for Inspection</td>
<td>3.95</td>
</tr>
<tr>
<td>Arrows accurately pointing at parts</td>
<td>3.5</td>
</tr>
<tr>
<td>User friendliness</td>
<td>4.27</td>
</tr>
<tr>
<td>Retention of Material</td>
<td>4.05</td>
</tr>
<tr>
<td>Knowledge gained</td>
<td>4.05</td>
</tr>
</tbody>
</table>

The VCRS was evaluated by the students in the experimental group. All the questions in this evaluation were based on a Likert scale of 1 to 5, 5 being excellent and 1 being bad. As shown in the above figure, the values in “retention of the material” (M: 4.05) and “user friendliness” (M: 4.27) shows that the participants used VCRS without any significant difficulties and retained the learning material to a resonable degree. Students acknowledged the amount of material that was covered in the VCRS was in line with the material being taught at the MFT.
by rating the “Instructional material for Inspection” almost 4.00 (M: 3.95); Quality of the illustrations was also rated the same (M: 3.95). As shown in Table 10 all of the evaluation questions were rated above 3.00; and the overall rating for the VCRS was M: 3.68. When asked whether the Virtual inspection could be used for the future students, twenty four students out of twenty five reported “Yes”.


CHAPTER 6: DISCUSSION

6.1. Discussion of Results

The purpose of this research was to integrate computer-based VCRS into the conventional truck driving training program at the MFT. As stated in CTBSSP, Brock et al. (2007), Synthesis 13, the computer-based applications used in the CDL truck driving training programs must be in compliance with the 10 characteristics required as mentioned in Table #, and the VCRS fulfills these requirements. Below are the major findings in this research study:

- The students in an experimental group who received conventional training and used the VCRS scored significantly higher as compared to the students in a control group who used conventional training only. This suggests that learning was facilitated by using the VCRS.

- Students using the VCRS showed a moderate tendency to improve their test scores from test 1 to test 3.

- The students evaluated “quality of illustration” and “instructional material for the inspection” fairly high with an average score of 3.95 on the Likert scale of 1 to 5, 5 being excellent whereas 1 being bad.

- Moreover, the students rated “user friendliness”, “retention of material”, and “knowledge gained” with the average score of 4.27, 4.05, and 4.05 respectively on the Likert scale of 1 to 5, 5 being excellent whereas 1 being bad.

65
• All the participants, except one, answered “yes” when asked whether the VCRS can be used for the future truck driving students at the MFT.

These results demonstrate that integrating computer-based application into the CDL driving training can be beneficial as it increases students learning and their performance. The students at the MFT used the VCRS at least three times in four week period; the amount of practice to get similar results by using such VCRS type application may vary in different CDL driving training programs.

6.2. Implications of Results

As described in chapter two, large truck related statistics, the Table 1 and 2 relates to the number crashes and vehicles affected due to the failure of vehicle components such as tires, braking system, and steering system. Most of these vehicles could have been prevented from crashes or casualties if faulty or worn-out parts have been inspected in a timely manner. Lack of knowledge of faulty parts or identifying the lifecycle of the truck parts may also lead to such truck accidents. The VCRS provides detailed procedures for conducting inspections; moreover, it also tests students’ knowledge on handling hazardous material as well as safety procedures. Of course truck drivers need to be proactive and perform inspection of an entire truck for their trips.

6.3. Limitations

To understand, learn, and gather the learning material of first four weeks the principal investigator was required to attend the majority of the classroom sessions during the early phase of designing test-instruments for this research study. The instructors do not keep fixed daily or weekly syllabus. However, at the end of the eight weeks, all the learning material is
finished completely. Nearly all of the topics on inspections were taught in the first four weeks and the students are expected to pass their inspection test prior to the truck-driving test.

Students have to have passed the inspection test and the truck driving test in order to get their CDL Class-A license. The validity of the study depends upon the honesty of the participant answers to the questions

6.4. Suggestions for Future Research

The current version of the VCRS makes use of digital images of the trucks used for training at specific training sites. However, the VCRS has been designed so that it can be configured to incorporate any visually rich digital images of the trucks available at any training institute. Design of the engine compartment is not uniform among truck manufacturers; engine parts located at certain position may not be the same among different manufacturers and this may require reposition of arrows on these engine parts image. The VCRS can integrate such changes with minimal effort without affecting the relational database system. The curriculum in the VCRS can be shortened or expanded depending on the requirements; moreover, the instructor can update the minimum percentage required for the pass grade and can set the time limit to finish the training module. This functionality can be helpful in conducting the research studies or integrating the VCRS at the training institutes whose training requirements are not similar to the MFT.

6.5. Design Recommendation

Integrating the computer-based VCRS into the conventional truck driving training program at the MFT was one of the aims of this research study. In fact, this was its first test and we expected that we would find some design issues which would to be addressed. There were a
number of design issues which were reflected by lower ratings for two of the Likert scale question. The students and instructors actively participated in this study and also evaluated the VCRS. The students gave the lowest ratings to “effort required while using the VCRS” (M: 3.32) and “arrows pointing at the parts” (M: 3.5) on the Likert’s scale of 1 to 5, 5 being excellent whereas 1 being bad. The face-to-face interactions with the instructors and students revealed that the arrows were not accurately pointing at a few of the engine-parts pictures. For example, an arrow not pointing exactly on wiper may confuse student in making selection from wiper or windshield. Such type of misrepresentation can get more complicated while dealing with the parts of an engine compartment. Students do have the flexibility of going back to the previous question and changing their selection. Having the functionality of switching back to prior question can help students in increasing their learning. Digital images do not provide viewing of parts from different angles. Sometimes, this may lead the student in wrongly indentifying the part-type even if the student has a comprehensive understanding of that part. Grouping the pictures taken from different angles can resolve this issue. Additionally, from the student’s feedback, utilizing video can also help in making the correct selection.

Truck drivers need to be motivated in conducting the inspection for every trip, and also should be aware of consequences that might follow if the inspection is not taken seriously. One of the possible solutions is to enhance the VCRS module by adding instructional video material that demonstrates the pros and cons of conducting the inspection. For example, include the module that shows a graphical material of road accident scene involving large trucks; highlight the number of casualties, vehicle and people affected, and the monetary cost of such accidents for the property damage, emergency evacuation, medical support, and the number of days away from work while getting medical treatment.
APPENDIX A: DEMOGRAPHIC INFORMATION
Occupation: ________________________________________________

Highest level of education: ________________________________

Department: _____________________________________________

Major: __________________________________________________

Gender: Male / Female (Please Circle one)

Age (optional): __________

Date (optional): (MM/DD/YYYY): ____/____/________

Do you have any hearing problem?
Yes / No
If yes, please describe it.

___________________________________________________________________________
_____________________________________________________________________

Do you have any problem in vision?
Yes / No
If yes, please describe it.

___________________________________________________________________________

How often do you use the computer?
   a) Up to 5 times a week
   b) Less than 5 times a week
   c) Multiple times each day
   d) Do not use computer

For what do you use the computer?
   a) E-mail
   b) Accessing Internet for shopping, banking, etc.
   c) Data processing
   d) Gaming and entertainment

What is your level of computer expertise?
   a) Beginner
   b) Some experience
   c) Fair amount of experience
   d) Expert
   e) Programmer and software development
APPENDIX B: INFORMED CONSENT
General: Please read this consent document carefully before you decide to participate in this study. Upon completion of your reading it, please sign if you agree to participate. “You must be 18 years of age or older to participate.”

Project title: Computer Based Virtual Check Ride Inspection for Transfer of Training

Privacy Protection: University of Central Florida’s Institute for Simulation and Training (IST) maintains a secure records holding area that only those who need to know can access. All the paper documents will be kept in locked cabinet. The information from the paper will be tabulated in the password protected computer.

Purpose of the research study: To investigate the effectiveness of virtual check ride Pre-trip inspection in CDL test.

What you will be asked to do in the study: Fill out a demographic survey, participate in the computer based training and fill out the post test survey. You will be asked to do inspection of various parts of the truck using computer based application.

Time required: One hour.

Risks: This study may make use of desktop computer with flat panel monitor. Risks are no greater than those normally encountered in the daily lives of healthy people using computers.

Information regarding your rights as a research volunteer may be obtained from:
IRB Coordinator
Institutional Review Board (IRB)
University of Central Florida (UCF)
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: (407) 823-2901

Benefits / Compensation: Potential benefits are: Increase your skills and knowledge by using computer based application in education and training. There is no monetary compensation. Decision to give extra credit will be made by individual instructors.

Confidentiality: Your identity will be kept confidential to the extent provided by law. Your name will not be used in any report.

Voluntary participation: Your participation in this study is voluntary. There is no penalty for not participating. There is no penalty for declining videotaping should you be asked to tape your game-play.

Right to withdraw from the study: You have the right to withdraw from the study at any time without consequence.

Whom to contact if you have questions about the study:
Table 3: Contact Information

<table>
<thead>
<tr>
<th>Name</th>
<th>Contact number</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ron Tarr</td>
<td>407-822-1391</td>
<td>Institute for Simulation and Training. 3280 Progress Dr., Orlando, FL 32826.</td>
</tr>
<tr>
<td>Dr. James Whitmire</td>
<td>407-882-0290</td>
<td>Institute for Simulation and Training. 3280 Progress Dr., Orlando, FL 32826.</td>
</tr>
<tr>
<td>Alpesh P. Makwana</td>
<td>407-882-0289</td>
<td>Institute for Simulation and Training. 3280 Progress Dr., Orlando, FL 32826.</td>
</tr>
</tbody>
</table>

I have read the procedure described above.

I voluntarily agree to participate in the procedure.

I have received a copy of this description.

/  
Participant  Date
APPENDIX C: DRIVER COPING QUESTIONNAIRE
These questions are concerned with how you usually deal with driving when it is difficult, stressful or upsetting. Think of those occasions during the last year when driving was particularly stressful. Perhaps you nearly had an accident, or you were stuck in a traffic jam, or you had to drive for a long time in poor visibility and heavy traffic. Use your experiences of driving during the last year to indicate how much you usually engage in the following activities when driving is difficult, stressful or upsetting, by circling one of the numbers from 0 to 5 to the right of each question.

<table>
<thead>
<tr>
<th>Very much</th>
<th>Not at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

1. Relieved my feelings by taking risks or driving fast
2. Cheered myself up by thinking about things unrelated to the drive
3. Stayed detached or distanced from the situation
4. Tried to make other drivers more aware of me by driving close behind them
5. Wished that I was a more confident and forceful driver
6. Ignored my feelings about the drive
7. Made sure I avoided reckless or impulsive actions
8. Showed other drivers what I thought of them
9. Drove assertively or aggressively
10. Tried to gain something worthwhile from the drive
11. Showed other drivers I was in control of the situation
12. Made an extra effort to drive safely
13. Felt that I was becoming a more experienced driver
14. Made an effort to stay calm and relaxed
15. Swore at other drivers (aloud or silently)
16. Thought about good times I've had
17. Wished that I found driving more enjoyable
18. Made sure I kept a safe distance from the car in front
19. Went on as if nothing had happened
20. Refused to believe that anything unpleasant had happened
21. Told myself there wasn't really any problem
22. Let other drivers know they were at fault
23. Criticised myself for not driving better
24. Thought about the consequences of having an accident
25. Flashed the car lights or used the horn in anger
26. Felt I was learning how to cope with stress  
   3  0  1  2

27. Deliberately slowed down when I met a difficult traffic situation or  
   bad weather  
   3  0  1  2

28. Made a special effort to look out for hazards  
   3  0  1  2

29. Blamed myself for getting too emotional or upset  
   3  0  1  2

30. Concentrated hard on what I had to do next  
   3  0  1  2

31. Worried about what I was going to do next  
   3  0  1  2

32. Looked on the drive as a useful experience  
   3  0  1  2

33. Worried about my shortcomings as a driver  
   3  0  1  2

34. Thought about the benefits I would get from making the journey  
   3  0  1  2

35. Learnt from my mistakes  
   3  0  1  2
APPENDIX D: EVALUATION OF COMPUTER-BASED INSPECTION
Please tick-mark one of the available choices:

**Note:** Virtual Check Ride is the computer application that you have used in the computer lab at Mid Florida Tech.

**Overall impression**
How do you rate the quality of the Virtual Check Ride?
☐ Excellent  ☐ Good  ☐ Fair  ☐ Poor  ☐ Bad

**Effort**
How would you describe the effort were required to make in order to understand the material covered in Virtual Check Ride?
- ☐ Complete relaxation possible; no effort required
- ☐ Attention necessary; no appreciable effort required
- ☐ Moderate effort required
- ☐ Effort required
- ☐ No meaning understood with any feasible effort.

**Visibility problem**
Did you find certain images unclear and blur?
- ☐ None
- ☐ Few
- ☐ Some
- ☐ Majority of the images
- ☐ All of the images

**How much material of Inspection is covered in Virtual Check Ride?**
- ☐ All of the material
- ☐ Majority of the material
- ☐ Some of the material
- ☐ Less
- ☐ None

**Acceptance**
Do you think that the Virtual Check Ride could be used for future truck driving students?
- ☐ Yes
- ☐ No

**Please rate the instructional material that you have just used**

5 = Highest rating (Excellent)
1 = Lowest rating (Bad)

1. Quality of illustration
<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Instructional material for Inspection</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

<p>| | | | | |</p>
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</tr>
</thead>
<tbody>
<tr>
<td>3. Presentation of parts using arrows</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

<p>| | | | | |</p>
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</tr>
</thead>
<tbody>
<tr>
<td>4. User friendliness</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

<p>| | | | | |</p>
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<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>5. Retention of Material</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

<p>| | | | | |</p>
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<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>6. Knowledge gained?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

**Comments:**

________________________________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________

______________
APPENDIX E: IRB LETTER – GREGORY OLSON
Subject: Endorsement Agreement

Ronald W. Tarr
Program Director & Principal Investigator
Advanced Performance Technology
Institute for Simulation and Training
University of Central Florida

I verify that as a Mid Florida Tech instructors, I understand my role as part of the subject study, and my role to recruit and monitor students from my class. My fellow instructors have been working with members of the UCF study team for the last few months and are ready to begin a series of research experiments using the Virtual Check Ride System to determine ways to enhance the Commercial Driver License (CDL) training here at Mid Florida Tech. The first of these research efforts will look at the Pre-Trip Inspection. I understand that as part of the research procedure at the University of Central Florida (UCF) a research oversight organization, the Institutional Review Board (IRB), requires permission from any agencies personnel, in this case Mid Florida Tech instructors; my understanding of my role and permission to participate is provided by my signature below.

Name: [Signature]
Signature: [Signature]
Date: 9-17-08
APPENDIX F: IRB LETTER –DERRAN OAKES
Subject: Endorsement Agreement

Ronald W. Tarr  
Program Director & Principal Investigator  
Advanced Performance Technology  
Institute for Simulation and Training  
University of Central Florida  

I verify that as a Mid Florida Tech instructors, I understand my role as part of the subject study, and my role to recruit and monitor students from my class. My fellow instructors have been working with members of the UCF study team for the last few months and are ready to begin a series of research experiments using the Virtual Check Ride System to determine ways to enhance the Commercial Driver License (CDL) training here at Mid Florida Tech. The first of these research efforts will look at the Pre-Trip Inspection. I understand that as part of the research procedure at the University of Central Florida (UCF) a research oversight organization, the Institutional Review Board (IRB), requires permission from any agencies personnel, in this case Mid Florida Tech instructors; my understanding of my role and permission to participate is provided by my signature below.

Name: [Signature]

Signature: [Signature]  
Date: 4/17/08
Subject: Endorsement Agreement

Ronald W. Tarr  
Program Director & Principal Investigator  
Advanced Performance Technology  
Institute for Simulation and Training  
University of Central Florida

I verify that as a Mid Florida Tech instructors, I understand my role as part of the subject study, and my role to recruit and monitor students from my class. My fellow instructors have been working with members of the UCF study team for the last few months and are ready to begin a series of research experiments using the Virtual Check Ride System to determine ways to enhance the Commercial Driver License (CDL) training here at Mid Florida Tech. The first of these research efforts will look at the Pre-Trip Inspection. I understand that as part of the research procedure at the University of Central Florida (UCF) a research oversight organization, the Institutional Review Board (IRB), requires permission from any agencies personnel, in this case Mid Florida Tech instructors; my understanding of my role and permission to participate is provided by my signature below.

Name: [Signature]

Signature: [Signature] Date: 04-17-08
Subject: Endorsement Agreement

Ronald W. Tarr  
Program Director & Principal Investigator  
Advanced Performance Technology  
Institute for Simulation and Training  
University of Central Florida

I verify that as a Mid Florida Tech instructors, I understand my role as part of the subject study, and my role to recruit and monitor students from my class. My fellow instructors have been working with members of the UCF study team for the last few months and are ready to begin a series of research experiments using the Virtual Check Ride System to determine ways to enhance the Commercial Driver License (CDL) training here at Mid Florida Tech. The first of these research efforts will look at the Pre-Trip Inspection. I understand that as part of the research procedure at the University of Central Florida (UCF) a research oversight organization, the Institutional Review Board (IRB), requires permission from any agencies personnel, in this case Mid Florida Tech instructors; my understanding of my role and permission to participate is provided by my signature below.

Name: {handwritten: "Mark Swift"}  
Signature: {handwritten: "Mark Swift"}  
Date: 4/22/08
APPENDIX I: FEEDBACK IN VCRS
Upon completion of the virtual inspection, the student is able to review the result and feedback of the test at any time. The FIGURE below shows questions, correct answer, student’s answer, and an image related to a question. Different colors are used to highlight the correct choices, mistaken choices, and missed choices. As shown in Figure 4, the red highlighted area shows that the student’s answer was incorrect. The green highlighted answer shows that the student’s answer was correct; whereas, the yellow highlighted area shows the correct answer(s) that were missed. The image related to a question will open in a new window that has large image size; this functionality helps students in analyzing additional details by leveraging large clear image. A report is also generated to show the statistics of the test.

![Figure 12: VCRS Feedback](image)

In the test review, an image is displayed next to the parts identification questions. When this image is clicked, a new window gets opened and a larger picture of this image is displayed. This larger image shows closer view of the arrows pointing to a picture; this functionality helps students in analyzing the details of a particular part and its adjoining parts.
Reporting in VCRS

The report of VCRS is segregated into sections categorized by parts type. For example the engine compartment parts are categorized into: Engine Hose and Power Steering, Engine Compartment Belts, and Gauges. This is illustrated in figure# and figure#. In this report a numerical score is calculated based on the student’s performance; numerical value is generated for correctly identified parts and defect-questions. This analysis may be helpful to students in identifying their strengths and weakness in certain components of inspection. For example, as shown in figure#, student scored well in the section of Kingpin; whereas score on Tandem release and Slide Pin is poor. The report also shows the total score on correctly identified parts and defect-questions. In this example the student scored 91% and 80 on questions of parts and defects respectively.
Virtual Walk-Around Test Report

<table>
<thead>
<tr>
<th>Subsection ID</th>
<th>Subsection</th>
<th>Part Identification Questions</th>
<th>No. of Correct - Part Id.</th>
<th>Possible Defects Questions</th>
<th>No. of Correct - Possible Defects</th>
<th>Parts %</th>
<th>Defects %</th>
</tr>
</thead>
<tbody>
<tr>
<td>101</td>
<td>Engine Hose and Power Steering</td>
<td>16</td>
<td>16</td>
<td>4</td>
<td>3</td>
<td>100%</td>
<td>75%</td>
</tr>
<tr>
<td>102</td>
<td>Engine Hose and Power Steering</td>
<td>16</td>
<td>14</td>
<td>3</td>
<td>2</td>
<td>88%</td>
<td>67%</td>
</tr>
<tr>
<td>103</td>
<td>Engine Compartment Belts</td>
<td>9</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>68%</td>
<td>100%</td>
</tr>
<tr>
<td>104</td>
<td>Gauges</td>
<td>6</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>105</td>
<td>Mirrors and windshield</td>
<td>14</td>
<td>14</td>
<td>2</td>
<td>2</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>106</td>
<td>Emergency</td>
<td>8</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>75%</td>
<td>100%</td>
</tr>
<tr>
<td>107</td>
<td>Brake Valves</td>
<td>8</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>108</td>
<td>Lights &amp; Reflectors</td>
<td>9</td>
<td>9</td>
<td>8</td>
<td>6</td>
<td>90%</td>
<td>75%</td>
</tr>
<tr>
<td>109</td>
<td>Steering Gear Box</td>
<td>9</td>
<td>7</td>
<td>3</td>
<td>3</td>
<td>78%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Figure 14: Test report in the VCRS -1
Currently, VCRS can store the result of only one test. If the user re-takes the test then, the VCRS will overwrite the existing score and result with this new test score and result. There are two control buttons for test-report, logout and back-to-report-page. Upon clicking logout button, the user will exit VCRS; whereas back-to-report-page will direct the user to report’s home page as shown in figure#.
Figure 16: Types of report in the VCRS
APPENDIX J: VEHICLE CONTROL SKILLS
At MFT the students are tested for their basic vehicle control skills using the below driving exercises on the driving field of MFT:

- Straight line backing.
- Offset back/right
- Offset back/left
- Parallel park (driver side).
- Parallel park (conventional).
- Alley dock.

These skills are practiced during the first four weeks of their training. While practicing these skills, students get a chance of interacting with different truck parts and its components which enforce them to remember their names and identify their defects, if present.

Alley Doc: In this maneuver, the student driver is asked to back his/her vehicle into the alley, bringing the rear of the vehicle as near as possible to the rear of the alley without touching or moving over the boundaries of cones.

**Straight line backing:** As shown in Figure 17 the student driver need to back the vehicle in a straight line without touching or moving over the boundaries of cones.
Offset back/right: As shown in Figure 18 the student driver is asked to back into the spot located on the right side of his/her vehicle. This needs to be done without hitting the boundary cones on left, right and rear sides. The vehicle needs to be completely in the area covered by the cones.

Offset back/left: As shown in Figure 19 the student driver is asked to back into the spot located on the left side of his/her vehicle. This needs to be done without hitting the boundary cones on left, right and rear sides. The vehicle needs to be completely in the area covered by the cones.

Parallel park (conventional) In this driving skill, the student driver is asked to park the vehicle in a space located on his/her right side. The student needs to drive past the parking
spot and back into it. Bring the rear side of the vehicle as near as possible without crossing over or hitting the cones on the rear side. The vehicle needs to be completely in the area covered by the cones.

**Parallel park (driver side):** In this driving skill (refer Figure 21) the student driver is asked to park the vehicle in a space located on his/her left side. The student needs to drive past the parking spot and back into it. Bring the rear side of the vehicle as near as possible without crossing over or hitting the cones on the rear side. The vehicle needs to be completely in the area covered by the cones.
APPENDIX K: LARGE TRUCK CRASH DUE TO PARTS FAILURE
Figure 23: Number of Crashes, Fatality Analysis Reporting System, 2000 to 2008

Figure 24: Number of Persons Affected, Fatality Analysis Reporting System, 2000 to 2008
Figure 25: Number of Vehicles affected, Fatality Analysis Reporting System, 2000 to 2008
APPENDIX L: POST HOC TEST
**POST HOC TEST**

Table 11: Control Group – Post Hoc Test

<table>
<thead>
<tr>
<th>Test</th>
<th>Test</th>
<th>Mean Difference</th>
<th>Std. Error</th>
<th>Sig.</th>
<th>95% Confidence Interval Lower Bound</th>
<th>95% Confidence Interval Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test1</td>
<td>Test2</td>
<td>4.381</td>
<td>2.477</td>
<td>0.189</td>
<td>0.1034</td>
<td>0.0623</td>
</tr>
<tr>
<td>Test2</td>
<td>Test3</td>
<td>0.269</td>
<td>2.477</td>
<td>0.993</td>
<td>0.1058</td>
<td>0.0158</td>
</tr>
<tr>
<td>Test3</td>
<td>Test1</td>
<td>4.381</td>
<td>2.477</td>
<td>0.189</td>
<td>0.1015</td>
<td>0.0103</td>
</tr>
<tr>
<td>Test3</td>
<td>Test3</td>
<td>4.650</td>
<td>2.507</td>
<td>0.161</td>
<td>0.0166</td>
<td>0.0138</td>
</tr>
</tbody>
</table>

Table 12: Experimental Group – Post Hoc Test

<table>
<thead>
<tr>
<th>Test</th>
<th>Test</th>
<th>Mean Difference</th>
<th>Std. Error</th>
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<td>0.510</td>
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<td>Test2</td>
<td>3.523</td>
<td>1.842</td>
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<td>0.0089</td>
<td>0.0794</td>
</tr>
</tbody>
</table>
APPENDIX M: IRB CONSENT PROCEDURE
Notice of Expedited Initial Review and Approval

From: UCF Institutional Review Board
FWA0000035, Exp. 5/07/10, IRB00001138
To: Alpesh P. Makwana
Date: April 18, 2008
IRB Number: SBE 08 01538

Study Title: COMPUTER BASED VIRTUAL CHECK RIDE PRETRIP INSPECTION FOR TRANSFER OF TRAINING

Dear Researcher:

Your research protocol noted above was approved by expedited review by the UCF IRB Vice-chair on 4/18/2008. The expiration date is 4/17/2009. Your study was determined to be minimal risk for human subjects and expeditable per federal regulations, 45 CFR 46.110. The category for which this study qualifies as expeditable research is as follows:

7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing surveys, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

The IRB has approved a consent procedure which requires participants to sign consent forms. Use of the approved, stamped consent document(s) is required. Only approved investigators or other approved key study personnel may solicit consent for research participation. Subjects or their representatives must receive a copy of the consent form(s).

All data, which may include signed consent form documents, must be retained in a locked file cabinet for a minimum of three years (or if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained on a password-protected computer if electronic information is used. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel.

To continue this research beyond the expiration date, a Continuing Review Form must be submitted 2 – 4 weeks prior to the expiration date. Advise the IRB if you receive a subpoena for the release of this information, or if a breach of confidentiality occurs. Also report any anticipated problems or serious adverse events (within 5 working days). Do not make changes to the protocol methodology or consent form before obtaining IRB approval. Changes can be submitted for IRB review using the Addendum/Modification Request Form. An Addendum/Modification Request Form cannot be used to extend the approval period of a study. All forms may be completed and submitted online at http://irb.ucf.edu.

Failure to provide a continuing review report could lead to study suspension, a loss of funding and/or publication possibilities, or reporting of noncompliance to sponsors or funding agencies. The IRB maintains the authority under 45 CFR 46.110(e) to observe or have a third party observe the consent process and the research.

On behalf of Tracy Detz, Ph.D., UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Marzorini on 04/18/2008 02:02:10 PM EDT

IRB Coordinator
1) When inspecting engine hoses, which statement(s) best indicate potential problems? Select all that apply.

- Look for dripping fluids on underside of engine and transmission
- Check the belt for snugness (up to 3/4 inch play at center of belt), cracks, or frays.
- See that oil level is within safe operating range. Level must be 1 inch below the refill mark so it has room to expand when heated.
- Make sure the temperature gauge is working; the temperature should begin to climb to the normal operating range or temperature light should be off.
- Look for puddles on the ground
- Inspect hoses for condition and leaks

2) When inspecting the oil level, which statement(s) is/are true? Select all that apply.

- See that oil level is within safe operating range. Level must be above refill mark.
- Inspect reservoir sight glass
- Make sure component(s) are operating properly, are not damaged or leaking, and are mounted securely.

3) When inspecting the coolant level, which statement(s) best indicate proper procedure? Select all that apply.

- When engine is hot, remove radiator cap and check for visible coolant level.
- This part of the pre-trip can be skipped.
- If engine is not hot, remove radiator cap and check for visible coolant level.
- Inspect reservoir sight glass

4) When inspecting the power steering fluid, which statement(s) is/are true? Select all that apply.

- See that power steering fluid level is within safe operating range. Level must be above refill mark.
- Check the belt for snugness (up to 3/4 inch play at center of belt), cracks, or frays.
- See that oil level is within safe operating range. Level must be 2 inches below the refill mark so it has room to expand when heated.
5) When inspecting the oil pressure gauge, which of the following statement(s) is/are true? Select all that apply.

☐ Not all vehicles have oil pressure gauges; for those that do not, you can skip this part of the pre-trip inspection.
☐ Make sure oil pressure gauge is working; oil temperature gauge should begin a gradual rise to the normal operating range.
☐ If the warning light does not turn off, do no worry about it; it is probably just a loose wire.
☐ Check that pressure gauge shows increasing or normal oil pressure or that the warning light goes off.

6) When inspecting the temperature gauge, which of the following statement(s) is/are true? Select all that apply.

☐ Not all vehicles have a temperature gauges; for vehicles that do not, you can skip this part of the pre-trip inspection.
☐ If the temperature light does not turn off, do not worry about it; it is probably just a loose wire.
☐ Make sure the temperature gauge is working; the temperature should begin to climb to the normal operating range or temperature light should be off.

7) When discussing steering play, which of the following statement(s) is/are true? Select all that apply.

☐ For non-power steering vehicles, check for excessive play by turning steering wheel back and forth. Play should not exceed 10 degrees (or about two inches on a 20-inch wheel).
☐ For non-power steering vehicles, check the LED read out meter on the dash by turning the steering wheel back and forth. Play should not exceed 10 degrees (or about 2 inch on a 20-inch wheel) before front left wheel barely moves.
☐ For vehicles with power steering, with the engine running, check for excessive play by turning the steering wheel back and forth. Play should not exceed 10 degrees (or about two inches on a 20-inch wheel) before front left wheel barely moves.
☐ For vehicles with power steering, with the engine running, check the LED read out meter on the dash by turning the steering wheel back and forth. Play should not exceed 10 degrees (or about 2 inch on a 20-inch wheel) before front left wheel barely moves.

8) When inspecting the wipers/washers which of the following statement(s) is/are true? Select all that apply.

☐ Check that wiper arms and blades are secure, not damaged, and operates smoothly.
☐ Time the wipers at their interval speeds to verify they are operating properly.
☐ Check for the expiration date on the blades; they can not be more than 1 month old.
9) When inspecting the lighting indicators, which of the following statement(s) is/are true? Select all that apply.

- Test that dashboard indicators work when corresponding lights are turned on for Left turn signal, Right turn signal, Four-way emergency flashers and High beam headlights.
- The four-way emergency flashers do no need to work as long as you have the red reflective emergency triangles.

10) When inspecting lights, which of the following must be included? Select the correct five answers.

- Brake lights
- Headlights (high and low beams)
- Clearance lights (red on rear, amber elsewhere).
- Dashboard lights
- Dashboard indicator lights
- Map reading light
- Four-way flashers
- Taillights
- Parking lights
- Turn signals

11) When inspecting reflectors, which statement(s) is/are correct? Select all that apply.

- Clearance lights (red on rear, amber elsewhere).
- Red reflectors are on the rear.
- Amber reflectors are everywhere else.
- Red reflectors are everywhere else.

12) When inspecting the spring brakes, which statement(s) is/are true? Select all that apply.

- Look for leaks.
- Look for broken or distorted coil springs.
- Cracks are acceptable.
- Look for missing, shifted, cracked, or broken leaf springs.
13) When inspecting an air suspension system which statement(s) is/are true? Select all that apply.
- Leaking is acceptable.
- Air ride suspension should be checked for damage and leaks.
- Damage is acceptable.

14) When inspecting torsion bars or torque arms, which statement(s) is/are true? Select all that apply.
- If vehicle is equipped with torsion bars, torque arms, or other types of suspension components, check that they are not damaged and are mounted securely.
- Check for leaking.
- Mounting can be loose but not broken.

15) When inspecting the exhaust system, which statement(s) is/are correct? Select all that apply.
- If equipped, check that spacers are not bent, damaged, or rusted through.
- Check system for damage and signs of leaks such as rust or carbon soot.
- The system mounting can be loose.
- System should be connected tightly and mounted securely.

16) When inspecting the locking jaws, which statement(s) is/are correct? Select all that apply.
- Look into the fifth wheel gap and check that the locking jaws are partially closed around the kingpin.
- Safety cables or chains must be secure and free of kinks and sufficiently slack.
- Look into the fifth wheel gap and check that the locking jaws are fully closed around the kingpin.

17) When inspecting the platform (fifth wheel), which statement(s) is/are correct? Select all that apply.
- Check that the fifth wheel is positioned properly so that the tractor frame will clear the landing gear during turns.
- Check for cracks or breaks in the platform structure which supports the fifth wheel skid plate.
- Check for cracks or breaks in the platform structure which supports the kingpin.
IDENTIFICATION OF PARTS

Question: 1

Figure 26: Gauges

<table>
<thead>
<tr>
<th>Part</th>
<th>a</th>
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<td>Fuel Gauge</td>
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<tr>
<td>Oil Pressure Gauge</td>
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Question: 2

Figure 27: Brakes and air control

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**Question: 3**

![Figure 28: Lights and Reflectors](image)

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Question 4

Figure 29: Fire Extinguisher

- Clutch Pedal: None
- Fuel Pedal: None
- Engine Housing: None
- Gear Shift: None
- Brake Pedal: None
- Fire Extinguisher: None
- Red Reflective Triangle: None
- Driver Grab Rail: None
Question 5

Figure 30: Exhaust and Mirrors

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Question 6

Figure 31: Kingpin

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<td>Pivot Pin</td>
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<tr>
<td>Slide Stops</td>
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<td>Slide Locking Pin</td>
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<td>Locking Jaw</td>
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</table>
1) When inspecting the mirrors, which statement(s) is/are true? Select all that apply.

- Look for leaks of any kind.
- Mirrors should be clean and adjusted properly from the inside.
- The mirrors should be adjusted while driving down the road in order to get the proper line of sight.

2) When inspecting the windshield which statement(s) is/are true? Select all that apply.

- Any sticker is acceptable as long as it does not directly obstruct the driver's view.
- Windshield should be clean with no illegal stickers, no obstructions, or damage to the glass.
- Look for leaks of any kind.

3) Which of the following statement(s) is/are true when inspecting emergency equipment? Select all that apply.

- Check for spare electrical fuses.
- Check for three red reflective triangles.
- Check for seven red reflective triangles, three for the front and four for the back.
- Check for flare gun in case you are stranded.
- Check for a properly charged and rated fire extinguisher.

4) When inspecting automatic slack adjusters, which of the following statement(s) is/are correct? Select all that apply.

- See that brake chambers are not leaking, cracked, or dented and are mounted securely.
- Look for broken, loose, or missing parts.
- Missing parts are acceptable as long as there are more present than missing. For instance if 1 of 4 parts are missing, it is ok, however if 3 of 4 parts are missing.

5) When inspecting manual slack adjusters, which of the following statement(s) is/are correct? Select all that apply.

- For manual slack adjusters, the brake rod should not move more than two inches (with the brakes released) when pulled by hand.
- For manual slack adjusters, the brake rod should not move more than one inch (with the brakes released) when pulled by hand.
6) When inspecting brake chambers, which statement(s) is/are correct? Select all that apply.
- Cracks are acceptable.
- See that brake chambers are not leaking, cracked, or dented and are mounted securely.
- Brake chambers can be loose but not broken.

7) When inspecting drum brakes, which of the following statement(s) is/are correct? Select all that apply.
- Check for cracks, dents, or holes, as well as loose or missing bolts.
- Cracks are acceptable.
- Missing bolts are acceptable as long as there are more present than missing. For instance, if 1 of 4 bolts are missing, it is ok; however if 3 of 4 bolts are missing it is not ok.

8) When inspecting rims, which statement(s) is/are correct? Select all that apply.
- Bent rims are acceptable but cracked rims are not.
- Welding repairs are acceptable.
- Check for damaged or bent rims; rims cannot have welding repairs

9) When inspecting hub oil seals/axle seals, which statement(s) is/are correct? Select all that apply.
- Sight glass is not always accurate for checking oil levels; therefore you must always use the dipstick.
- See that hub oil/grease seals and axle seals are not leaking.
- Leaks are acceptable

10) When inspecting lug nuts, which statement(s) is/are correct? Select all that apply.
- Check that all lug nuts are present, free of cracks and distortions, and show no signs of looseness such as rust trails or shiny threads.
- Cracks are acceptable.
- Missing lug nuts are acceptable as long as there are more present than missing. For instance, if 1 of 4 lug nuts are missing, it is ok; however, if 3 of 4 lug nuts are missing it is not ok.
11) When inspecting tires, which statement(s) is/are correct? Select all that apply.
- Tire inflation: Check for proper inflation by using a tire gauge, or inflation by striking tires with a mallet or other similar device.
- Tread depth: Check for minimum tread depth (4/32 on steering axle tires, 2/32 on all other tires).
- Tread depth: Check for minimum tread depth (8/32 on steering axle tires, 6/32 on all other tires).
- Tire condition: Check that tread is evenly worn and look for cuts or other damage to tread or sidewalls. Also, make sure that valve caps and stems are not missing, broken, or damaged.
- Tread depth: Check for minimum tread depth (5/32 on steering axle tires, 3/32 on all other tires).

12) When inspecting spacers, which statement(s) is/are correct? Select all that apply.
- Spacers should be evenly centered, with the dual wheels and tires evenly separated.
- Spacers should be evenly centered, with the dual wheels and tires separated by exactly 16 inches.
- If equipped, check that spacers are not bent, damaged, or rusted through.
- Bent spacers are acceptable.

13) When inspecting the fuel tank, which statement(s) is/are correct? Select all that apply.
- Check that tank(s) are secure, cap(s) are tight, and that there are no leaks from tank(s) or lines.
- Check for leaks from tank(s) or lines, small drips are acceptable.
- The tank mounting can be loose but can not be cracked or broken.

14) When inspecting the battery box, which statement(s) is/are correct? Select all that apply.
- Cell caps are not necessary.
- Wherever located, see that battery(s) are secure, connections are tight, and cell caps are present.
- As long as battery connections make contact, they do not need to be tight.
- Battery box and cover or door must be secure.
- Battery connections should not show signs of excessive corrosion.

15) When inspecting doors, ties and lifts, which statement(s) is/are correct? Select all that apply.
- Check that doors and hinges are not damaged and that they open, close, and latch properly from the outside, if equipped.
- Missing parts on a cargo lift are acceptable.
- Lift must be fully retracted and latched securely.
If equipped with a cargo lift, look for leaking, damaged or missing parts and explain how it should be checked for correct operation.

- Ties, straps, chains, and binders must also be secure.
- Check that the lift is off the ground enough to drive.

16) When inspecting the release arm (fifth wheel), which statement(s) is/are correct? Select all that apply
   - Check to see if the kingpin is loose.
   - Look for holes and leaking.
   - If equipped, make sure the release arm is in the engaged position and the safety latch is in place.

17) When inspecting the locking pins (fifth wheel) which statement(s) is/are correct? Select all that apply
   - Check that the fifth wheel is positioned properly so that the tractor can make wide sweeping turns.
   - If equipped, look for loose or missing pins in the slide mechanism of the sliding fifth wheel. If air powered, check for leaks.
   - Make sure locking pins are unengaged during inspection.
   - Make sure locking pins are fully engaged.

18) When inspecting the kingpin, which statement(s) is/are correct? Select all that apply.
   - Make sure the kingpin is made of high tech plastic.
   - Check that the kingpin is not bent.
   - Check to see if the kingpin is the correct size.

19) When inspecting the apron, which statement(s) is/are correct? Select all that apply.
   - Make sure the visible part of the apron is not bent, cracked, or broken.
   - Make sure the apron is loosely attached.
   - Check that the landing gear is fully raised.
PARTS IDENTIFICATION

Question 1

Figure 32: Front Lights

- **Right Turn Signal**
  - a
  - b
  - c
  - d
  - None

- **Rearview Mirror**
  - a
  - b
  - c
  - d
  - None

- **Driver Side Review Mirror**
  - a
  - b
  - c
  - d
  - None

- **Clearance Lamp**
  - a
  - b
  - c
  - d
  - None

- **Left Turn Signal**
  - a
  - b
  - c
  - d
  - None

- **Windsheild Wiper**
  - a
  - b
  - c
  - d
  - None

- **Four-way Flashers**
  - a
  - b
  - c
  - d
  - None

- **Windshield**
  - a
  - b
  - c
  - d
  - None
Question 2

Figure 33: Lights and Mirrors

<table>
<thead>
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Question 3

Figure 34: Brake Chamber

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Question 4

Figure 35: Rim and Brake Shoe

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Question 5

![Figure 36: Tire and Lug Nut](image)

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Question 6

Figure 37: Rim and Hub Oil

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Question 7

Figure 38: Tire and Valve Stem

Air Bag Mount  a b c  None
Spring Mount  a b c  None
Valve Stem  a b c  None
Air Bag  a b c  None
Lug Nut  a b c  None
Tire  a b c  None
Question 8

Figure 39: Frame

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Figure 40: Fuel Tank
Question 10

Figure 41: Door Latch

Door Hinge  a  b  c  c  None
Door Latch  a  b  c  c  None
Door Seal  a  b  c  c  None
Splash Guard  a  b  c  c  None
Brake Light  a  b  c  c  None
ICC Bumper  a  b  c  c  None
Question 11

Figure 42: Brake Lights

Door Hinge [ ] a [ ] b [ ] c [ ] None
Door Seal [ ] a [ ] b [ ] c [ ] None
Reflector [ ] a [ ] b [ ] c [ ] None
Brake Light [ ] a [ ] b [ ] c [ ] None
Door Latch [ ] a [ ] b [ ] c [ ] None
Door Hook [ ] a [ ] b [ ] c [ ] None
Question 12

Figure 43: Side Locking Pin

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Question 13

Figure 44: Kingpin

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</table>
1) When inspecting the power steering belt, which statement(s) is/are true? Select all that apply.
- Check the belt for snugness (up to 3 inches play at center of belt), cracks, or frays.
- There is no need to tell the examiners which component(s) are not belt driven; they already know.
- Check the belt for snugness (up to 3/4 inch play at center of belt), cracks, or frays.

2) When inspecting mounts, which of the following statement(s) is/are correct? Select all that apply.
- Cracks are acceptable.
- Missing bolts and ubolts are acceptable as long as there are more present than missing. For instance if 1 of 4 bolts are missing, it is ok, however if 3 of 4 bolts are missing it is not ok.
- Look for cracked or broken spring hangers, missing or damaged bushings, and broken, loose, or missing bolts, ubolts or other axle mounting parts. (The mounts should be checked at each point where they are secured to the vehicle frame and axle[s]).

3) When inspecting shock absorbers, which statement(s) is/are correct? Select all that apply.
- Shock absorbers are no longer used.
- See that shock absorbers are secure and that there are no leaks.
- One missing shock absorber does not matter.

4) When inspecting the frame, which statement(s) is/are correct? Select all that apply.
- Small holes are acceptable.
- Look for cracks, broken welds, holes or other damage to the longitudinal frame members, cross members, box, and floor.
- Cracks, broken welds, holes or other damage is acceptable.

5) When inspecting the drive shaft, which statement(s) is/are correct? Select all that apply.
- The drive shaft can be slightly bent.
- See that the drive shaft is not bent or cracked.
- Couplings can be loose.
- Couplings should be secure and free of foreign objects.
6) When inspecting the air connections, which statement(s) is/are correct? Select all that apply.
☐ Trailer air connectors should never be sealed.
☐ Make sure glad hands are not locked in place.
☐ Check that trailer air connectors are sealed and in good condition.
☐ Make sure glad hands are locked in place, free of damage, and have no air leaks.

7) When inspecting the electrical connections, which statement(s) is/are correct? Select all that apply.
☐ Make sure lamps turn off when electrical system is connected
☐ Make sure the trailer electrical plug is firmly seated and locked in place.
☐ Make sure glad hands are not locked in place.

8) When inspecting the catwalk, which statement(s) is/are correct? Select all that apply.
☐ Check that the catwalk is solid, clear of objects, and securely bolted to the lift.
☐ Check that the catwalk is solid, clear of objects, and securely bolted to tractor frame.
☐ Check that the catwalk is solid, clear of objects, and securely bolted to the fuel tank.

9) When inspecting mounting bolts, which statement(s) is/are correct? Select all that apply.
☐ Both the fifth wheel and the slide mounting must be loosely attached, to allow for the trailer to move easily with the truck.
☐ Loose mounting brackets, clamps, bolts, or nuts are acceptable.
☐ Look for loose or missing mounting brackets, clamps, bolts, or nuts. Both the fifth wheel and the slide mounting must be solidly attached.

10) When inspecting the landing gear, which statement(s) is/are correct? Select all that apply.
☐ If power operated, check for air or hydraulic leaks.
☐ If manually operated, check for cracks in air or hydraulic system.
☐ Check that the landing gear is raised at least enough to clear the ground.
☐ Check that the landing gear has no missing parts, the crank handle is secure, and the support frame is not damaged.
☐ Check that the landing gear is fully raised.

11) When inspecting the tandem release arm which statement is correct?
☐ Make sure the release arm is loose so that it moves easily for adjustments.
Make sure the release arm is the proper length for the trailer.
Make sure the release arm is secured.

12) When inspecting the locking pins which statement is correct?
Make sure the locking pins are the proper length for the tandem.
Make sure the locking pins are locked.
Make sure the locking pins have not broken off in place.
IDENTIFICATION OF PICTURES

Question 1

Figure 45: Engine Parts-1

Turbo Charger
Steering Pump
Engine Air Duct Work
Power Steering Reservoir
Radiator Brace
Air Governor
Steering Column
Fuel Filter

a b c d None
Question 2

Figure 46: Engine Parts-2

Windsheild Washer Fluid Reservoir  a  b  c  d  None
Steering Column  a  b  c  d  None
Air Govenor  a  b  c  d  None
Frame Rail  a  b  c  d  None
Steering Pump  a  b  c  d  None
Engine Air Duct Work  a  b  c  d  None
Steering Gear Box  a  b  c  d  None
Fuel/Water Separator  a  b  c  d  None
Figure 47: Engine Parts-3

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Question 4

![Figure 48: Engine Parts-4](image)

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Question 5

![Figure 49: Engine Parts-5](image)

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Question 6

Figure 50: Engine Parts-6

<table>
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<td>Brake Chamber</td>
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<td>S-Cam</td>
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<td>Shock Absorber Mount</td>
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</table>
Question 7

Figure 51: Torque Rod

Differential  a  b  c  d  e  None
Torque Rod  a  b  c  d  e  None
Drive Shaft  a  b  c  d  e  None
Air Bag  a  b  c  d  e  None
Brake Chamber  a  b  c  d  e  None
Slack Adjuster  a  b  c  d  e  None
Universal Joint  a  b  c  d  e  None
Fifth Wheel  a  b  c  d  e  None
Frame Rail  a  b  c  d  e  None
Question 8

Figure 52: Trailer Registration

Glad Hands

Trailer Registration

Trailer Frame

Reflectors

Emergency Air Supply Line

Electrical Hook-Up

Placard Holder

Trailer Number

Service Brake Air Line

All are None
**Question 9**

![Figure 53: Catwalk](image)

<table>
<thead>
<tr>
<th>Component</th>
<th>a</th>
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<td>Drive Shaft</td>
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<td>Spring Mount</td>
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<td>Battery Box</td>
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Question 10

![Figure 54: Landing Gear](image)

<table>
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<th>Item</th>
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<th>c</th>
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Question 11

Figure 55: Tandem Slide Pin

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APPENDIX Q: T TEST
Two-sample T test for Paper-based TEST#1

<table>
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<tr>
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<th>SE Mean</th>
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<td>47.14</td>
<td>4.53</td>
<td>0.99</td>
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<tr>
<td>Experimental Group</td>
<td>25</td>
<td>50.32</td>
<td>3.09</td>
<td>0.62</td>
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</table>

Difference = mu (Control Group) - mu (Experimental Group)
Estimate for difference: -3.18
95% CI for difference: (-5.55, -0.81)
T-Test of difference = 0 (vs not =): T-Value = -2.72  P-Value = 0.010  DF = 34

Two-sample T test for Paper-based TEST#2

<table>
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<tr>
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<td>60.65</td>
<td>5.75</td>
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<tr>
<td>Experimental Group</td>
<td>25</td>
<td>69.76</td>
<td>6.10</td>
<td>1.2</td>
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</table>

Difference = mu (Control Group) - mu (Experimental Group)
Estimate for difference: -9.11
95% CI for difference: (-12.69, -5.53)
T-Test of difference = 0 (vs not =): T-Value = -5.14  P-Value = 0.000  DF = 41

Two-sample T test for Paper-based TEST#3

<table>
<thead>
<tr>
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<tr>
<td>Experimental Group</td>
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<td>61.00</td>
<td>2.32</td>
<td>0.52</td>
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</tbody>
</table>

Difference = mu (Control Group) - mu (Experimental Group)
Estimate for difference: -6.95
95% CI for difference: (-9.56, -4.34)
T-Test of difference = 0 (vs not =): T-Value = -5.47  P-Value = 0.000  DF = 26


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