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PROPOSAL OF A VALIDATION MODEL FOR INSTRUCTIONAL SIMULATORS

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PROPOSAL OF A VALIDATION MODEL FOR INSTRUCTIONAL SIMULATORS

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PROPOSAL OF A VALIDATION MODEL FOR INSTRUCTIONAL SIMULATORS

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I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

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ABSTRACT

PROPOSAL OF A VALIDATION MODEL FOR INSTRUCTIONAL SIMULATORS

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There were two aims of the study. First one was to validate a truck simulator designed to train truck drivers on economic fuel consumption. Second one was to develop a simulator validation model for instructional simulators. This aim merged as a result of literature review since there is a controversy on the categorization and application of validation approaches. To accomplish two aims, the simulator validation approaches were categorized according to their descriptions in the literature, namely, “Behavioral”, “Face” and “Instructional” validation and combined in the current study.

Blending Mixed Methods Research Design and Designed Case Formative Research Design were employed together in order collect data. To validate the simulator and investigate the main characteristics of instructional validation process, 110 truck drivers from a logistics and transportation company participated to the economic fuel consumption training. The data were collected in two parts as during the training and 5 months after the training. Both quantitative and qualitative research approaches were used to collect data. To analyze the qualitative data, open coding analysis method were employed and quantitative data were analyzed using SPSS statistics software. According to the study results, although the Truck Simulator did not represent the real model in 100% percent or had some usability problems, it was valid in overall since it did what it was supposed to do during the training. Also, the results of the study showed that the validation determination should have been done according to the instructional goals; not the reality or usability of it.

Keywords: Instructional simulator validation model, behavioral validation, use validation, face validation, instructional validation, transfer of training

ÖZ

ÖĞRETİMSEL SİMULATÖRLER İÇİN BİR GEÇERLEME MODELİ ÖNERİSİ

SANCAR, Hatice

Doktora, Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümü

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Eylül, 2010, 291 sayfa

Bu çalışmanın iki amacı vardır. Birincisi ağır vasıta şoförlerini ekonomik yakıt tüketimi konusunda eğitmek için üretilmiş Ağır Vasıta Simülatörünün geçerlemesini yapmaktır. İkincisi öğretimsel simülatörlerin geçerlemesinde kullanılacak bir model geliştirmektir. Bu amaç, literatür taraması sonucunda ortaya çıkmıştır çünkü öğretim amaçlı geliştirilen simülatörlerin geçerlemesinde kullanılacak yaklaşımların kategorilenmesi ve uygulanması ile ilgili anlaşmazlık bulunmaktadır. İki amacı gerçekleştirebilmek için, güncel çalışmada simülatör geçerleme yaklaşımları literatürdeki tanımlarına göre, "Davranışsal", "Yüzeysel" ve "Öğretimsel" olarak kategorilenmiş ve birleştirilmişlerdir.

Karma ve Biçimlendirici araştırma yöntemleri veri toplamak için birlikte uygulanmışlardır. Simülatörü geçerlemek ve öğretimsel simülatörlerin geçerleme süreçlerinin karakteristiklerini araştırmak için bir lojistik ve nakliyat şirketinin 110 şoförü ekonomik yakıt tüketim eğitimine katılmışlardır. Veriler eğitim sırasında ve eğitimden 5 ay sonrasında olmak üzere iki aşama halinde toplanmıştır. Veri toplamak için nicel ve nitel araştırma yöntemlerinin ikisi birden kullanılmıştır. Nitel veriyi analiz etmek için açık kodlama yöntemi ve nicel veriyi analiz etmek için SPSS istatistik yazılımı kullanılmıştır. Çalışma sonuçlarına göre, simülatör gerçek modele 100% oranda benzemediği halde veya bazı kullanım problemlerine sahip olduğu halde, bütünsel olarak geçerlidir çünkü eğitim sırasında kendisinden bekleneni yapmaktadır. Ayrıca, çalışma sonuçları göstermektedir ki geçerleme konusundaki karar, öğretim amaçlarına göre belirlenmelidir; gerçeklik veya kullanım kolaylığına göre değil.

Keywords: Öğretimsel simülatör geçerleme modeli, davranışsal geçerleme, yüzeysel geçerleme, öğretimsel geçerleme, eğitimin transferi.

To My Grandmother

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CHAPTER 1

INTRODUCTION

This section reveals the background, purpose, significance and the research questions in order to justify the research issue. Moreover, the terms which were essential to be defined and abbreviations used in document were placed in this part.

1.1. Background of the Study

Although simulation and simulators concept appeared in the literature in 1920s, according to Tarr (2006) the roots of them traces back ancient times. Tarr (2006) states that, the writings on cave walls that represent how to hunt are simulations. Moreover, in the ancient times, soldiers had been using war equipments that is made of wood, these tools are one types of simulators (Tarr, 2006). As understood from examples given by Tarr (2006), the simulations and simulators are used for training from the beginning of human history. Blana (1996b) states that the current simulations and simulators concept traces back 1920s. Moreover, simulators are firstly developed for military (Blana, 1996b; Tarr, 2006; Straus, 2005; Emery, Robin, Knipling, Finn & Fleger, 1999). Similarly, Blana (1996b) and Slob (2008) state first simulators are flight simulators developed for military. The use aims of the simulators in the military are to train personnel and teach them how to use specific war equipments in a safe environment (Blana, 1996b; Straus, 2005).

On the other hand, the simulators are not use only for training purposes. Uke (2006) mentions the research simulators while Straus (2005) mentions evaluation simulators. Similarly, Driscoll and Carliner (2005) state that companies use simulations to select employee. On the other hand, the use of simulations and simulators in learning environments are getting more popular. Janke and Eberhand (1998) state that use of simulations and simulators is expanding since development in technology enables developers to produce simulators more cost effectively (as cited in Lee, 2002). However, economy is not the only reason for increase in the numbers of simulators. Also, some advantages that simulators provide makes people prefer to demand simulators. Deyo, Briggs and

Doenges (1988) point out these advantages by emphasizing that training may be more effectively presented in a safe environment thanks to the simulators. Similarly, Driscoll and Carliner (2005) state that simulations bring real life learning experiences to the training environment since they are based on experiential learning theory.

On the other hand, although there are many advantages of using the simulators for instructional purposes, as Estock, McCormack, Bennett and Patrey (2008) state that they are not the cure for every instructional problem. Similarly, Parkes (2005) emphasizes the importance of using the appropriate simulators for instruction.

Shortly, “simulators are the tools designed to produce effects which are simulating those of specific environmental conditions” (Leitao, Moreira, Santos, Sousa & Ferreira, 1998 as cited in Uke, 2006, p.2). Since they enable learners experience real life conditions, they make abstract knowledge concrete and enhance effectiveness of the instruction (Kolb, Boyatzis & Mainemelis, 2002). However, it is not true to say that they are solutions for every type of instructional problem (Estock et al., 2008). It is true to say that validation of the simulators is the first step to define whether the specific simulators is right tool for specific instruction (Galloway, 2001)

1.2. Purpose of the Study

The purpose of the study was to validate the TS which had been designed to train expert truck drivers on the economic fuel consumption. To do this, firstly different validation approaches in the literature related with simulation, simulator and interactive learning system validation were searched. The results of the literature review showed that there is a controversy on simulator validation. Moreover, there is no specific validation approaches for instructional simulators. However, the results showed that different validation approaches should be combined to validate instructional simulators. For that reason, the researcher categorized different validation approaches in the literature. These approaches are behavioral validation, face validation and instructional validation. The researcher combined these three approaches in a complementary manner to explain the different facets of the instructional simulator validation phenomena. So, the truck simulator was validated in terms of 1) how much it represents a real truck; 2) how do the truck drivers evaluate the truck simulator; 3) what is the truck simulator contribution to the training.

Since a specific validation model for instructional simulators are needed according to literature reviewed, a second research aim was merged. This aim was to develop a model for instructional simulator validation process. To do this, the researcher also investigated the process of combining different approaches defined according to the literature. During the study, the relationship of different validation approaches with each other and how the two characteristics of the training simulators as a technological tool and an instructional tool affected the simulator validation process were described in detailed via interviews, observations and experiences of the researchers.

In the study, the researcher started to the study with the purpose of validating the Truck Simulator. Then, an additional purpose was emerged at the beginning of the study. According to Greene (2007) complementarity purposes may range from convergence to divergence as well as to practice of the research may change the purpose and this may result in the unanticipated insights to better understanding.

1.3. Significance of the Study

The significance of this study is quite many:

Firstly, defining validity process for instructional simulators is not well-established because there is no standard validation approach (Blana, 1996a; Feinstein & Cannon, 2001; Hoskins & El-Gindy, 2006). The validation approaches used for the instructional simulators were categorized differently. For example, some researchers mention the behavioral and physical validity (Mudd, 1968 as cited in Blana, 1996a; McCormick, 1970 as cited in Blana, 1996a; Reed & Green, 1995; Jamson, 1999; Lee, 2002); some use a different terminology for behavioral and physical validity as the closed-loop and the open loop techniques (Bertollini, Johnston, Kuiper, Kukula, Kulczycka & Thomas, 1994). Blana (1996a) mentions the face validity concept by stating what Leonard and Wierwille (1975) suggested taking the subjective opinion about the simulator fidelity in order to get detailed information on simulator fidelity (as cited in Blana, 1996a). Moreover, educational validity concept was described by Feinstein and Cannon (2001). Kaptein et al. (1996a) uses the terms absolute validity, relative validity, internal validity and external validity (as cited in Hoskins & El-Gindy, 2006). Feinstein and Cannon (2001) divided simulation environments validity as internal and external validity. However, Blana (1996a) and Reed and Green (1995) claim that absolute validity, relative validity, internal validity and external validity are the criteria for the simulator validation studies. In this study, these validation approaches were taken into account and categorized according to their descriptions and methodologies. These categories are Physical Validation, Behavioral Validation, Face validation and Instructional Validation. Due to this categorization, this study could be a reference for the researchers who would want to employ simulator validation study.

Secondly, most of the research studies in the literature validate the simulators according to one facet, e.g. behavioral validity, physical validity, instructional validity. However, all these type of validation approaches were combined in the scope of this training simulator validation study. Also, other factors which may affect the validation process, namely, the simulator type and design goal (Reed & Green, 1995; Blana, 1996a; Galloway, 2001; Hoskins & El-Gindy, 2006) were taken into account in this study. This holistic approach may also be used by the researchers who wanted to conduct research on simulator validation.

Thirdly, the literature does not propose a detailed simulator validation model for simulators designed for instructional purposes. With this study, a detailed validation process description and interviews with trainers on the simulator validation process enabled us to reach a tentative instructional simulator validation model. In the proposed model, the researchers can find information about which methods can be used, which parameters are important, which analysis can be conducted during the instructional simulator validation study.

Fourthly, in most of the behavioral validity studies, the performances of the drivers on the simulator and ones on the real road had been compared. However, as stated by Blana (1996b) “There will always be the issue of validity, i.e. of to what extent behavior in a simulator corresponds to that in the real life” (p.8) because simulators can never represent fully their real models in their all aspects. The experimental parts of previous studies were based on the assumption that there is need to compare driver performances on the simulator and on the real road. However, in this design a different driver performances comparison was offered according to the expected outcomes of the training and role of the training simulator in the learning process. The validity of the training simulator can be evaluated via comparing the driver performances before and after the training on the simulation environment or transfer of training. In that design, it was focused on the drivers’ professional development and for that reason expected behavioral changes may affect the training outcomes after the training. In the experimental design, the drivers’ fuel consumption amounts before and after the training were compared. Also, what extend the drivers transfer the training was investigated by comparing their real-life fuel consumption before and after the training. As realized, the most criticized side of the approaches used in simulator validation studies is performance comparison of two different environment, real world and simulator, was eliminated.

Fifthly, in many simulator validation studies, interactive and instructional characteristics of simulators were not taken into account. On the other hand, in this study both the interactive and instructional characteristic of the simulator was focused in experimental designs, interview, observation and detailed description of the validation process. So, a new perspective for simulator validation studies was applied.

Sixthly, although the instructional research on simulation traces back 1960s, still there is few studies focus on the academically acceptable methodology proposition for them (Feinstein & Cannon, 2001). In this research study, a scientific manner was followed by complementarily bringing different simulator validation approaches.

Seventhly, the simulator validation process is studied by different disciplines such as psychology, education, and engineering fields and this causes emergence of different validation concepts, approaches and parameters. On the other hand, as Reeves (2003) states the instructional designers should investigate and merge different disciplines perspective on the instructional simulator validation process. In this study, the instructional designer tried to merge perspectives of different disciplines for validating the TS. For that reason, the current study results are expected to be used by studies from different disciplines.

Eighthly, the study was an example of how to validate an instructional simulator. For that reason, the validation process applied in this study may provide information about practical use of the training simulator validation model which was one of the results in this study.

Ninthly, since the TS were validated in the scope of the current study, results of the study also had conclusions for the recommendations for the truck simulator improvement. For that reason, the improvement in the Ts could be done and improved version was started to be used for the real economic fuel consumption training. So, the truck simulator validated was used more effectively according to its design aim.

Tenthly, the developed instruments during the current study can be used in the scope of other simulator validation studies.

Lastly, although validation studies included the behavioral, face and instructional validation types are not new in the field, what is new is that focusing on forming a systemic way to combine these approaches in this study.

1.4. Research Questions of the Study

Since the instructional simulator validation models in the literature are not precise and they focus on evaluation of simulator in one facet, the aims of this study were to validate the truck simulator and develop a validation model for instructional simulators. With respect to this goal, the following research questions were investigated:

1. What extend does the truck simulator do what is supposed to do?

   In terms of Behavioral Validity

   1.1. What extend does the fuel consumption measure of the truck simulator represent to the fuel consumption measures of presented in instructional part of the training?

   In terms of Face Validity

   1.2. How do the stakeholders evaluate the truck simulator?

      1.2.1. How do drivers and trainers evaluate the truck simulator driving experience in terms of reality, usability and instructional benefits of the simulator?

In terms of Instructional Validity

1.3. What extend does the truck simulator contribute to the effectiveness of the training what is supposed to do?
    1.3.1. Is there a difference in the drivers' performances before and after the training?
    1.3.2. What are the contributions of the drivers who took the economic fuel consumption training with the truck simulator to their workplace in terms of return of investment?
    1.3.3. What are the factors which affect transfer of the knowledge gained from the training?

2. What are the main characteristics of an effective and efficient instructional simulator validation process?
3. What should an instructional simulator validation model include for effective and efficient validation process?

1.5. Definitions of Terms

Alpha Phase: Alpha phase is the developer level test phase of the software development life cycle. In this phase, software is tested inside the organization. At the end of the alpha phase, released software is "feature complete" which means the software acts as it is required to be. (Software Release life Cycle [Online]).

Beta Phase: Beta phase is the user level test phase of the software development life cycle. At the end of alpha phase, beta phase starts. A subset of potential users / customers that are willing to test the software is selected (beta testers) and the software is released to them. (Software Release life Cycle [Online]).

General Availability: When the software is fully tested, commercialized, packed or made ready for download, in other words when the software is ready, it is released to public. This point is named as "General Availability" (Software Release life Cycle [Online]).

1.6. Abbreviations

FAA: Federal Aviation Administration
PP: Philosophy Project
TS: Truck Simulator
UMTRI: University of Michigan Transportation Research Institute
VTI: Swedish National Road and Transport Research Institute

CHAPTER 2

LITERATURE REVIEW

The literature review section includes theoretical aspect of the study. For that reason, first part of the literature review informs readers on the simulators and their history. The second part addresses driving simulators and driving simulator examples. The third part focuses on the simulator validation discussion in the literature and the need a driving simulator validation model. Finally, in the fourth part, the approaches which were applied to validate instructional driving simulators in the literature were presented.

2.1. Simulation and Simulators

There are a variety of simulation definitions and categorizations in the literature. According to Lee (1999), depending on the researchers, simulation definitions and categorizations are changing in the literature. Also, the investigated literature shows that there is no special effort to define simulation and simulator separately. For that reason, some authors use simulation instead of simulator term. Also, according to their field of investigation, the definitions and categorizations are changed. There are some simulation definitions which are placed in the literature:

> A simulation is an analogue, a reproduction of the reality, but the model upon which it is based need not be a mathematical one essentially. Indeed many of the most successful of the armed forces simulations were based on a physical model (Tansey & Unwin, 1969, p. 6).
>
> A simulation is an experience in that participants step into assigned roles; accept the responsibilities and constraints and work through the problems and difficulties that arise in the execution of roles (Gredler, 1992, p.141)

> In a broad sense, a simulation is defined as a computer program in which it temporarily creates a set of things through the means of a program and then relates them together through cause and effect relationships (Lee, 1999, p. 72)

> …the act of mimicking a real object, event or process by assuming its appearance or outward qualities (Gorman, Meier & Krummel, 1999 as cited in Kneebone, 2003, p.269).

> Simulation is a particular type of modeling. Building a model is a well recognized way of understanding the world. A model is a simplification-smaller, less detailed, less complex or all of these together- of some other structure or system (Gilbert & Troitzch, 2005, p. 2)

The definitions presented here have some different and common sides. As realized, while Tansey and Unwin (1969) and Lee (1999) define simulation from computer science point of view, Gredler (1992), Gorman, Meier and Krummel (1999 as cited in Kneebone, 2003) and Gilbert and Troitzch (2005) define it from the social science or training point of view. For that reason, in the Tansey and Unwin (1969) and Lee (1999)'s definitions, a simulation is the reproduction of reality by using computer devices. On the other hand, in Gredler (1992), Gorman, Meier and Krummel (1999 as cited in Kneebone, 2003) and Gilbert and Troitzch (2005)'s definitions, there is no need to the computer or virtual reality to model the reality. According to them, important thing is to simulating a system and it can be done by assigning roles to individual and changing the creating an environment which similar to real ones.

Moreover, the definitions from the same field have some small differences. While Tansey and Unwin (1969) focus on hardware sides by mentioning the similarities between simulation environment and real model in terms of physical properties, Lee (1999) focuses on software side of the simulation. While Gredler (1992) and Gorman et al. (1999 as cited in Kneebone, 2003) focus on the people's acting roles and experiences, Gilbert and Troitzch (2005) focus on modeling the system which provide the experience.

Despite the mentioned differences, simulation definitions have some commonalities. They all include representation or reproduction of reality, as Jones (1984; 1987) states "reality of function" (as cited in Gredler, 1992) and the importance of bringing experiences. As stated by Gilbert and Troitzch (2005) simulation is not as the same as its real model but similar to it. It represents a small and less detailed part of the real model.

According to the above definitions and reviewed literature, the researcher advocates that how much the simulation environment represent the real model, system or process; how much it provides real world experience; and how much it provides the similar performance to the one observed in the real world are important issues and included in the simulation definitions. Feinstein and Cannon (2001) name these mentioned characteristics of the simulations as believability (how much the simulation environment represent the real model, system or process); educational validity (how much it provides real world experience); and operational validity (how much it provides the similar performance to the one observed in the real world). A simulation is the representation of the real model, system or process in order to bring real world experience and performance measures (Feinstein & Cannon, 2001). The important thing in this definition is that only physical similarity of a designed model and real model is not adequate to define the designed model as simulation, it is just a representation of real model. However, if this model is a part of a simulated system or process, it can be defined as a part of simulation.

In the reviewed literature there are no specific simulator definitions but some authors mentioned also simulator as well as to simulation as following:

> Simulators are designed to produce effects which are simulating those of specific environmental conditions (Leitao, Moreira, Santos, Sousa & Ferreira, 1998 as cited in Uke, 2006, p.2).
>
> Per definition, a (driving) simulator offers merely a representation of reality. That is, a (driving) simulator reproduces the states, behaviors and perceptions of the real world to a limited degree (Winter, Wieringa, Dankelman, Mulder & Paassen, 2007, p.2).
>
> Simulators are representations of a piece of machinery or equipment (or a situation) in which the user is expected to react in a certain way (Tarr, 2006, p.1)

Although the above simulator definitions have some similarities with the simulation definitions, they refer to the devices which reproduce the reality and enable user to live real life experiences. According to the author, for that reason, simulators are the devices which reproduce the effects of the real model in a limited degree in terms of physical and behavioral side. With the word of physical side refers to appearance similarity between simulator and real model. On the other hand, behavioral side refers to its enabling users to show similar behaviors as they are using real models.

Hertel and Millis (2002) state that simulation should be thought together with people, an environment and activities. Blana (1996a) points out that, simulators are man interacted systems and this side should not be ignored during the researches or trainings.

2.1.1. History

There are different claims about the origin of the simulations. According to the Tansey and Unwin (1969) the origin of simulations is uncertain. On the other hand, Tarr (2006) states that the representation of simulation use can be seen on the cave drawings that show how to hunt and for that reason the simulation use traced back pre-date history. Moreover, Tarr (2006) also said that simulators and simulation items were used from ancient times because warriors use wood swords or different imitation war equipments to practice. Computer based simulators are firstly are developed for Army (Blana, 1996b; Tarr, 2006; Straus, 2005; Emery et. al., 1999). Blana (1996b) and Slob (2008) state that the first simulators are the flight simulators and developed for training the pilots in the Army.

2.1.2. Classification

According to Eryilmaz, Isler, Cagiltay, Sancar and Ozmen (2010) simulator classification is important for the training studies since the type of simulators critical to reach instructional goals. In the literature, different classification clusters are used. While some authors prefer to classify simulators according to their use, some others prefer to classify them according to their properties or fidelity levels (Blana, 1996b). Seropian, Brown, Gavilanes, and Driggers (2004) classificate simulators as low-fidelity simulators, medium-fidelity simulators and high fidelity simulators. On the other hand, Eryilmaz et. al. (2010) developed a classification for the simulators with guidance of an existing standard of JAR for flight simulator classification (JAA Helicopter Flight Simulation Training Device Standards (Online)) and classificate them as A level, B level, C level, D level. Blana (1996b) acknowledges the classification of simulators according to their use, namely, research and training simulators as well as according to their costs, namely, low-cost, medium-cost and high cost simulators. Research simulators are used for research purposes, for example investigating the relationships between age and reflex speed of the drivers (Blana, 1996b) On the other hand, training simulators are mainly used for instructional purposes (Blana, 1996b)

2.2. Driving Simulators

Simulators are designed in order to present effects which real models produce and driving simulators are started to be largely used by educational institutions, army and transportation companies. According to Janke and Eberhand (1998), reduction in the cost of laboratory based driving simulators due to the improvement in electronic and computer technologies causes the driving simulators' to get more and more popular today (as cited in Lee, 2002). Uke (2006) states that they are used for the training and experimentation purposes. Also, they are used to test drivers' performances at driving license exams in Australia, Canada, New Zeland, England and America (Straus, 2005).

Deyo, Briggs and Doenges (1988) state that the use of simulation provides achieving training and design at lower cost, controlling experiments again and again and evaluating vehicle designs. According to Reed and Green (1995), using the driving simulation is superior to in-vehicle testing for three reasons as "Safety", "Equipment Cost" and "Experimental Control". Lee (2002) also emphasizes that driving simulators provide safe and economical testing driving performance.

Driving simulators are used by automotive industry, military, academic research fields, government, space, recreational computer markets, driver schools and medical sector (Straus, 2005). In the early 1910s, the first driving simulators were developed in order to evaluate the public operators' skills and competence. Followed about four decades, the drivers' responses to a range of stimuli were tested by equipments placed in mockup automobiles (Straus, 2005). Film approach simulators were started to be used by automobile manufacturers, universities, military agencies, automobile insurance companies and aerospace companies in the 1960s (Decina, Gish, Staplin & Kirchner, 1996). In 1970, Case, Hulbert, and Beers (1970) were among first researchers conducted a study which investigated performance of older and younger drivers. By 1983, in order to be used in a variety of studies Highway Driving Simulator (HYSIM), a fixed-base driving simulator, was developed. Then the Swedish National Road and Transport Research Institute (VTI) Driving Simulator and driving simulations in the Netherlands followed this simulator (Ponds, Brouwer & Van Wolffelaar, 1988; Brouwer, Waterink, Wolffelaar and Rothengatter, 1991). By the 1980s the development of advanced interactive driving simulation led to complex driving simulators by the 1990s.

Driving simulators have been used in a variety of research studies for more than 20 years (Lincke, Richter & Schmidt, 1973 as cited in Reed and Green, 1995; Alm & Nilsson, 1994 as cited in Reed & Green, 1995; Green, 1993 as cited in Reed & Green, 1995). The driving simulator researches include studies simulator validation (Blana, 1996a; Starus, 2005; Allen & Tarr, 2005) effects of simulators to learning (West, Snellen, Tong, & Murray, 1991; de Winter, Wieringa, Dankelman, Mulder,van Paassen & de Groot, 2007; Wallace and Regan, 1998), usability of simulators (Kluj, 2003; Uke, 2006), simulator sickness (Durdu & Cagiltay, 2006), evaluating drivers' performances by driving license bureaus (Straus, 2005) and driver workload (Green, Lin & Bagian, 1993).

2.2.1. Driving Simulators Examples

Driving simulator examples in this literature review are presented below:

2.2.1.1. HYSIM (Alicandri, 1994):

First Generation HYSIM:

"FHWA (The Federal Highway Administration) Human Factors Laboratory" has used HYSIM (Highway Driving Simulator) simulator in the early 1980's. The properties of HYSIM are it's being fixed-based and interactive driving simulator. For the visual display, it uses computer-generated imagery. The first generation HYSIM contained the following modules:

- graphics computer module,
- scenario computer module,
- roadway projection module,
- sign-generation module,
- sound generation module,
- psycho physiological module,
- operator control center module.

In time some modules were added. For example its screen size was changed. Moreover, to enhance the image quality and brightness, the projection equipment war was relocated. On the other hand, the basic system was not changed. Figure 2.1 shows the HYMS simulator.

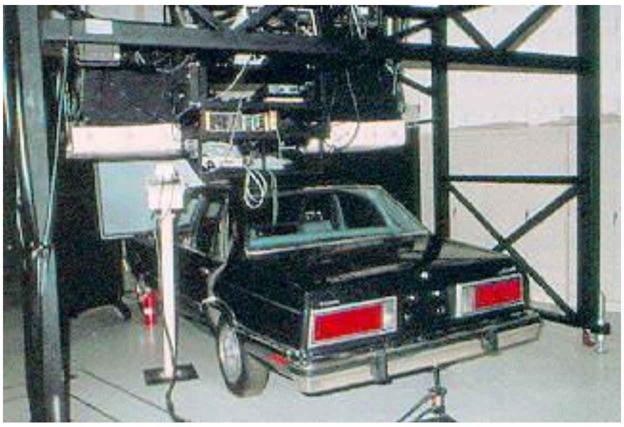

Figure 2.1 Highway Driving Simulator

Second-Generation HYSIM:

By 1990, state of the art in computer graphics made it possible to cost effectively simulate complex visual scenes in real time. A polygon-based system was placed instead of the graphics-generation module. Thus, system provides to display color images for roadway and surrounding environment. There is a projector behind the screen with an angular field of view of approximately 70 degrees horizontally and 35 degrees vertically. Moreover, the system has a small-scale motion system module in the second generation HYSIM different that the first generation one.

2.2.1.2. **AutoPw** (Ponds, Brouwer & Van Wolffelaar, 1988)

The Warsaw University of Technology developed the AutoPw in order to test simulation's vehicle motion and dynamics. This simulator was used by a project group which worked on simulator test methods. AutoPw included 3 vehicle types as small automobile (1200 kg.), medium-class automobile (1550 kg.), truck (11500 kg.)

The tests have been performed for the following maneuvers in compliance with the respective ISO Recommendations:

- Steady-state motion along a circular path (ISO 4138)
- Step input at the steering wheel (ISO 7401)
- Straight braking (ISO 6597)
- Single-cycle sine-wave input function at the steering wheel (ISO 7401,8725)
- Double lane change maneuver (ISO 3888)

Drivers' abilities and reactions in the special times (standard and dangerous road traffic situations) can be measured by AutoPw.

- Starting and accelerating the vehicle including the changing gears
- Braking of the vehicle in the homogeneous road surface
- Sudden braking opposite to the obstacles or drive around the obstacle.
- 2 lane version of the situations above
- Stopping and starting according to vehicle on the front.

Figure 2.2 Auto PW Road View

2.2.1.3. The Pennsylvania Transportation Institute Research Center Driving Simulator (Johansson & Nordin, 2002)

The truck represented by the driving simulator is a fully instrumented Mack Trucks, Inc. CH cab mounted on a Moog, Inc. Motion base. There are three screens in the front. These screens provide a 140-degree field of view. Moreover, there are two rear-view screens to enhance the realism. It has two software programs that control the system. One of them is the vehicle dynamics model software program. Second one is The Renault software. The cues were produced by the first software program and images on the screen were produced by the second software program (Figure 2.3).

Figure 2.3 Pennsylvania Transportation Institute Simulator

2.2.1.4. The Iowa Driving Simulator (Kuhl, Evans, Papelis, Romano & Watson, 1995)

The Iowa Driving Simulator is a simulator developed in the Iowa University and located in the University of Iowa's Center for Computer-Aided Design (CCAD). The aim of IDS design is to create a simulation environment that provides the driving experience full of realism and fidelity. To do this, the full control is given to the driver and the IDS has a physical configuration same to the real vehicles with hexapod motion platform, interchangeable vehicle cabs, a full range of sensory cues including visual and, auditory, and haptic. Also, simulation environment includes roadway configurations, environmental conditions, traffic-control devices, realistic cultural features, vehicular traffic and pedestrians (Figure 2.4).

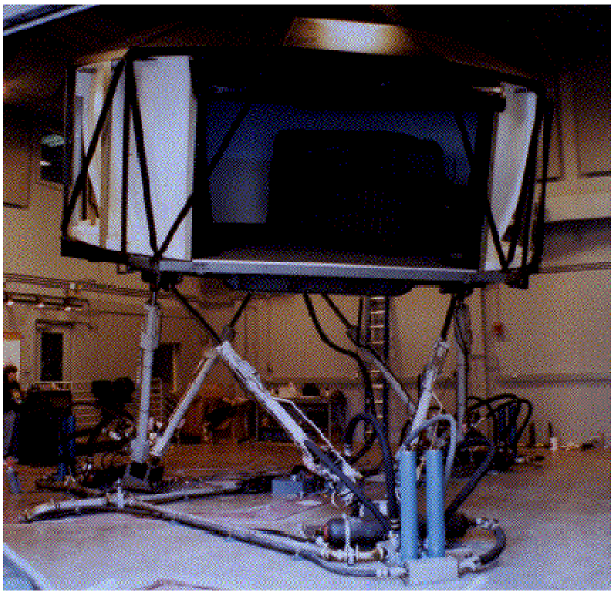

Figure 2.4 IDS (Cremer, Kearney & Papelis, 1995)

2.2.1.5. **The National Advanced Driving Simulator** (The National Advanced Driving Simulator [Online])

NADS is another simulator developed in the Iowa University. It was developed by the National Highway Traffic Safety Administration (NHTSA) and located at The University of Iowa's Research Park. The development aim was to conduct research studies to enhance safety on nation's roadways.

There are many NADS projects studied. These projects are about:

- Driver distraction
- Driver attention
- Clinical trials / pharmaceutical
- Drugs and driver impairments
- Advanced vehicle systems
- Advanced simulation

NADS is the most advanced ground vehicle simulator of the IOWA University. It has a huge dome. This dome includes the car and the trucks cabin. Also, electronic and mechanical equipments are used in cabin design according to their real models (Figure 2.5)

Figure 2.5 NADS Motion Platform

2.2.1.6. **Patrol Simulator** (Allen & Tarr, 2005)

Patrol Simulator was designed by modeling Ford Crown Victoria. Generally, Police and Emergency Response drivers have used it. It has not air brakes or manual transmission systems. However, it has 180-degree field of view (FOV) and its cost is $160,000 (see Figure 2.6 below).

Figure 2.6 Patrol Driving Simulator

2.2.1.7. **FTM Driving Simulator** (Driving Simulator at Technische Universitat München [Online])

Technische Universitat Munchen Institute developed the FTM. This dynamic driver simulator was used to conduct research of vehicle components, vehicle intersystem and vehicle handling. In other words, the simulators system is tested here. Different car and trucks cabins are able to be used thanks to the convenient motion platform and projectors (Figure 2.7)

Figure 2.7 FTM Driving Simulator

2.2.1.8. **Combat Convoy Simulator (CCS)** (Combat Convoy Simulator [Online])

Combat Convoy Simulator has been developing by a private company, Lockheed Martin for training purposes. It has been used to train army personnel who have duty about addressing a terrorist threat or delivering needed medical supplies (Figure 2.8). The CSS represents a variety of military vehicles with weapons and other equipments that appropriate to training. Moreover, its properties aim to make training environment as realistic as possible. Its properties are:

- 360 degree field of view
- Realistic virtual environment
- Dense urban pattern of life
- Run Time Authoring
- Actual cab
- Weapons
- High fidelity sounds
- Not need to wear training equipment

Figure 2.8 Design of Combat Convoy Simulator

2.3. Review of Driving Simulator Validation Studies

The success of the driving simulators depends on how much they meet the design purposes (Galloway, 2001). Moreover, Gosen and Washbush (2004) state that the assessment of the experiential learning is complement to purpose. For that reason, the driving simulator evaluation studies are so important. Blana (1996) divides driving simulator evaluation into three categories as “Reliability”, “Validation” and “Transferability” and states that validation is the most important stage among the three stages because how much the driving simulators meet the design goal can be determined via validation studies. On the other hand, Borenstein (1998) and Revees (2003) state that evaluation and validation refer to different things although they are connected with each other because evaluation includes validation, a broader meaning. Figure 2.9 shows the evaluation of the instructional program in which the simulator was validated. As seen in Figure 2.9, there are two scope of the validation research as reality and usability and two of them affect the user experience. Reality of the simulator also forms a base for the usability of the simulator but there is another important factor as learner characteristic (Blana, 1996a). Moreover, the user experience forms a base for the learning, transfer of the training and return of investment but not guarantee them. For that reason, instructional part and technology part of the simulator cannot be separated and should be taken into account in the instructional simulator validation research.

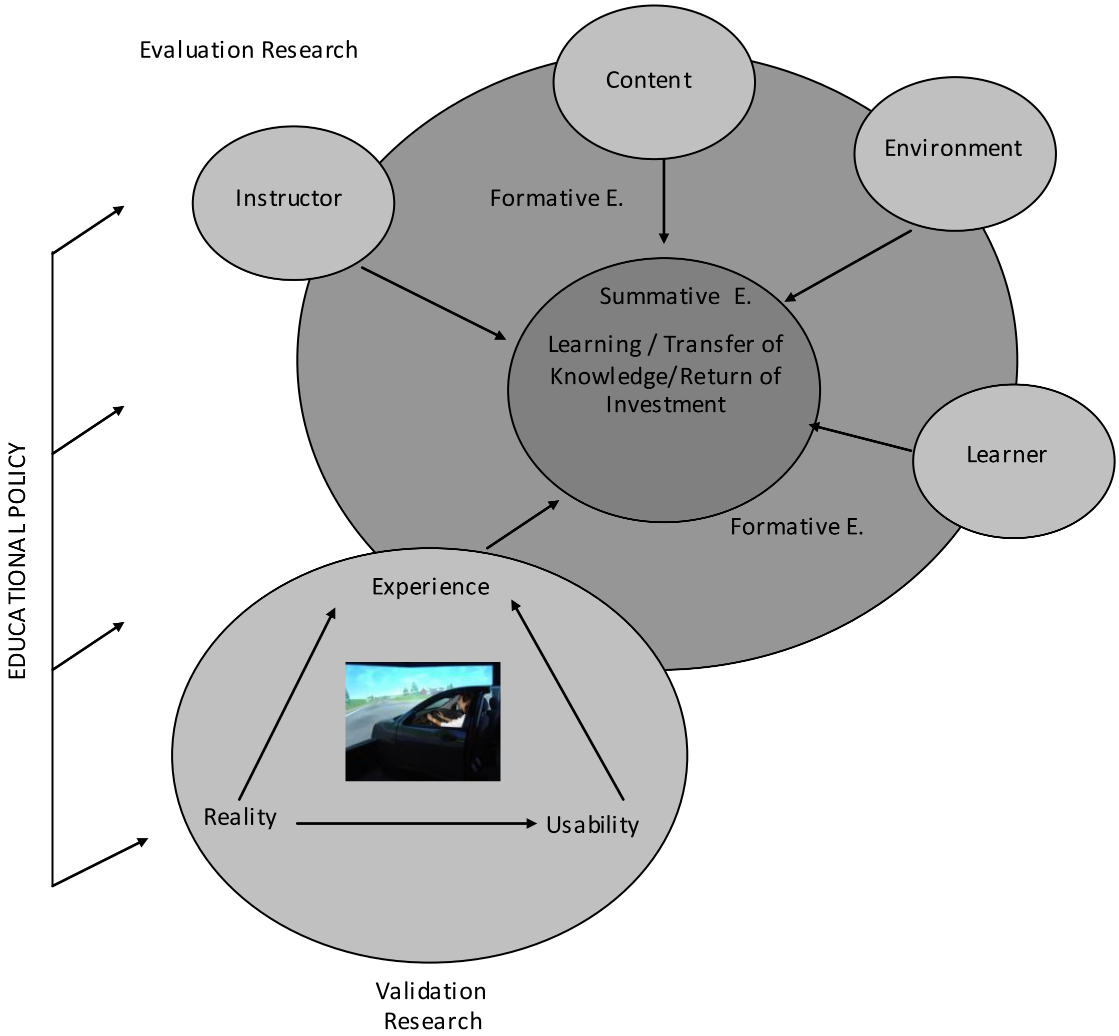

Figure 2.9 The Place of the Validation Process in the Evaluation Research (Source of Simulator Picture [Online]

From the psychology point of view, validity of a test is important because if validity is not provided, it means that the test developed is not the right tool to reflect or assess the specific concept. APA (1985) divides validity into three categories as “The Content-Related Validity”, “The Construct-Related Validity” and “The Criterion-Related Validity”. According to Gleitman (1991) the test validity refers to the degree to which it measures what it is supposed to measure (as cited in Blana, 1996a). Simulator validation is also as important as the test validation and should be taken into account because as Galloway (2001) said "The success of a man-in-the -loop real time simulator depends upon how well it meets the design goals which is determined via a process called Validation.” (p. 1). Eskandarian, Delaigue, Sayed and Mortazavi (2008) also state that being a valuable research tool for a driving simulator depends on its validity for a selected driving application. However, the validity concept and methods are not precise as one used in Psychology (Blana, 1996a) and there is not a standard method to validate simulators (Eskandarian, et.al., 2008).

According to Feinstein and Cannon (2001) "*Validation* is the process of assessing that the conclusions reached from a simulation are similar to those reached in the real-world system being modeled." (p.58). Leonard and Wierwille (1975) describe simulator validation process as "obtaining parallel measures in a full scale and in simulation and bringing these two sets of measures into correspondence" (as cited in Blana, 1996a). Straus (2005) also equates simulator validation with correlation between driving performance in simulators and on the road. On the other hand, Robin (2000) differentiates validation of simulators used for training and describes validation as assessment training transferability.

Moreover, there is confusion on types and methods used for the simulator validation (Eskandarian et. al., 2008; Blana, 1996a; Hoskins & El-Gindy, 2006). Moreover, Blana (1996a) states that the validity methods used for a test cannot be used to validate a simulator because the simulators are a human in the loop tools. However, he uses validation types in Psychology as "construct, content and criterion validity" for simulator validation by proposing different validation methods for each type. According to Reed and Green (1995), Physical Correspondence and Behavioral correspondence are the two aspects of simulator validity are generally focused in the literature. On the other hand, according to Feinstein and Cannon (2001) validity can be divided as internal and external validity while Hoskins and El-Gindy (2006) classify model validation and behavioral validation.

Some literature review studies which focus on different validity concepts also show the confusion on simulator validation concepts, types and methods in the literature. Feinstein and Cannon (2001) summarize simulator validation concepts as accuracy, algorithmic validity, Believability, conceptual (face) validity, construct validity, content validity, criterion (predictive) validity, educational validity, empirical validity, empiricism (objectivism, foundationalism, verificationalism), event validity, external validity, hermeneuticism, internal validity, operational validity, plausibility, positive Economics, rationalism, realism, relativism (conventionalism), representational validity, validation, verification and verisimilitude.

Moreover, classifications in the literature on the simulator validation approaches are summarized differently by the authors. Blana (1996a) summarized the simulator validation approaches in the literature as behavioral, physical, face validation while Feinstein and Cannon (2001) summarized it as verification, internal and external validation and added educational validity type for the educational simulators validation. Chang and Ho (2002) classified the literature on simulator validation as physics performance consistency and experiment performance consistency and show it in a figure (Figure 2.10). As seen from classification presented by Chang and Ho (2002), the approaches can be named as "behavioral validation" and "physical validation".

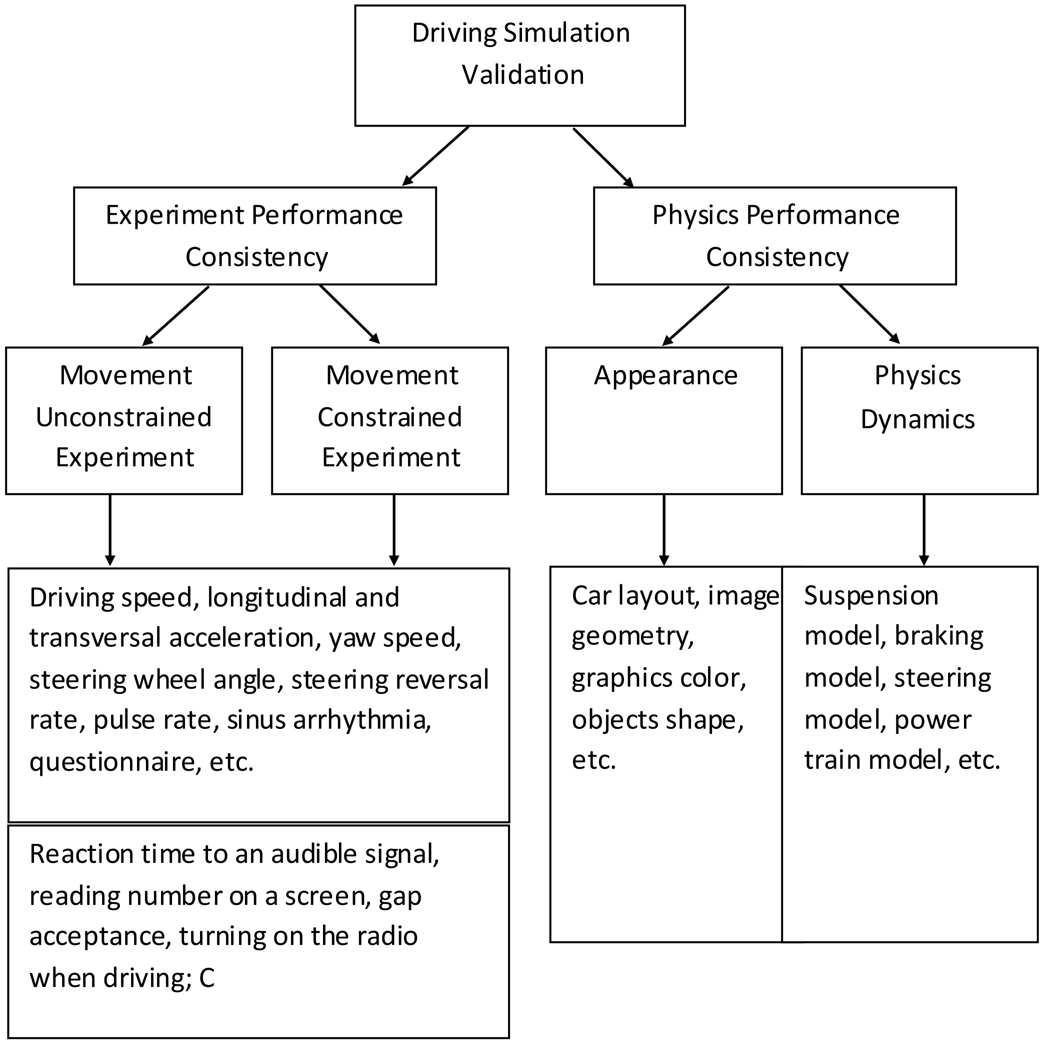

Figure 2.10 The general validation method of driving simulator (Chang & Ho, 2002)

2.3.1. Outcomes of the Literature: Base for Followed Approaches to Validate the Truck Simulator

The three outcomes of the simulator validation literature are base for the validation process followed during the study. One of them is that the purpose of the simulator should be taken into account in the simulator validation process. The second one is that although many of the simulator validation studies focus on physical or behavioral validation approaches, the best validation study is the one which combines all of the validation approaches in a complementary manner. The third one is that there is a relationship between the approaches in that one is necessary for another.

2.3.1.1. Design Aim of the Simulator

In the literature there is a conflict on the dependence of simulator validation process to development purpose of it. While some authors advocate that the simulator validation process bounded to the development purpose of the simulator, others advocate that it is independent from it. Actually, this conflict starts from the definition of the simulator validation phenomenon. While some authors connects validation of simulations to the what extent it serves to purpose (Hoskins & El-Gindy, 2006; Sargent, 2001), some connects it to similarity of the conclusions reached in simulation and real world system (Feinstein & Cannon, 2001; Estock, Alexander, Stelzer & Baughman, 2007); Blana 1996a). However, according to the researcher, the question is here that if the similarity between the conclusions of real world model and simulator is adequate to determine that the instructional purpose of the simulators is met.

According to the Blana (1996b) there are two types of simulators, namely, research and training (instructional) simulators. Straus (2005) added an additional type, namely, assessment simulators. The research simulators are used to investigate correlation between the variables or cause and effect relationship among the some variables. For example, the simulators used for investigating age effect on drivers' reaction (Staplin, 1995; Reed & Green, 1995; Lee, 2002; Yan, Radwan & Guo, 2007; Cunto, 2008); gender effects on driving (Yan et. al., 2007); driver drowsiness and stress effects on driving behaviour (Rimini-Doering, Manstetten, Altmueller, Ladstaetter & Mahler,2001); road design effects on the drivers' performance / crash number (Martens, Kaptein, Claessen & van Hattum, 1998; Alexander, Barhan & Black, 2002), simulator designs (Manes & Green, 1997; Wierwille, Ellsworth, Wreggit, Fairbanks & Kim, 1994; Wierwille, Lewin & Fairbanks, 1996); or different vehicle systems designs via simulator (Lecocq, Kelada & Kemeny, 1999; Kemeny & Panerai, 2003; Cacciabue & Martinetto, 2006). According to this type of simulator, if the conclusions gathered from the simulator are different from the real model, the research findings conducted via it does not valid or reliable. On the other hand, for the instructional simulators, the similarity of the conclusions between the simulator and real world model is one part of the validation process, not the whole (Parkes, 2005). It is named as evaluation of technology by Foshay and Quinn (2005) and according to them evaluation of instructional technology includes the human learning, a more complex and different issue than evaluation of technology. In the simulator validation literature, the approaches applied to validate simulators (evaluation of technology) are named as physical validation and behavioral validation. Also, it is advocated that these validation approaches are necessary but not adequate to validate instructional simulator (Blana, 1996a; Feinstein & Cannon, 2001; Parkes, 2005).

In the literature, realism of the simulator is named as fidelity and the literature of instructional simulator is emphasized that high fidelity does not provide the effectiveness of the training or transfer of knowledge (Parkes, 2005; Estock, McCormack, Bennett & Patrey, 2008). According to them, low fidelity simulators may be adequate to meet the instructional purposes (Parkes, 2005; Estock et. al, 2008).

Estock et al. (2008), Parkes (2005) state that the fidelity of the simulators should be defined according to the instructional needs. The simulators are classified as high, medium and low fidelity simulators (Blana, 1996a; Estock et. al., 2008; Eryılmaz et. al., in press;) and high fidelity simulators has more capabilities and best representation of the real world model. However, while the fidelity level of the simulator increases, the cost of the training also increases. Estock et. al. (2008) present the following figure in order to show bi-directional relationships between each of three aspects of training, training effectiveness, cost and fidelity (Figure 2.11). They explain the figure with the words "The relationship between cost and training effectiveness is not direct, but is implicit through their mutual relationships with fidelity" (Estock et. al. 2008, p.7)

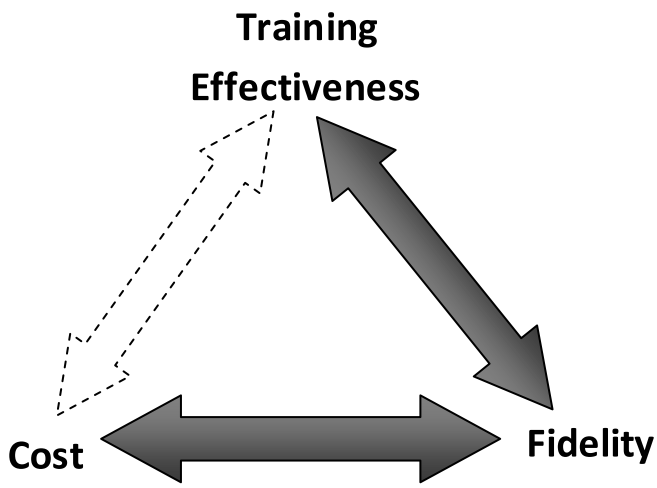

Figure 2.11 Interactions within the integrated model (Estock et. al. 2008, p. 7)

Many debates in the IT focuses on this issue in that media is effective or not on learning (Clark, 1983; Kozma, 1991; Clark, 1994; Kozma, 1994; Cagiltay, 2001). The meta-analysis results show that not the media but the instruction is effective on learning (Kulik, Kulik & Cohen, 1979; Bangert, Kulik & Kulik, 1982). From this perspective, a simulator can work properly or in other words it may represent the real world model perfectly, but it does not provide students' learning. The effectiveness of the instruction which is in the scope of program evaluation research and the validation is different than evaluation according to Reeves (2003) and Borenstein (1998). They also state that validation is a part of the evaluation (Reeves, 2003; Borenstein, 1998). On the other hand, in simulator validation research, the simulator (media) is the center of the research. In other words, in the validation research, the researchers do not focus on whether the simulator impact on learning, they just focus on what is the role and contribution of the simulator to the instruction. These research studies are valuable since they presents information on the capabilities of the instructional simulators and how these capabilities can be used to enhance the effectiveness of instruction. In the IT field the roles of the media in the instruction are defined as tool, tutee, tutor (Bates, 1994; Jonassen, 1995). Similar role sharing is done for the simulations. Also, Kneebone

(2003) states that the simulations can be used presentation and practice purposes. However, aforementioned in the literature review part, simulators are man-interacted systems and aim to provide users experience the real world conditions (Blana, 1996a; Lee, 1999). For that reason, they are devices used as practice tools in the instruction and the validation issue of these devices can also connected with their usability. The importance of usability issues while designing the simulators is stated by Kluj (2003), Tracey (2009) and Uke, 2006. Usability is described as the factors affecting the interaction between users and products by Nielsen (1993). Moreover, Richey and Klein (2007) describes usability with the words, ''information on the extent to which a product, tool, or model can be effectively, efficiently, and satisfactorily used in the context for which it was intended'' (p. 160 as cited in Tracey (2009). Kılıç and Güngör (2006) state that the aim of the usability is to design the products according to the users' expectations and needs. All these statements show that the usability issues also affect users' performances while using the products. Similarly, usability in driving simulators is also important since the drivers have difficulty to drive them if there is a usability problem. Moreover, usability issue is related to the validation process of the simulator since users' experiencing the real world conditions is the center of the validation research, the user interaction with the system is also an important issue (Uke, 2006).

2.3.1.2. Complementarity of Simulator Validation Approaches

In the literature, simulator validation studies conducted different methodologies under the different validation approach names. Blana (1996a) gives the example of the validation categories that are used for the psychological tests, namely, criterion-related, content-related and construct related and explains the simulator validation in terms of these validity categories. However, as man-interacted systems, this categorization is not appropriate for simulator and a validation model was needed according to him (Blana, 1996a). Also, Hoskins and El-Gindy (2006), Chang and Ho (2002), Blana (1996a) point the need for the simulator validation model. Chang and Ho (2002) advices a new model, namely, human behavior validation model, based on the past works for the simulator. Moreover, Borenstein (1998) propose a model for DSS simulators again based on the past studies. However, any of these studies does not imply the categorization of past validation studies. They specifically focused on the one aspect of the simulators such as user performance comparison between the simulator and real world; taking their perception on the simulator reality; fidelity level effects on performance and so on. The reviewed literature showed that the simulator validation approaches conducted can be categorized, namely, physical, behavioral and face validation. In addition to them, for the instructional simulators, different validation methods are advised (Singer, 1993; Lee, 1999; Parkes, 2005; Estock et. al., 2008; McDougall, Corica, Boker, Sala, Stoliar, Borin, Chu & Clayman, 2006) but not specifically pointed how the instructional simulator can be validated. Feinstein and Cannon (2001) points out the importance of this issue and call it as "educational validation".

The simulation validation literature heavily includes the research studies that conduct physical validation or behavioral validation approaches (Blana, 1996a; Chang & Ho, 2002; Hoskins & El-gindy, 2006; Estock et. al. 2008). However, it is advocated that the necessity of taking users' perceptions about the simulator during the behavioral validation application (Blana, 1996a; Chang & Ho, 2002). In other words, face validation approaches can be used as a complementary to behavioral validation. On the other hand, as aforementioned, simulators designed for instructional purposes should be validated in terms of their instructional side (Estock et. al, 2008; Parkes, 2005). The methodologies conducted to validate simulators physically and behaviorally are experimental research (Blana, 1996a; Feinstein & Cannon, Hoskins & El-Gindy, 2006; Santos, Merat, Mouta, Brookhuis & de Waard, 2005). On the other hand, the interviews and observations which are the qualitative inquiry methods are conducted to get information in the scope of face validation (Blana, 1996a; Feinstein & Cannon, 2001; Chang & Ho, 2002). Also, it is emphasized that the best validation study is the one that includes all these approaches (Rothe, 1985; Blana, 1996a). Clearly, the mixed-methods research methodology is advised to validate instructional simulators.

In the literature there are the ways for how each of these simulator validation approaches can be conducted, except instructional validation approach. However, there is no prescription about how these all approaches can be combined in a single simulator validation study. For that reason, parallel to the simulator validation literature, mixed methods research literature and educational research literature on evaluation were reviewed.

2.3.1.3. The Relationship between the Simulator Validation Approaches

Although there is no prescription how the validation approaches can be combined, the simulator validation literature is full of the information on the relationships between the approaches, namely, physical, behavioral, face and instructional validation. It is important information that can be used while combining the approaches under a validation model umbrella since it also refers to which order the approaches can be applied and what are their weights in the validation process. Creswell (2003), Creswell, Clark, Gutmann and Hanson (2003), Greene (2007) and Mertens (2003) and Mertens (2005) state mixed method research topologies are based on the weight and order of the methods and these issues define the research designs. According to Cunto (2008), Blana (1996a) and Hoskins and El-gindy (2006), the physical validation is necessary for the behavioral validation but it does not guarantee it. In other words, if the physical validation is not provided, the behavioral validation also cannot be provided. However, the behavioral validation depends on different factors such as the drivers' motivation, experiment conditions etc. For that reason, although the physical validation is provided, the behavioral validation may not be provided. Similarly, behavioral validation is necessary for the face validation (Blana, 1996a; Feinstein & Cannon, 2001) since the drivers' perceptions on the simulator that s/he drove depends on the results of the experimental test. In other words, if the expected performances cannot be gotten, the drivers' perception on the simulator cannot be positive. However, although the behavioral validation is provided, the face validation may not be provided (Blana, 1996a; Feinstein & Cannon, 2001). What extend behavioral validation and face validation is needed is defined according to the instructional goal (Estock, et. al; Parkes, 2005). For that reason, instructional validation depends on behavioral and face validation. Feinstein and Cannon (2001) states that although the face validation is provided, instructional validation may not be provided. Also, another side of the instructional validation, the transfer of the knowledge, depends on many different conditions such as road conditions, weather conditions, and drivers' psychology.

The literature on simulator validation shows that the validity of the simulator starts from the development phases of these tools. Many engineering articles focus on the model validation during the development of the simulators (Chang & Ho, 2002; Borenstein, 1998; Hoskins & El-Gindy, 2006; Cunto, 2008). According to them the model validation is provided iterative testing of the applications during the alpha and beta phases of the development (Chang & Ho, 2002; Borenstein, 1998; Hoskins & El-Gindy, 2006; Cunto, 2008). In the development phase software engineers use mathematical and algorithmic formulations to simulate performance of particular parts of the real model, for example simulating the gear chance of a real truck. After simulating the particular parts performance, they also validate them with the physical and behavioral validation approaches (Blana, 1996a; Hoskins & El-Gindy 2006; Chang & Ho, 2002). Since the physical validation provides the base for behavioral validation, the testing of the performance of the specific parts of the simulators is conducted without human by comparing the performance conclusions of the real vehicle and its simulated parts (Blana, 1996a; Chang & Ho; 2002). Parallel this process, testing with human is conducted to realize if the behavioral validation is provided. The behavioral validation is critical issue for the simulators because they are man-interacted systems. According to the Chang and Ho (2002) to taking users' opinions in this stage is very important. In other words they advice to apply face validation approaches in these stage. On the other hand, in the development stage face validation approaches that is applied is unstructured and not the real users but software engineers, testing engineers or experts tests the system. For that reason, the face validation approaches are applied during the general availability phase of the simulator. The relationships between the approaches are illustrated in the Figure 2.12.

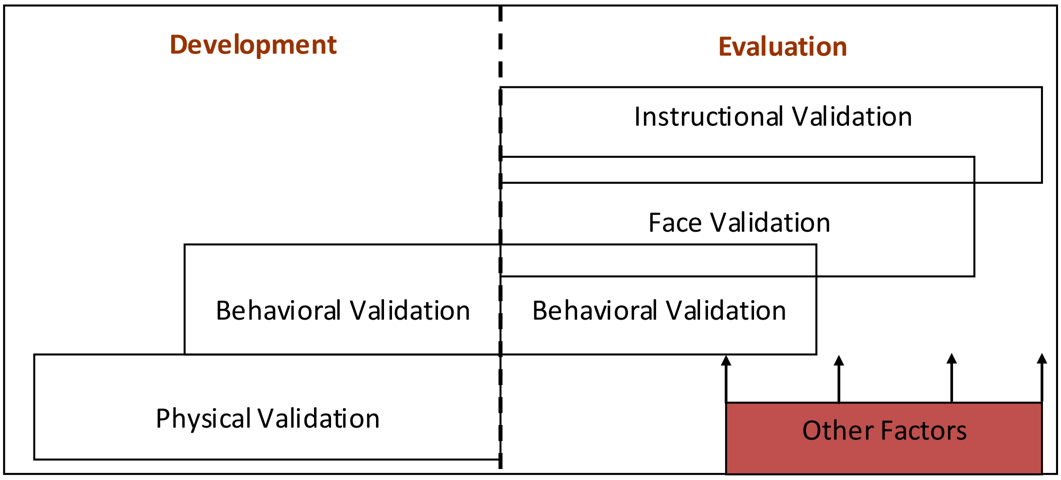

Figure 2.12 The relationships between the approaches

According to the Figure 2.12, physical validation and behavioral validation are conducted during the simulator development. In the engineering agenda these term is named as alpha and beta phases. The experts and developers are the users who conducted behavioral validation tests during this phase (Chang & Ho, 2002; Hoskins & El-Gindy, 2006; Desel, 2000). The process is iterative to reach the real model performance measures. After the development phase, the validation tests are conducted with the participation of real users (Blana, 1996a). Borenstein (1998) labels these test as field tests. In the engineering agenda this term is named as general availability phase. In the IT field, this term is named as evaluation phase. During the evaluation phases, many factors such as driver motivation, environmental conditions so on affects the results of the validation research. Since this validation research is the part of evaluation phases conducted after the simulator developed, the model proposed includes the behavioral, face and instructional validation approaches. Figure 2.12 illustrates that behavioral validation is a base for face validation and face validation is a base for instructional validation. For that reason, behavioral validation also indirectly affects the instructional validation results. Also, these outcomes of the literature show that in the simulator validation research behavioral approaches firstly conducted. Then, the face validation approaches were applied and lastly the instructional validation approaches are conducted.

2.3.2. The Overall Simulator Validation Process Including Analysis, Development and Evaluation Phases Extracted from the Literature

Since the simulators are technological tools, different validation approaches are applied by the developer during the development stages. The model proposed by Hoskins and El-Gindy (2006) illustrate the combination of physical and behavioral validation in the development stage. Chang and Ho (2002) propose a behavioral-based model that focuses on lane changes of the drivers and states importance of apply this model from the development stage. According to the researcher the validation of the simulator starts from the analysis stage since the experimental research conducted without man (physical validation) and with man (behavioral validation) is based on the comparisons between the simulator and real world model. For that reason, the real world model should be validated through experimental research without man and with man during the analysis stage. Figure 2.13 shows the validation model that can be used analysis, development phases of the simulators and field test evaluations of instructional simulators. When a training project was launched, the aim is low cost and more effective designs (Estock et. al., 2008; Parkes, 2005; Lee, 1999). The advised manner for the training via simulators is that fidelity of the simulator should be determined according to the instructional aim. Although the real world data are important, the high fidelity the simulator in terms of appearance and performance should not be necessary for the effective application of the instructional simulators (West, Snellen, Tong & Murray, 1991; Singer, 1993; Lee, 1999; Parkes, 2005; Estock et. al., 2008) and for the development of the simulator, the more fidelity means more cost (Santos, et. al., 2005; Estock et al. 2005). For that reason, before the analysis phase, the aim to use the simulator and how much fidelity is necessary should be defined (Parkes, 2005; Estock et. al, 2008).

Shortly, in the instructional validity studies, with respect to the determined fidelity criteria, analyses of conclusions of real world model should be conducted. Then, again according to the fidelity of the simulators, the physical and behavioral validation borders should be determined. Whatever the fidelity of the simulator is (high or low), the validation procedures and determination of the validity of the simulator should be determined instructional goals. Figure 2.13 shows the overall instructional simulator validation process developed according to the literature. This model includes the validation approaches that may be conducted during the analysis, development and evaluation phases.

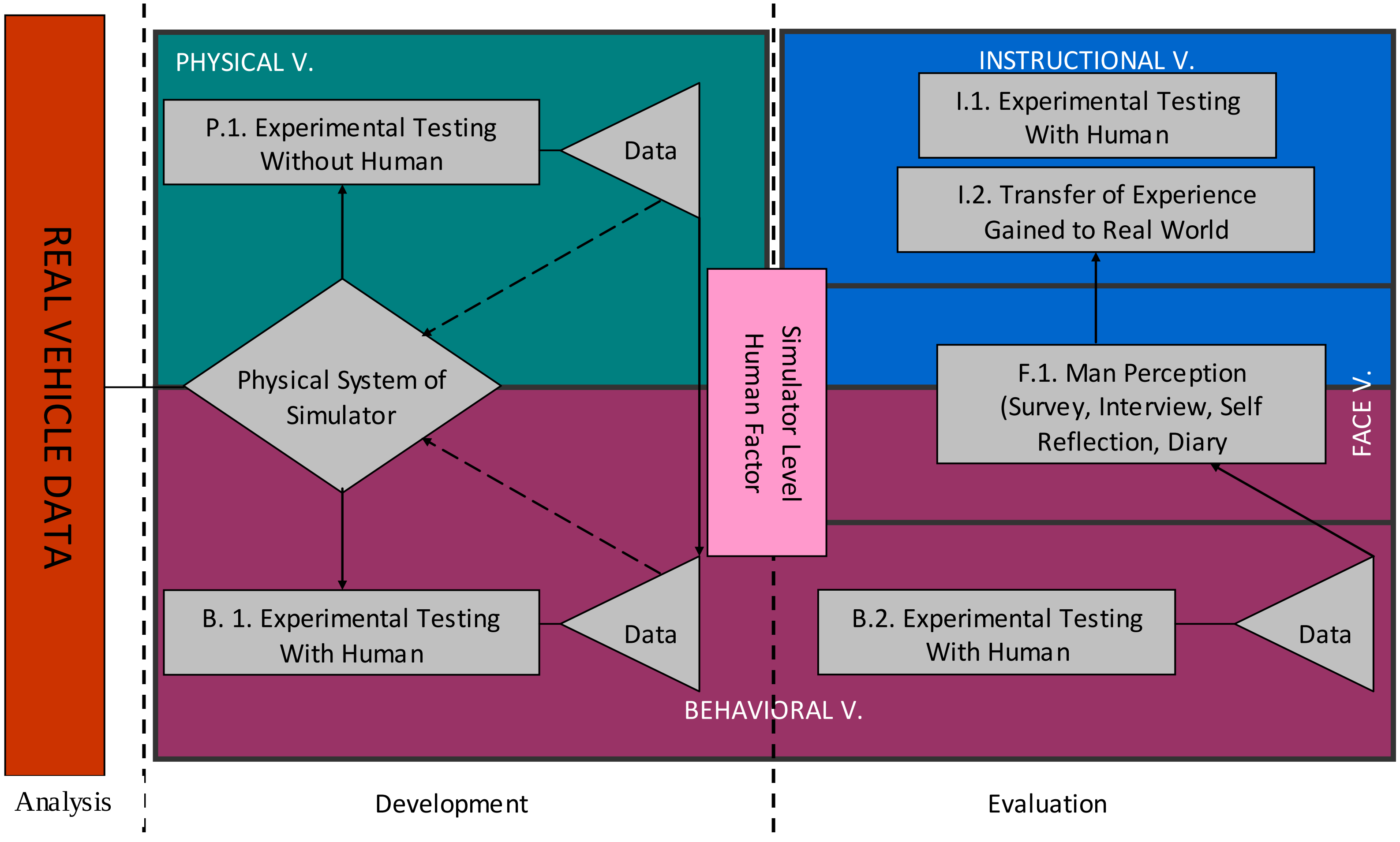

Figure 2.13 The overall validation process needs to be conducted during the analysis, development and evaluation phases

Analysis Phase: In the model, the physical system of the simulator was developed according to the real vehicle which was modeled in the simulation environment in terms of physical representation and performance. The physical representation refers to the appearance of the real vehicle which was modeled in the simulator. Also, parts of the vehicle performance should be similar to real vehicle. Although this phase is not mentioned during the validation process conducted in the development and evaluation phases, it should be kept in mind that all the validation process depends on the comparisons of measures between the real vehicle and simulator. In other words, the similar conclusion was the base of the whole process. For that reason, during the analysis phase the tests should be conducted with the real models and target users of the simulator. Moreover, the purpose of the simulator also affects the analysis tests designs. For example, if the simulator is designed to train truck drivers on economic fuel consumption. The factors they may affect the economic fuel consumption should be defined. Then the tests should be designed according to these effective factors. Moreover, it is important to take expert opinion (developer, instructional designer, experience user) during this phase.

Development Phase: During the development phase, software engineers run the iterative validation processes by applying both physical validation and behavioral validation methods (Blana, 1996a; Chang & Ho, 2002; Hoskins & El-Gindy, 2006). In the physical validation parts, they use the mathematical formulas or real vehicle performance data and validate the simulator performance without user. For example, they use a speedometer to assess the speed change of the simulator (Chang & Ho, 2002).

In the behavioral validation part they validate simulator by conducting experiments with users. This user can be a real user or an experts or developer of the simulator. According to the iterative validation process, the simulator is developed. If there is a validation problem the developer turns the beginning and solves the problem. During the validation process under the scope of behavioral validation, it should be kept in mind that the human factor affects the results of the data. For that reason, measures from the real vehicle and simulator should be compared.

Evaluation Phase: After the development stage, end product validation process was started. During the evaluation phase, the simulator is tested how well it meets design aims. In this phase, behavioral validation tests are conducted with the participation of real users. For the instructional simulators, the simulators effects and role hat form learning experience are investigated. For that purpose, behavioral validation, face validation and instructional validation approaches are conducted. Since the scope of this thesis is the validation process for the instructional simulator conducted after the development phase, the center of the proposed model is the behavioral, face and instructional validation approaches.

2.4. Summary

There are many validation studies in the literature and there is an inconsistency between them about the simulator validation descriptions and approaches. Most of them followed different approaches to validate simulators. The approaches categorized by the researcher are physical, behavioral, face and instructional validation approaches. Moreover, the literature shows that behavioral validity approach which are based on the experimental research designs are heavily followed by the researcher. However, according to the literature review, the similar conclusions that are results of the comparisons between the simulators and real world models do not provide the adequate proof on the validity of the instructional simulator. For that reason, with regard to the validation definition which is "the extent of simulator that serves to purpose the validation", methodologies that enable researchers to investigate both technology and instructional side should be followed in the scope of validation research of the instructional simulators.

CHAPTER 3

METHODOLOGY OF THE STUDY

This chapter includes detailed description of the research methodology which was applied in this thesis. Research questions, design of the study, the research methodology and justification of used methodology, the Truck Simulator, pilot study and its findings, the study with subheadings, namely, data collection methods and instruments, sampling selection procedure, data analysis procedures and the validity and reliability issues were presented in this chapter of the thesis.

3.1. Research Questions

This study aimed to validate the truck simulator which was designed to train the truck drivers on economic fuel consumption by using different simulator validation approaches, namely, behavioral, face and instructional validities. The result of the literature review shows that instructional simulator validation phenomenon had different facets. Moreover, according to the literature, in order to have an accurate picture on the validation of an instructional simulator, different approaches should be combined in a complementary manner. However, most studies investigate simulator validation in one facet and there is no standard procedure for the validation of instructional simulator. Therefore, a second aim emerged at the beginning of the study: to develop an instructional simulator model. The process of combining different validation approaches to get a holistic picture about an instructional simulator may also provide invaluable information about the instructional simulator validation process. Moreover, the development of a new instructional simulator validation serves to validate different instructional simulators and brings a standard for the validation process of instructional simulators. With respect to these aims and expectations, the main research questions with sub-questions are:

1. What extend does the truck simulator do what is supposed to do?
   In terms of Behavioral Validity:

1.1. What extend does the fuel consumption measure of the truck simulator represent to the fuel consumption measures of presented in the fuel consumption theory?

In terms of Face Validity:

1.2. How do the stakeholders evaluate the truck simulator?

1.2.1. How do drivers and trainers evaluate the truck simulator driving experience in terms of reality, usability and instructional benefits of the simulator?

In terms of Instructional Validity:

1.3. What extend does the truck simulator contribute to the effectiveness of the training what is supposed to do?

1.3.1. Is there a difference in the drivers' performances before and after the training?

1.3.2. What are the contributions of the drivers who took the economic fuel consumption training with the truck simulator to their workplace in terms of return of investment?

1.3.3. What are the factors which affect transfer of the knowledge gained from the training?

2. What are the main characteristics of an effective and efficient instructional simulator validation process?

3. What should an instructional simulator validation model include for effective and efficient validation process?

3.2. Background of the Current Study

This thesis was the last phase of a big project, the Philosophy Project (PP) supported by well known petroleum company around the world. The born of the Philosophy Project can be traced back in 2005. The project consists of three main phases as Needs Assessment, Development and Evaluation. Each phase was implemented by expert companies which the petroleum company made appointment with. The aim and the expectation of the company were to sell their products to the logistics and transportation companies which are their likely purchasers by presenting them a service which they need. For that purpose, they made a market research among transportation companies. As a result of the research, the problem of the most transportation companies was defined as the high fuel consumption. Training on fuel consumption to the drivers of transportation companies was determined to be serviced. To do that, the petroleum company contacted with one of well known training and consulting firms. The training and consulting company gives training to truck, articulated lorry and car drivers of big transportation companies and consults to the big petroleum companies about the road conditions by conducting highway analysis for safe driving. Moreover, the selected training and consulting firm has been working for the petroleum company in order to select truck drivers for them by conducting tests with the truck drivers on real trucks and provides training for their drivers on safe driving and economic fuel consumption. The training and consulting company has conducted research on the highway conditions and given reports about which roads are safe to transport products for the petroleum company.

The second phase, Development, of the PP was started after the petroleum company made an appointment with the training and consulting firm. This phase was related to the determination of the training design. The training given before by the training and consulting firm was consisted of two parts as theory presentation and the practice of the theory with the truck drivers on real truck. This type of training was beneficial because the drivers had a chance to practice what they had learned on the real truck. However, few drivers had this chance because of the cost, safety issues and limited time. In the PP, the petroleum company's expectation was different than traditional trainings in that they wanted to provide training to as many drivers as they could. To replace a truck simulator with the real truck in the training was seen the most appropriate option because they could carry the training design model which includes both theory presentation and practice. Also, all the drivers could have chance to practice what they learn on a safe environment and via cost effective manner. For the development of a truck simulator, the petroleum company made an appointment with a software company which was one of the biggest companies in IT sector. During the Truck Simulator Development, the expert trainers of the training and consulting firm provided necessary theoretical background and real truck economic fuel consumption measures to the software company engineers. For enhancing fidelity of the TS, as experts, the trainers of the training and consulting firm, also worked with the computer engineers during the development process. To enhance the similarity of the TS to the real truck in terms of appearance, they presented different real trucks' hardware information to the software company and controlled the traffic rules and the traffic signs in which the traffic scenario of the TS includes. Necessary changes were done according to trainers' opinions in order to enhance similarity of the traffic environment in the TS to the real road environment. The development of the TS took about 3 years.

The last phase, Evaluation, of the project was determined to be conducted in the scope of Release Candidate cycle of the TS development. For that purpose, the petroleum company contacted with a research department in one of the top university in Turkey. The petroleum company asked the research company to conduct research in a scientific manner in order to see if the TS is a correct tool or not to provide practice for the truck drivers on economic fuel consumption. To do this, firstly a research group which was consisted of six people (two experts and four doctorate students (one of them was the researcher of this thesis investigation) was formed. One of the experts in the research group was from the Instructional Technology Department while the other one was from Computer Engineering Department in the university. The research group firstly, started to review related literature and then developed a methodology regarding the literature. The role of the researcher was to develop materials which were used in the investigation. During this process, the experts' opinions were taken. Then, the expert trainers of the training and consulting firm were contacted with and a pilot study was conducted with the participation of eight truck drivers. The result of the Pilot study was reported and presented in a meeting to the petroleum company, the training and consulting firm and the software company. Regarding to the prepared report, the TS was improved.

Later, the petroleum company asked the improved version of the TS to be evaluated during the real training activities, with high number of the truck drivers' participation and in the field tests in the scope of General Availability cycle of the simulator. So, this investigation study was lunched. The researcher of this thesis wanted to conduct a research study on if the improved version of the TS was a valid tool to provide practice for the truck drivers on the economic fuel consumption training. For that purpose, firstly, the scope of the pilot research was expanded with regard to the validation model developed for training simulators according to the related literature as well as the experts' opinions (both from the university and trainers of the training and consulting firm). Then, to reduce the external variables effects to the study such as truck drivers' background information and work conditions, the data was determined to be collected with the participation of the truck drivers of a specific transportation company. Since the petroleum company provided training on economic fuel consumption via the TS to the transportation companies which had accepted to buy their products, the data could be collected from one of these transportation companies. The transportation companies were investigated by the researcher and the biggest one was chosen to arrange a meeting about the study for three reasons:

- Firstly, the number of the truck drivers which was participated to the study was important.
- Secondly, this logistics and transportation company was the only transportation company which has a Training Department and arranges trainings for its personnel among other companies which made agreement with the petroleum company. For that reason, they were likely to support this study.
- Thirdly, because the researcher wanted to investigate the transfer of training in terms of return of investment and compare the truck drivers' fuel consumption measures in real life before and after the training for that purpose, the most appropriate time was January, February and March months for the training and the time schedule of the training sessions given to this logistics and transportation company included January, February and March months. So, she can compare the truck drivers' fuel consumption measures in the Fall and Spring seasons which have the similar weather and way conditions.

Then, a meeting was arranged in order to explain the aim of the research and asked the logistics and transportation company to permit the researcher to collect data from the truck drivers during the trainings given by the training and consulting firm trainers. The researcher, the petroleum company managers and the logistics and transportation company managers participated to the meeting. Moreover, the logistics and transportation company manager allowed the researcher to collect data from the truck drivers worked for them. Since the researcher wanted them to provide all information about the truck drivers' services, she prepared a list that showed what information that she needed (Appendix A). The company wanted the researcher to prepare a confidentiality agreement to keep important information of the company secret (Appendix B). This agreement included items that guarantee: "The researcher would not explain the information about the truck drivers' services to the public in detail".

Although the agreement was prepared on collection of data from the truck drivers' of the logistics and transportation company, the data were collected from the volunteer ones. All the instruments and voluntarily participation form were presented to the ethic committee at the university. The Instruments used in the study after the approval of ethic committee were in the Appendix Part of the thesis (Appendix C to H). Before the data collected, each truck drivers who were volunteers signed voluntarily participation form (Appendix I). After the study, the participants were given an "Informing Form after Participation" (Appendix J). Over, 121 truck drivers took the training but 110 of them were volunteers to participate to the study. For that reason, 110 truck drivers' data were collected during the training sessions given by the training and consulting firm trainers.

3.3. Design of the Study

This thesis study included validation of a training simulator. In the current study, it was focused on determining whether the simulator met its design aim. Figure 3.1 shows the phases of the project and which phase was investigated under this thesis study.

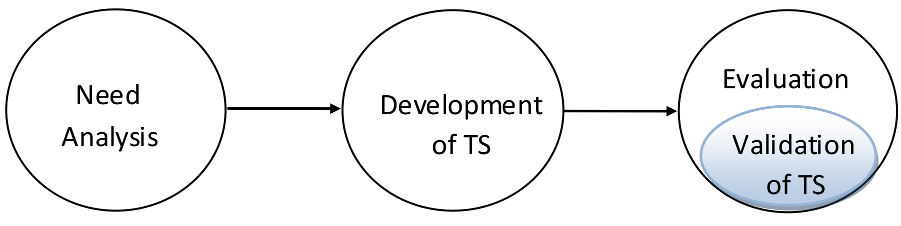

Figure 3.1 The Phases of the project and which phase was the thesis study

After the purpose of the study defined, the related literature was reviewed to define best way or ways to validate instructional truck simulator. However, the literature on driving simulator validation composed of many research studies from different fields such as "Industrial and Operations Engineering" (e.g. Reed & Green, 1995), software engineering (e.g. Chang & Ho, 2002), Civil Engineering (e.g.Cunto, 2008), health (e.g. Lee, 2002; Kneebone, 2003), Education-Applied Mechanic Engineering (e.g. Wallace & Regan, 1998; Wade-Allen, Chrstos, Howe, Klyde & Rosenthal, 2002), Education (e.g. Allen & Tarr, 2005; Baker, Niemi & Chung, 2008), Computer Engineering (e.g. Uke, 2006; Behrens, Frezzo, Mislevy, Kroopnick & Wise, 2008), Evaluation (Lesgold, 2008; Cohn, Stanney, Milham, Jones, Hale, Darken & Sullivan, 2007) and so on. Moreover, Straus (2005) states that automotive industry, military, academic research fields, government, space, recreational computer markets and medical sector use driving simulators with different purposes such as training, performance, assessment and so on. For that reason, the aims and methodologies of the studies in the literature differs from field to field. In other words, there is no specific approach or methodology to validate instructional simulators.

Also, the literature on simulator validation is full of the complexity on simulator validation definition, followed validation approaches and labels of these approaches (Blana, 1996a; Feinstein & Cannon, 2001; Hoskins & El-Gindy, 2006). Most of the authors state the need for a validation approach (Blana, 1996a; Boinstein, 1998; Chang & Ho, 2002; Hoskins & El-Gindy, 2006). Also, different labels were used for the same validation approaches. For example, Blana (1996a) proposes a simulator validation categorization by using the test categorization labels, namely, content-related, criterion related and construct related validity. Also, he defines the methods that could be used to validate simulators for each categorization although he states that his proposal does not fit simulators which are the human-interacted systems. Similarly, McDougall, et. al. (2006) uses the same categorization to validate a surgical training simulator. On the other hand, Blana (1996a) states that his literature review results showed that simulator validation approaches are labeled as behavioral validation and physical validation. Chang and Ho (2002) and Hoskins and El-Gindy (2006) use the same labels for the simulator validation process in the development and field test phases. Blana (1996a) also states that “A similar technique to the behavioral and physical correspondence for validating the driving simulators was introduced by Bertollini et al (1986): the closed-loop and the open loop techniques.” (p.11). Some authors such as West et. al. (1991), Emery et. al. (1999), Feinstein and Cannon (2001), Kihl and Wolf (2007) advocate validation process of the instructional simulator should be thought in terms of instructional side. Feinstein and Cannon (2001) carry this claim a further stage and label this validation as “educational validity”.

Since the labels of approaches are different although applied methodologies are same in the literature, the researcher decided the focus on applied methodologies. It was realized that experimental methods was very popular to validate simulators. However, some researchers use qualitative methods in addition to experimental designs in order to investigate how drivers’ perception on the simulator affects their behaviors (Blana, 1996a; West et al., 1991; McDougall et. al, 2006; Kihl & Wolf, 2007; Janson-Olstam, 2008). In other words, although experimental research designs are used heavily in the simulator validation studies, many authors advocates combining quantitative and qualitative approaches in order to validate simulator developed for educational purposes (e.g. Van Horn, 1971; Blana, 1996a; Lee, 2002; Uke, 2006; De Winter, Wieringa, Dankelman, Mulder & Paassen, 2007; Foshay & Quinn, 2005; Reeves, 2003; Feinstein & Cannon, 2001; Lee, 1999; Keenebone, 2003). Moreover, simulators are man-interacted systems (Blana, 1996a; Reeves, 2003) and human factor cannot be ignored in the researches in the social sciences (Greene, 2007). For that reason, Greene (2007) and Mertens (2005) advocates using the Mixed Methods Methodology by stating that multiple worldviews are necessary to conduct studies, especially evaluation ones, in which there is human factor. Moreover, instructional simulator validation was different than the simulator validation and the used approaches in the literature were not enough for validation of an educational simulator validation. Foshay and Quinn (2005) advocate that the experimental methods do not provide a complete picture for evaluation of educational technology. They claimed that the evaluation of technology and evaluation of instructional technology are different with the words: "The distinction is crucial to understanding the appropriate application of the experimental paradigm and the development of questions appropriate for the evaluation of technology. Instructional science is based a combination of descriptive and prescriptive theory; only prescriptive theories are testable using the experimental paradigm. Instructional design is a technology of design cannot be tested experimentally" (Foshay & Quinn, 2005, p 153). Similarly, Reeves (2003) states that the simulators can be used as interactive learning systems and pragmatic perspective is proposed to evaluate them.

The outcomes of the literature provided valuable information about the simulator validation approaches to the researcher. First one was that there is validation approach need for instructional simulator. Second one was that technological side and instructional side of the simulator as well as participants' opinions on these ides should be taken into account in a complementary manner to validate instructional simulators completely.

To validate simulators is a necessity as Blana (1996a) and Hancock, Caird and White (1990) state. This study emerged from this necessity but to get an accurate picture on the validation of the TS, the researcher had to define another purpose: to develop a simulator validation model for instructional simulators by combining the approaches emphasized in the literature. The research design of this study was fit the model of Interactive Research Design as described by Maxwell and Loomis (2003), Maxwell (2005) and Maxwell (2008). Maxwell (2005) and Maxwell (2008) emphasize the most important characteristic of the model with the words: "In this model, the different parts of a design form an integrated and interacting whole, with each component closely tied to several others, rather than being linked in a linear or cyclic sequence" (p.4). Also, Maxwell and Loomis

(2003) give the Mixed Methods Research study examples that have interactive research design nature. Figure 3.2 shows the Interactive Model of Research Design.

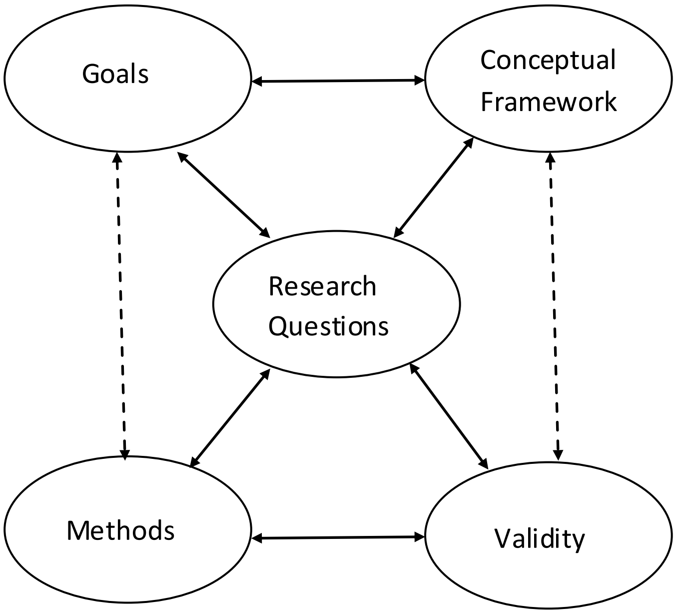

Figure 3.2 An Interactive Model of Research Design

SOURCE: From Qualitative Research Design: An Interactive Approach, by J. A. Maxwell, 2005. Copyright by SAGE.

Maxwell and Loomis (2003), Maxwell (2005) and Maxwell (2008) also provide contextual factors that influence the research design in detail. Figure 3.3 shows these contextual factors. In the figure, Maxwell and Loomis (2003), Maxwell (2005) and Maxwell (2008) acknowledge the related concerns and issues to each main part in the interactive approach model.

In this study, one of the contextual frameworks, prior research, affected the research design. With the guidance of the advisor, the researcher decided to define methods by grouping them under approaches. Then, she combined them by following the MMR in a complementary manner and investigated the relationships between applied approaches in vivo formative research.

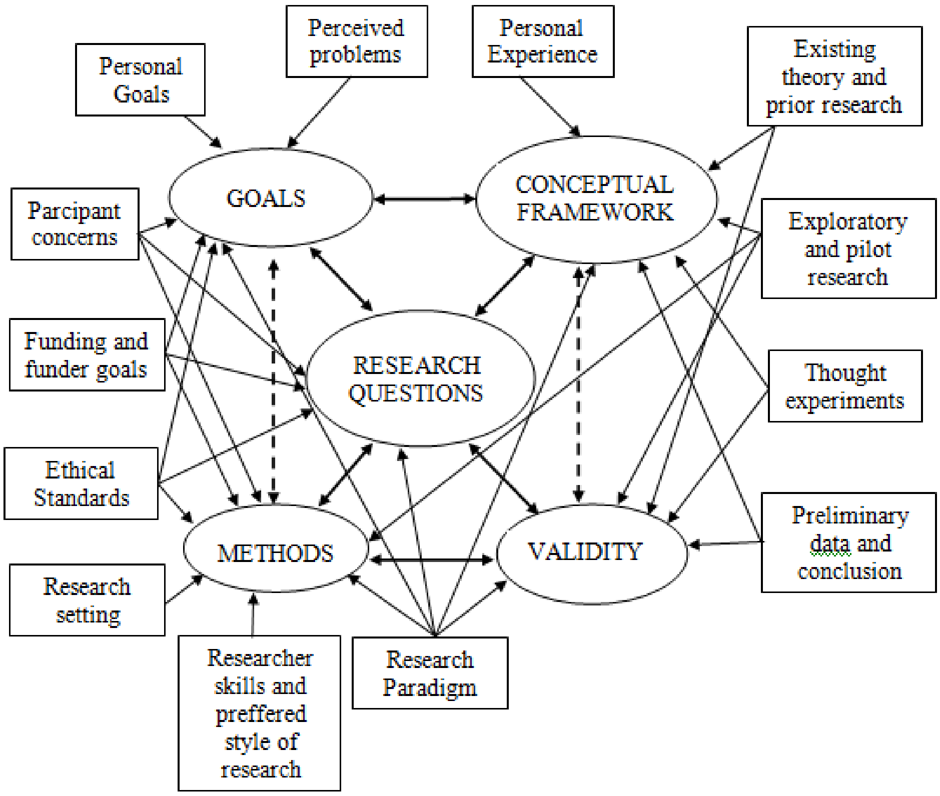

Figure 3.3 Contextual Factors Influencing a Research Design

SOURCE: From Qualitative Research Design: An Interactive Approach, by J. A. Maxwell, 2005. Copyright by SAGE.

Maxwell and Loomis (2003), Maxwell (2005) and Maxwell (2008) illustrate the research design of the many research study examples in the Model they described and showed in Figure 3.2 in their articles and books. The research design of the current study also was illustrated in Figure 3.4 by using Maxwell and Loomis (2003), Maxwell (2005) and Maxwell (2008) model of Research Design. As seen in Figure 3.4, two aims of the study were to validate the TS and to develop a tentative validation model for instructional simulators. The conceptual frameworks of the study were literature on the simulator validation and MMR and Formative Research as well as pilot study. To cope with the validity and reliability treads methods such as experimental controls, triangulation of sources and methods, taking expert opinions in every stage, comparison of results with other simulator validation studies were applied. Also, the methods of the current study were comparison of one group performance before and after treatment, narrative field notes of the events and interviews with all stakeholders.

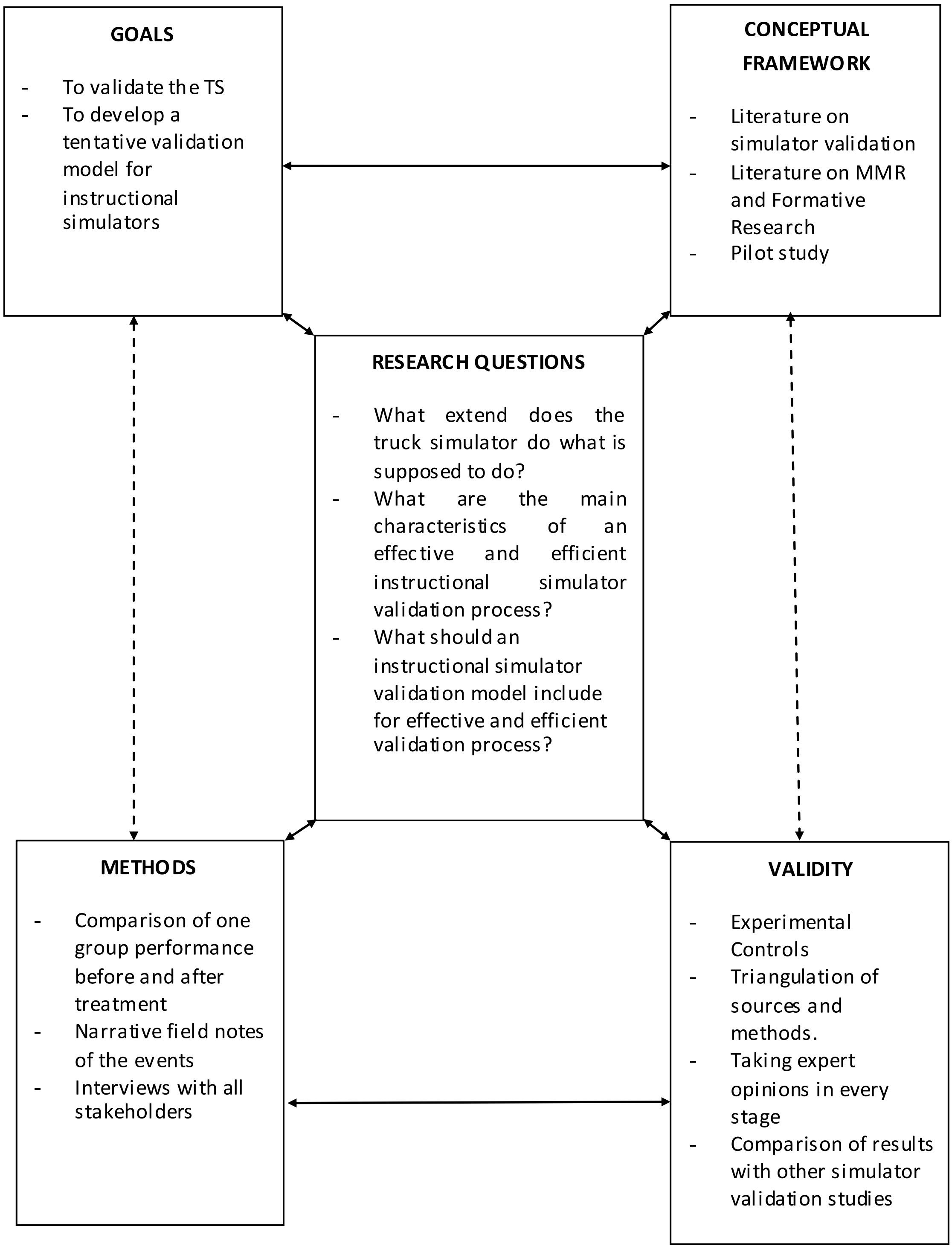

Figure 3.4 Thesis Study Research Design according to Model of Interactive Research Design

As realized, the simulator validation literature advocates the application of Mixed Methods Research for complementary purpose in order to validate instructional simulators. For that reason, MMR topologies were also reviewed to define a specific MMR design for the study. As a result of the MMR review, Greene's (2007) Blending Mixed Methods Research Design was determined to best fit research design to the nature of the thesis study because the Blending MMR to assess different facets of the same phenomena with the complementarity or initiation purpose (Greene, Caracelli & Graham, 1989; Greene, 2007). All the methods have equal weight and applied concurrently (Greene, Caracelli & Graham, 1989; Greene (2007). Figure 3.5 illustrates the Blending Mixed Methods Research Design.

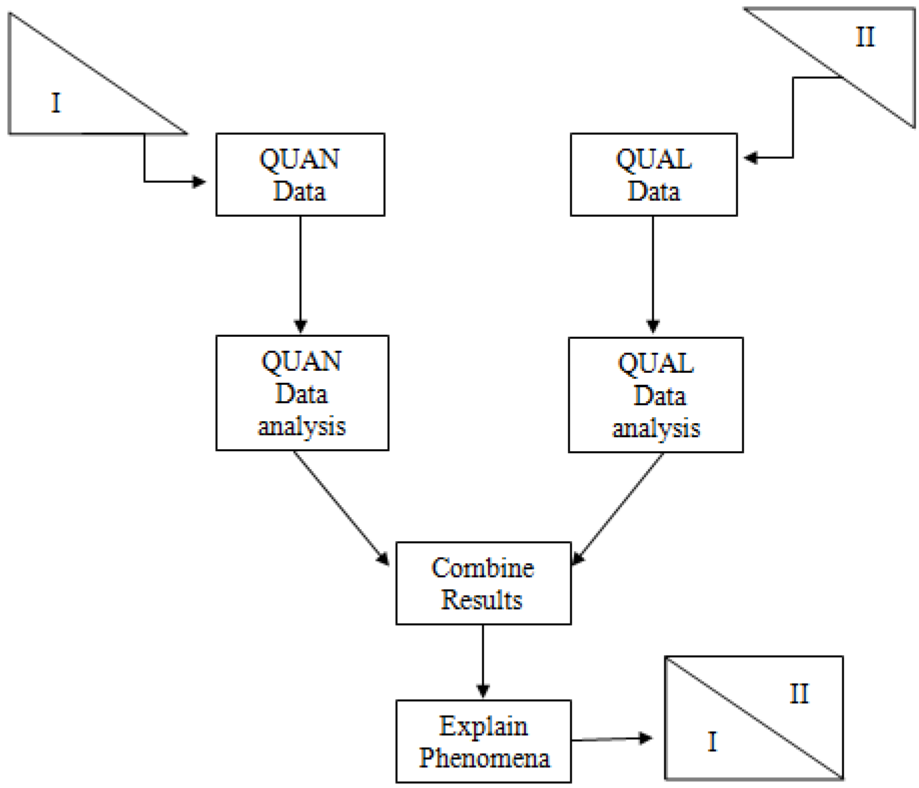

Figure 3.5 Blending Mixed Methods Research Design

As realized from Figure 3.5 while one method is enough to explain one facet of the phenomena (quan or qual), sometimes more than one method with different combinations of the quantitative and qualitative research methods such as quan+ qual, quan+qual+qual, qual+quan+qua n etc. may be applied to explain each facets of the phenomena. Greene, Caracelli and Graham, 1989 and Greene (2007) state that different combinations may be applied depend on the purpose of the study. In this study, the combinations of the methods in the light of the literature within the validation approaches were illustrated in Figure 3.5 While the researcher focused on the complementary in conducting methodology for expressing the different facets of the simulator validation phenomenon for each approaches, she focused on both triangulation while conducting methods. In other words, within approaches different methods and instruments were applied for the triangulation purposes while between approaches, the results of these each methods complemented each other to explain validation of the simulator. The triangulation within and complementarity between the validity types were illustrated in Figure 3.6.

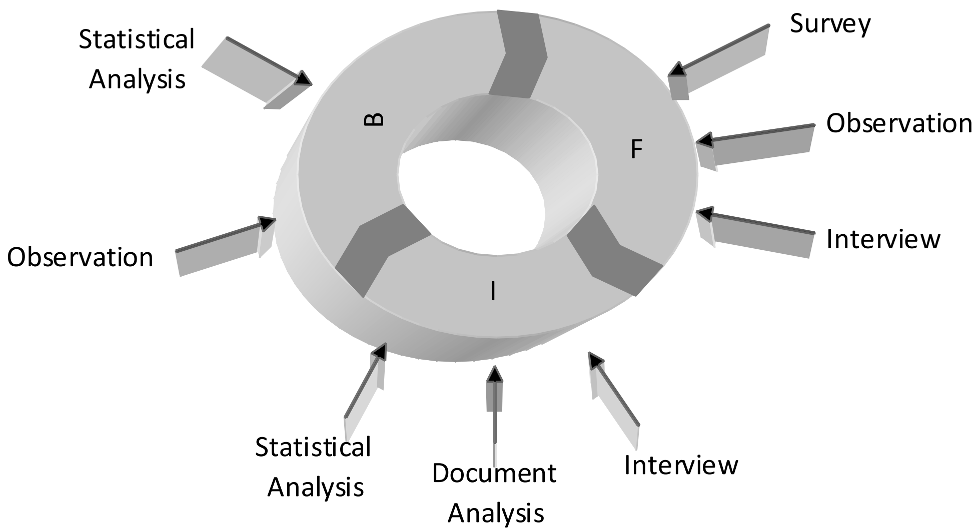

Figure 3.6 The Triangulation of the Methods within and Complementarity of Methodology between the Approaches in the Research Design

On the other hand, the need for an instructional simulator validation model and the more accurate/ scientific results called for another research methodology, Formative Research. With the guidance of the advisor, the researcher decided to label each group of the methods and combine them in a complementarity manner. In the research study implementing the methods to combine each facet of the validation approaches which was extracted from the literature review in a complementarity manner also enables researchers to get insight about the simulator validation process. In other words, qualitative part of the complementarity manner also implicates a theory or model construction and following the designed case formative research method by collecting data via observations/interviews helps researcher to define the relationships, factors that should be taken into account and the strengths/weaknesses of the each approaches and any other approaches that may emerged during the study. Figure 3.7 illustrates the research process for designed case studies (Reigeluth & Frick, 1999).

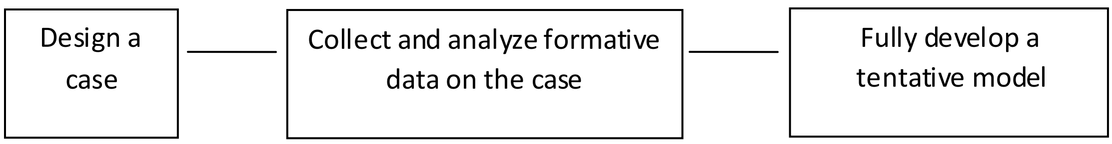

Figure 3.7 Designed case study research process

To sum, the main goal of this thesis study was to investigate whether the TS were the right tool to train truck drivers on the economic fuel consumption. However, to provide accurate and holistic evidence of the validation process, it was realized that the approaches illustrated in Figure 3.6 should be combined in a complementary manner. Also, the literature on simulator validation showed that a validation model for instructional simulators was a needed. For that reason a second aim emerged at the beginning of the study: to develop a tentative validation model in the light of the literature and apply the model to validate the TS. Although the nature of the study referred to the Mixed Method Research, applying developed model to a case called for another methodology, namely, Formative Research Methodology.

3.4. Research Methodology

In this thesis work, the followed methodologies were Mixed Methods Research (MMR) and Formative Research. Under the research methodology part, firstly, the MMR and the applied MMR topology developed by Greene, Caracelli and Graham (1989) were explained. Creswell (2009) suggested that the explanation of the MMR and selected research design to the phd candidates are necessary because the MMR is still developing. Secondly, Formative Research Methodology and applied designed case study were explained. Thirdly, justification of applied methodologies was explained.

3.4.1. Mixed Methods Research (MMR)

Instructional Technology (IT) is an interdisciplinary field that has two sides as technology and instruction. While the technology has advanced, the capabilities of the tools developed for instruction have advanced. Also, delivery of the instruction methods has been changing. As a result, new types of research studies have emerged. These types of the researches are based on a new perspective in which research process should be determined according to practice. MMR is based on this perspective (Clark & Creswell, 2008; Sale, Lohfeld & Brazil, 2002; Johnson & Onwuegbuzie, 2004; Tashakkori & Teddlie, 1998; Teddlie & Tashakkori, 2009; Mertens, 2005; Greene, Caracelli & Graham, 1989; Greene, 2007).

In this thesis work, the reason to choose MMR methodology was stemmed from the researcher's determination to define research methodology with respect to the purpose of the study. The research purpose of the thesis work was to validate the truck simulator developed for training truck drivers. Many authors such as Reeves (2000) and Greene (2007) state that the methods used in the study should be determined according to the purpose of the study. Creswell and Tashakkori (2007) mention the "methodological perspective" which is based on the idea that methods follow research purposes and questions that the researchers' and participants' cultural, philosophical, and value systems shape. Similarly, Reeves (2000) said that many factors including the epistemological views of the investigator, his/her research training, and the dominant research paradigms within his/her line of inquiry affect the instructional technology researchers while defining the purpose. In the research literature, there is a consensus about the idea based on a researchers' paradigm which is defined as "worldview, complete with the assumptions that are associated with that view" by Mertens (2003, p.139) affects the research process from beginning. Moreover, different paradigms, namely positivism, constructivism, pragmatism paradigms (Creswell, 2003; Sale, Lohfeld & Brazil, 2002; Johnson & Onwuegbuzie, 2004; Tashakkori & Teddlie, 1998; Teddlie & Tashakkori, 2009; Mertens, 2005; Greene, 2007) in addition to these, transformative paradigm (Mertens, 2005) are explained in terms of ontology, epistemology and methodology. On the other hand, many authors criticized the researchers and scholars who advocate one paradigm and refuse other ones (e.g. Creswell, 2003; Sale, Lohfeld & Brazil, 2002; Johnson & Onwuegbuzie, 2004; Tashakkori & Teddlie, 1998; Teddlie & Tashakkori, 2009; Mertens, 2005; Greene, 2007; Greene, Caracelli & Graham, 1989). Moreover, Reeves (2000) criticized IT researchers with the words: "One of the primary problems many IT researchers, especially novices, have is distinguishing between research goals and research methods. Evidence of this confusion is seen when a novice researcher states that he/she is only interested in conducting quantitative (or alternatively qualitative) studies without specifying the type of research goal he/she is pursuing." (p. 5). In the light of the literature, the purposes of current study guided the researcher to apply MMR and Formative Research Methodologies together.

3.4.1.1. Greene's MMR Design Topology and Blending MMR Design

There are a variety of research design topologies in the MMR literature (Greene, 2007; Teddlie & Tashakkori, 2009; Creswell, 2009). The design topologies of the MMR are mainly based on the notational system developed by Janice Morse (1991) (as cited in Morse, 2003; Creswell, 2009; Teddlie & Tashakkori, 2009). Three important points in her system are as "1) whether a project is QUAL or QUAN oriented; 2) Which aspect of the design is dominant (QUAN or QUAL); 3) Whether projects are conducted simultaneously or sequentially" (Morse, 1991, as cited in Teddlie & Tashakkori, 2009, p.142).

In the scope of this thesis work, the last version of the MMR topology which was developed by Greene, Caracelli & Graham (1989) was applied. The last version of this MMR design was proposed by Greene (2007) in the "Mixed Methods in Social Inquiry" book. There were two reasons to apply the Greene's (2007) MMR topology. First one, the thesis study was an evaluation study and Greene et.al. (1989)'s topology was generated as a result of empirical review of fifty seven evaluation studies which was applied MMR Second one, the current study consisted of three main phase and the researchers aimed to combine these phases to explain one complex phenomenon, educational truck simulator validation. Also, the topology proposed by Greene (2007) was based on the purpose of the mixing methods, and complementarity purpose best explain the study aim. Third one, each phase of the study had QUAN and QUAL branches and also these phases referred to different aims. Greene (2007) states that a variety aims could be in an inquiry. There are three important points in the used topology. Firstly, the purpose of mixing methods drives the Mixed Methods Designs.

Aforementioned, researchers should firstly define the purpose of the study, and then determine the methods of the study according to these purposes. The topology proposed by Greene, Caracelli and Graham (1989) attributes this idea to the MMR in that firstly, researchers define the purpose for mixing then according to these purposes they determine the mixes of methods, priorities or weights allocated to the methods, and sequences or timing of implementation (Greene, 2007). According to Greene, Caracelli and Graham (1989), Caracelli and Greene (1993), Rocco, Bliss, Gallagher and Pérez-Prado (2003) and Greene (2007), there are 5 purposes of mixing the methods, namely, Triangulation, Complementarity, Development, Initiation and Expansion. Table 3.1 summaries of the purposes for mixing methods and characteristics of each purpose.

Table 3.1 The purposes for mixing methods and characteristics of each purpose

Purpose for Mixing Methods	**Key Features**
Triangulation	The *same phenomenon* is measured. Convergence, corroboration or correspondences of the results of the study are keys of triangulation purpose. In this studies, the aim is to increases the validity and inquiry inferences by applying multiple methods (Greene, Caracelli & Graham, 1989; Greene, 2007)
Complementarity	The different facets or dimensions of the *same complex phenomenon* are measured in the MM study. In a complementarity study, the aim is to elaborate, broaden, and clarify the interpretation of the study (Greene, Caracelli & Graham, 1989; Caracelli & Greene, 1993; Greene (2007)
Development	*A set of constructs or phenomena* are measured. One method results are used to inform the development another method, including the including sampling and implementation (Greene, Caracelli & Graham, 1989; Caracelli & Greene, 1993; Greene, 2007).
Initiation	The different facets or dimensions of the *same complex phenomenon* are measured. Initiation seeks for divergence, contradiction and discovery of paradoxes (Greene, Caracelli & Graham, 1989; Caracelli & Greene, 1993; Greene, 2007).
Expansion	*Different phenomena* are measured. In an expansion MM study, methods are used to extend or range of the study by applying different methods for different components of the study (Greene, Caracelli & Graham, 1989; Caracelli & Greene, 1993; Greene, 2007).

Secondly, the practice of the study drives the Mixed Method Research Designs. Greene (2007) explains this idea by placing two important discussions affected the mixed method field. One of them is held by Tashakkori and Teddlie (1998) and it is about the interaction stages of the methods and if the methods separate from philosophical paradigm. The other one is held by Morse (2003) and it is about whether the mixed methods applied in a single study or across the study because according to her, there can be one "theoretical drive (inductive or deductive)" for a single study (as cited in Greene, 2007). Greene (2007) emphasizes that these discussions affected the Mixed Methods Designs but the Mixed Method Design focuses on mixing of methods within a given study.

Thirdly, dimensions of the Mixed Method Research. Greene (2007) states that these dimensions were generated from the empirical review of mixed methods evaluation studies she did with Caracelli and Graham in 1980s. According to Greene, Caracelli, Graham (1989), Caracelli and Greene (1993) and Greene (2007), there are seven dimensions of Mixed Methods Research. These are Paradigms, Phenomena, Methods, Status, Implementation (Independence), Implementation (Timing) and Study. Greene, Caracelli and Graham (1989) explains each of the dimensions of mixed methods research studies with the words:

> Methods. The methods characteristic represents the degree to which the qualitative and quantitative methods selected for a given study are similar to or different from one another in form, assumptions, strengths, and limitations or biases (as argued by Campbell & Fiske, 1959, p.262).
>
> Phenomena. The term phenomena refer to the degree to which the qualitative and quantitative methods are intended to assess totally different phenomena or exactly the same phenomenon. When different methods are implemented to assess different phenomena, the methods are usually responding to different questions. (p.262).
>
> Paradigms. The design characteristic labeled paradigms refers to the degree to which the different method types are implemented within the same or different paradigms. We recognize that any given pair of quantitative and qualitative methods either is or is not implemented within the same paradigm, rendering this design characteristic dichotomous. Evaluation practice, however, commonly includes multiple methods of both types (p.264).
>
> Status. This characteristic represents the degree to which a study's qualitative and quantitative methods have equally important or central roles vis-a-vis the study's overall objectives. In contrast to paradigms, the status design characteristic should directly reflect the relative weight and influence of the qualitative and quantitative methods with respect to their frequency and their centrality to study objectives (p.264).
>
> Implementation: Independence. The degree to which the qualitative and quantitative methods are conceptualized, designed, and implemented interactively

> or independently can be viewed on a continuum. Sometimes a study includes both components, representing a mid-range position (p.264).
>
> Implementation: Timing. Although we represent this characteristic as a continuum, we again recognize that a given pair of methods is typically implemented concurrently or sequentially, not in between (p.264).
>
> Study. The final design characteristic labeled study is essentially categorical. The empirical research either encompassed one study or more than one study. Although our own review yielded little variation on this design characteristic (all but four valuations represented a single study), it remains an important consideration for continued discussion of mixed-method designs (Cook, 1985; Kidder & Fine, 1987, p.264).

Greene (2007) states that she focuses on two MMR study dimensions of implementation (independence) and status as well as sequence of method implementation while presenting the MMR design with respect to the mixed methods purpose. Although the first version of the Mixed Method Research Design proposed by Greene, Caracelli and Graham (1989) consisted of 5 designs, namely, Triangulation (T) design, Complementarity (C) design, Development (D) design, Initiation (I) design, and Expansion (E) design, the last version proposed by Greene (2007) included 2 main classes of designs (Component and Integrated), with six design examples. Two of these six design examples (Convergence and Extension) were explained under Component design class while four of them (Iteration, blending, nesting or embedding, mixing for reason of substance or values) were explained under Integrated design class.

For that reason, Blending MMR design, one of the integrated MMR designs proposed by Greene (2007) was conducted under the scope of the current study. The researchers use this MMR design type to assess varied facets of the same phenomenon. The methods commonly have equal weight and are applied concurrently. The blending MMR type represents the methods purpose of complementarity or initiation. In this design, the integrative challenge is joint analysis and connection between the data sets during the analysis (Greene, 2007). According to Greene, Caracelli and Graham (1989) and Greene (2007), the most frequently used MMR design type in the evaluation study is blending design.

3.4.2. Formative Research Methodology

Reigeluth and Frick (1999) describe Formative Research methodology with the words: “a kind of developmental research or action research that is intended to improve design theory for designing instructional practices or processes." (p. 633). Similarly, van den Akker (1999) and Richey and Klein (2005) state that different labels are used for Developmental Research in the literature and one of these labels is "Formative Research". Moreover, Revees (2000), Kaplan Akıllı (2004) and Wang and Hannafin (2005) mention different terminologies used instead of each other, namely, design experiments, design-based research, developmental research, development research, design research, formative research.

Although the same terminology used these research methods in the literature, Reigeluth and Frick (1999) and Wang and Hannafin (2005) states there are slight differences between them. Wang and Hannafin (2005) describe these differences with the words: "…each has a slightly different focus, but the underlying goals and approaches are similar." (p.6). Reigeluth and Frick point out the aims of the Formative Research: to improve design theories and develop design theories. Edelson (2002) states 3 types of theories that can be developed thorough the design based research as domain theories, design frameworks and methodologies. On the other hand, Reigeluth and Frick (1999) give research study examples that use the Formative Research to improve existing theory or develop a new theory.

The case study and formative evaluation approaches were followed in the Formative Research according to Reigeluth and Frick (1999) and Wang and Hannafin (2005) and although the formative evaluation is not new in the literature (Collis, 1991; Van den Akker, 1999) formative research is new (Van den Akker, 1999)

Although English and Reigeluth (1996) state that in Formative Research studies the quantitative research methods can be used but heavily used methods are methods of qualitative research. Similarly, Reigeluth and Frick (1999) and Jen (2008) point out that the Formative Research is qualitative in nature. Although it is qualitative nature, Edelson (2002) emphasizes the importance of generalizability and shows the way to provide it with the words:

> In this process, the designer–researcher expands his or her focus beyond the current design context to look for generalizations to other contexts. Through a retrospective analysis, the designer–researcher treats the design problem, solution, and processes as instances of more general classes. In doing so, the researcher must be alert to elements of the design that can generalize to a useful range of situations (p.117).

Reigeluth and Fricks (1999) states that two types of Formative Research: 1) Designed Case Studies. 2) Naturalistic Case Studies. They also emphasize the main difference between these two types in that the study context is designed by the researcher in designed case Formative Research while the context which is appropriate to theory improved /developed is selected by the researcher in Naturalistic Case Formative Research Studies (Reigeluth & Frick, 1999). For that reason, the researcher should make justification of the context designed at the beginning of the study in the Design Case Formative Research while s/he should make justification the reasons to choose context that data collected in the Naturalistic Case Formative Research Studies.

Shortly, Formative Research Methodology which is heavily based on qualitative research is employed to develop tentative model or theory by designing or choosing appropriate context for theory development. In the current study, the researcher designed a case with the guidance of experts to investigate the instructional simulator validation process.

3.4.3. Justification of the Applied Research Design: Blending MMR Design along with Designed Case Formative Research

In this thesis study, the researcher applied Blending MMR design and Designed Case Formative Research Methodology together with the guidance of advisor and literature review. Having more than one purposes and applying different methodologies are not new in the literature. Maxwell and Loomis (2003), Maxwell (2005) and Maxwell (2008) label these types of research as "Interactive Research Design". Moreover, the research does not progress in a linear or step by step fashion but it is necessary to provide organized picture of important issues, tasks, processes to the reader (Mertens, 2009 as cited in Nelson (2009). In this thesis study, the researcher does not follow a linear path and instead she defined two purposes what the practice and literature requirements need.

Complexity of the research phenomenon calls for applying the different research methodologies and forming research teams according to Doyle et al. (2009) and Westhues, Ochocka, Jacobson, Simich, Maiter, Janzen and Fleras (2008). Tashakkori and Creswell (2007) advocate different perspectives in MMR designs. Also, Creswell and Garrett (2008) emphasize importance to be open to new methodologies with the words: "At this moment in the development of research approaches, the educational researcher needs a large toolkit of methods and designs to address complex, interdisciplinary research problems." (p.321).

Since the simulator validation research studies are conducted by many researchers from different fields, there are a variety of names used for the same validation approaches (Blana, 1996a). In other words, there is no standard validation approach for the simulators (Blana, 1996a; Feinstein & Cannon, 2001; Hoskins & El-Gindy, 2006). For that reason, simulator validation phenomena is very complex to investigate and grouping the different approaches or used methodologies in the literature is very difficult. Also, Reeves (2003) states that another reason of the complexity of the interactive learning systems with the words: "The complexities of the IL derive from competing theoretical foundations (such as behavioral versus cognitive physiology) and an often bewildering array of technological delivery options" (p.3). Similarly, Mark and Greer (1993) states that different evaluation methods should be used to evaluate complex process and objects because complex systems can be thought totally or in terms of system components and methods used for evaluating complete system may not appropriate to evaluate its components. Doyle et al. (2009), Westhues et. al. (2008), Strolla, Gans and Risica (2006), Lou and Dappen (2003), Sale, Lohfeld and Brazil (2002), Greene, Caracelli, Graham (1989) and Rothe (1985) point out that Mixed Methods Research Methodology should be followed to investigate complex phenomena. Similarly, Reeves (2000) advocates application of Mixed Methods Research Methodology if a complex phenomenon is the center of the research with the words: "The "eclectic" aspect of the "Eclectic-Mixed Methods-Pragmatic Paradigm" refers to openness to borrowing method of other 3 paradigms to collect information and solve a problem. The "Mixed Methods" aspect relates to the recognition that multiple perspectives are necessary to triangulate or bracket information and conclusion regarding complex phenomena" (p.35).

Aforementioned, there are different simulator validation approaches in the literature used for driving simulators (Blana, 1996a; Feinstein & Cannon, 2001; Hoskins & El-Gindy, 2006). However, many of them refer to the same approaches which have been named differently in the literature. To define the validation approaches, they were grouped according to the descriptions, used methods and methodologies. As a result of the literature review, it was realized that there were 3 main validation approaches, namely, Physical Validation, Behavioral Validation and Face Validation. There is, also, a Model Validation approach which includes both Physical and Behavioral Validation (Hoskins & El-gindy, 2006; Sargent, 1998). On the other hand, Feinstein and Cannon (2001) added "Educational Validation" approach by characterizing the relationship between validation and educational systems. Also, West et. al. (1991), Singer (1993), Emery et al. (1999), Lee (1999), Estock, Alexander, Stelzer, and Baughman (2007), McDougall et. al. (2006), Kilh and Wolf (2007) and Estock et. al. (2008) mention the instructional simulators and the relationship between validation-fidelity (realism) of these types of simulators. The general idea is that validation of the simulator is the first and important stage in the training offered via simulators because the realism of the simulator should be determined according to instructional aims. This means that instructional validation should be taken into account in simulator validation studies. Moreover, the relationship between the behavioral validity (realism-fidelity) and the instructional validity of the simulator could be different than ones explained in the literature. This also affects the determination of the overall validity of the simulator since these issues are not clear in the literature. Van Horn (1971) advices complementary research activities while conducting research on development and field tests of the simulation environments. Also, the researcher intention was to explain these issues under a model name in that shaped during the application of defined approaches in a complementary manner.

According to Greene (2007) complementarity purposes may range from convergence to divergence as well as to practice of the research may change the purpose and this may result in the an unanticipated insights to better understanding. Also, Rothe (1985) emphasizes this side of the complementarity manner by stating that the every scientific inquiry is based on the experiences and interpretation. Similarly, Borkan (2004) points out that qualitative side of the MMR is exploratory and implicates new theories. Similarly, Formative Research methodology intends to better understand the relationships between the constructs of existing theory or a new theory in order to explain a phenomenon (Reigeluth & Frick, 1999). As Edelson (2002) states literature review is important to clear needs of the field and undefined constructs of the new theory. Maybe for that reason, Greene, Cacarelli and Graham (1989), Focks, Daniels, Haile and Keesling (1995), Mercier, Piat, Peladeau and Dagenais (2000), Strolla et. al. (2006) start to define their theory from the literature. Reigeluth and Frick (1999) advices to benefit from the existing theories in the literature while constructing a new theory. Kaplan Akıllı's thesis is one of the best examples to this type of Formative Research inquiry in that she also uses rapid prototyping methodology to develop a model for creating game- like environments.

However, application of the only Formative research methodology is not sufficient in this study since weight of the quantitative approach equals to qualitative one. As English and Reigeluth (1996) state the researchers can conduct quantitative methods very limitedly but mainly they conducted qualitative methods during application of Formative Research Methodology.

All this issues were taken into account by the researcher of this study. What the researcher of this thesis study did is that she combined the approaches that extracted from the literature in a complementary manner to determine the validity of an instructional simulator and investigate the process to develop a validation model for instructional simulators. For that reason, in the study both deductive and inductive manners were employed. Moreover, for that reason, quantitative and qualitative research approaches had equal weights. While the researcher investigated whether the TS simulator was valid through experimental design, interviews, field notes and document analysis, she also investigated the characteristics of the validation process through interviews and field notes. Figure 3.8 represents the used methods and which purposes they served for.

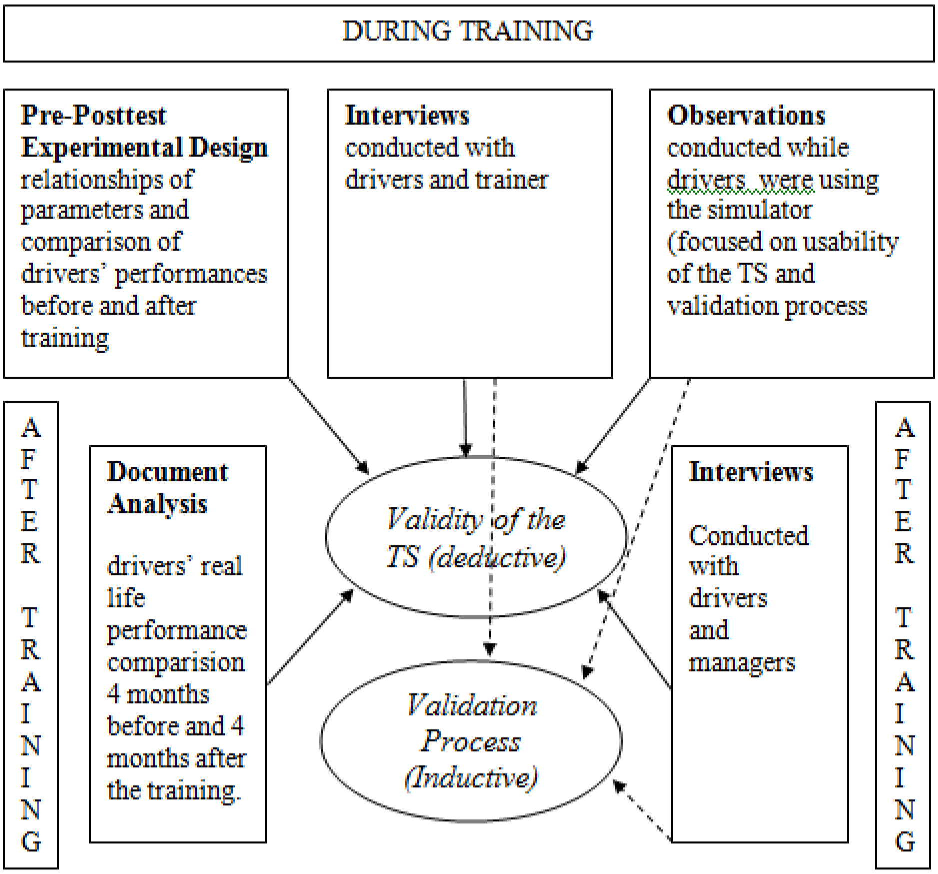

Figure 3.8 Applied Methods and Which Purposes They Served For

3.5. Simulator Validation Process

To define the steps of a research and follow these steps during the research are important in order to conduct a scientific study. Also, the results of the study could be more likely attributed to a theory, method or structure. For the simulator validation process, the mentioned logic should be followed in order to conduct scientific simulator validation research studies. According to Blana (1996a), there are a variety of simulator validation methodologies in the literature but only one methodology, proposed by Leonard and Wierwifle in 1975, gives detailed description for its each step. The following steps show their validation methodology:

1. ***Define the validation approach.*** The validation approach is to "adjust the simulator experimental conditions to obtain matching measure values between full-scale and simulation".
2. ***Define the validation objectives.*** "Determine whether an absolute matching of driver and driver/vehicle responses will result in an effective method for validating a driving simulator".

3. ***Define the independent variables.*** The independent variables are the adjustable parameters. Each adjustment e.g. roll, yaw, roll damping, lateral translation gains and steering sensitivity in the simulator may affect the subject's responses.
4. ***Define the dependent variables.*** These variables must be measures which theoretically can be obtained both in the simulator and on the test vehicle (or "full-scale" vehicle). These can include average steering wheel reversals over time, RMS lateral acceleration and average velocity standard deviation.
5. ***Define the type of statistical test .*** There are two different types of tests that can be used 1. the high power statistical test: The number of subjects (N) is large and the o-level is low. 2. the low power statistical test: The number of subjects (N) is small and the o-level is high.
6. ***Analysis of the results.*** This is the last step of their methodology where the results from both conditions are compared and analyzed (assuming that the real road data have already been collected). (Leonard and Wierwille, 1975 as cited in Blana, 1996a, p. 16)

Since the above methodology based on the methodology that can be used to compare the simulator and real model measurements, in this study, a different methodology was used. The research design in this study investigated whether the simulator provided the accurate measurement according to instructional part of the training on the fuel consumption. For that reason, firstly the design aim of the simulator was considered and the validity criteria were determined according to this aim. Secondly, the approaches in the literature were defined. Thirdly, scope and methods which was applied under each approaches were defined. Fourthly, the results were reported (Figure 3.9).

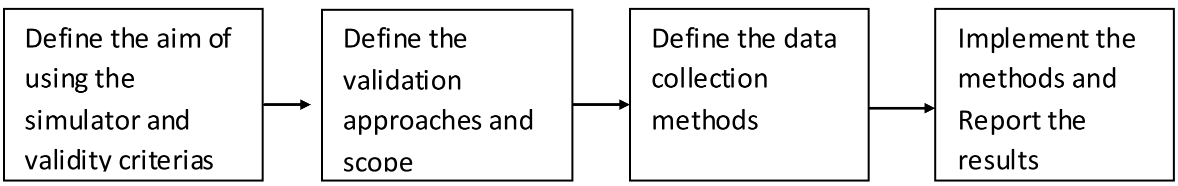

Figure 3.9 Steps of the Simulator Validation Methodology

The methodology suggested in this thesis study can be explained as following:

- ***Defining use goal of the simulators.*** Before conducting a simulator validation study, firstly, for which purposes the simulators are used should be defined. According to the use purposes of the simulator, the researcher should determine the validity criteria. The validity criteria are necessary to say whether the simulator is valid or not after collecting and analyzing data. Blana (1996b) states that driving simulators can be classified as Training Simulators and Research simulators according to their use and each simulator has specific properties of the classification it belongs to. For example, instructional side of the simulators should be taken into consideration during the validity studies of the training simulators. On the other hand, it is not necessary for the simulators which are aimed to research or evaluation purpose.

- ***Defining Approaches and Scopes of Validation.*** In the literature, there are various simulator validation approaches and methods (Blana, 1996a). These approaches are Model Validity, Physical Correspondence, Behavioral Validity, Behavioral Correspondence, Face Validity, Open Loop Techniques, Close Loop Techniques and Educational Validity. Meanings of some mentioned approaches are same. For that reason, to define and know the meaning of the approaches are important. Since there is not a known model to define which approaches should be used and how, the aim of the study is also to define a validation model based on the simulation approaches in the literature and result of the current study.
- After the approaches defined, the scope of the each approach should be determined. The scope of the validation can be "reality", "usability", "instructional benefit", "and research benefit" and so on.
- ***Defining Data Collection Methods.*** After defining the approaches and scope of a validation study, appropriate methods are defined. For example, for the physical and behavioral validity, experimental design method is used. As well, for the face validity, survey or qualitative research methods such as interview or observation are used. Although the methods are not defined specifically in the literature, there are implications that both qualitative and quantitative methodology methods can be used to investigate the instructional validity of instructional simulators.
- ***Implementing Methods and Reporting Results.*** In this step, the planned approaches were followed and the data was gathered according to the selected methods appropriate to the approaches. To analyze the data quantitative research analyze techniques such as t-test, ANOVA, descriptive statistic or qualitative research analyze techniques such as open coding. Then the results are evaluated according to the criteria previously defined and the validation study is completed.

Up to sum, in this study, firstly, the use aim of this simulator was defined: the truck simulator would be used for instructional purposes. Secondly, accordance with this purpose, the scope of this validation study was defined as "usability", "reality" and "contribution to instruction". Thirdly, the approaches which can be appropriate the defined scopes were determined as "Behavioral Validity", "Face Validity" and "Instructional Validity". For Behavioral Validity, pre-posttest experimental design in which the truck drivers' drove the simulator was conducted. The information provided by the simulator on parameter that affected the fuel consumption (number of steeping on gas pedal, number of changing gearshift, number of not keeping rpm in appropriate level and number of not keeping rpm in appropriate level while changing gearshift) and fuel consumption amounts was analyzed in order to understand similarity of the relationship between the parameters and fuel consumption to ones defined by the fuel consumption theory. For Face Validity, survey, interview and observation methods were used. For the Instructional Validity, an experimental study method in which the truck drivers' fuel consumption quantities before and after the training was compared in addition to survey, interview and observation methods. Moreover, 5 months after the training the researcher interviewed with the truck drivers about what they think on the transfer of the training and factors affecting it as well as their fuel consumption quantities in real life before and after training were compared. Fourthly, according to the chosen method, the data were gathered via prepared instruments and then results were reported. Figure 3.10 shows the steps of the current simulator validation study.

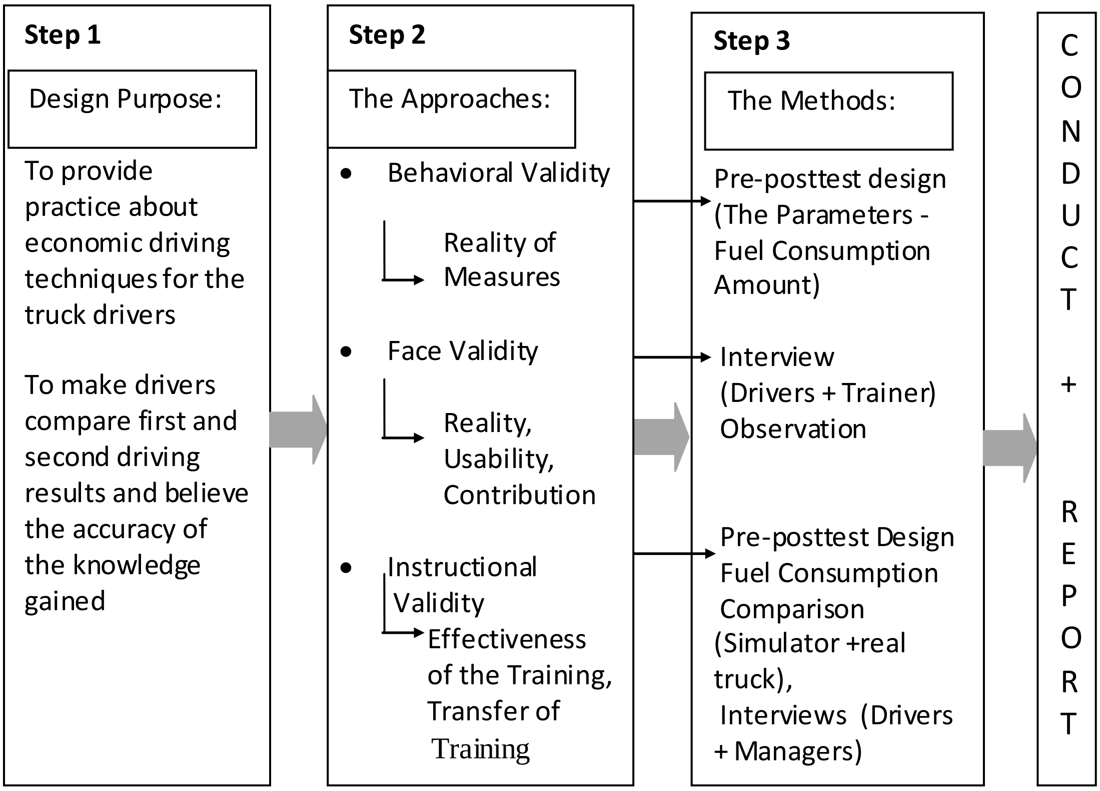

Figure 3.10 The Steps of the Current Simulator Validation Study

On the other hand, the timeline of these steps of the study were defined according to the relationships between the approaches as well as the data results collected during the study. For example, the behavioral validity was firstly investigated since the face and instructional benefits shapes according to the behavioral validity. Secondly, the data on face validity were collected and thirdly instructional benefits of the simulator were collected. Data of these approaches were collected concurrently as Greene (2007) advised for complementarity MMR. Moreover, during the data collection, the results showed that the researcher should have collected data on transfer of the training under the scope of instructional benefits. The qualitative parts of the data were analyzed differently to investigate the validation process. The timeline of all data collection procedures were showed in Figure 3.11.

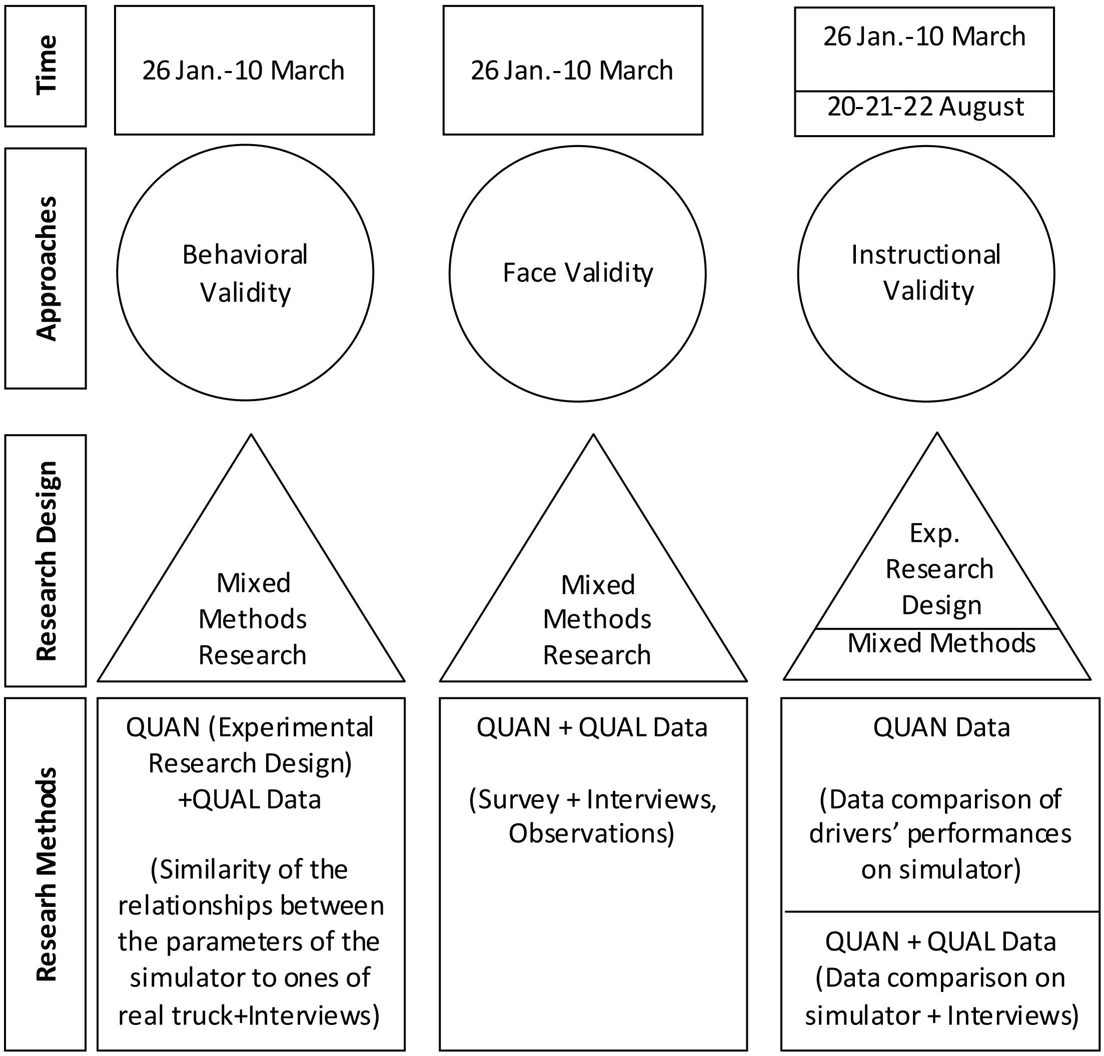

Figure 3.11 The Timeline of All Data Collection Procedures

3.6. The Truck Simulator (Meteksan Sistem Handbook, 2008)

The truck simulator was designed in order to train truck drivers on safe, economic and environmentally friendly driving. It simulates the physical performance of the real truck and articulated lorry vehicles and evaluates the drivers' behaviors (errors, sudden braking, rapid acceleration and deceleration etc.) related to fuel consumption and emission of the vehicle theory. The factors affected fuel consumption and emission are defined in the scenario of the truck simulator according to the related literature and the measures which are provided by the training and consulting firm trainers as a result of the experiments they conducted with the real truck drivers in the real road environments (Sevim, personal communications, January 28, 2009). Also, in the development phase of the truck simulator, the relations among the style of using a car, fuel consumption and emission are examined, so the importance of the training of the especially heavy vehicle drivers which use a vehicle for a long time, with respect to “environment friendly, economic and safe driving” is comprehended.

It is determined that the factors such as using the vehicle in a convenient engine speed, driving at a required gear and running the vehicle in suitable conditions etc. have a significant effect on the fuel consumption, and this driving simulator is developed for training the drivers about these issues. In the driving manner, the rules which are necessary and influence the emission is provided by Af Wåhlberg (2002);

- Do not use more than half-throttle
- Change gear at low engine speed (3000-4000 rpm)
- Plan ahead, as to avoid braking, i.e. adjust your speeding an early phase by the use of friction.
- Use a uniform throttle when a desirable speed has been achieved, i.e. do not compensate when loosing speed at an inclination
- Drive at the highest possible gear
- Use the engine brake instead of the brake pedal
- Do not overtake unnecessarily

Also, HED Academy trainers provided the real truck and articulated lorry vehicles fuel consumption amounts with respect to the load of the vehicle, situation of the road, the weather conditions and drivers’ driving manner (Sevim, 2008). All the factors and conditions affected the fuel consumption and emission were defined and confronted with the drivers’ driving style. The truck simulator evaluates and reports the drivers’ fuel consumption and emission amount according to the provided information. Figure 3.12 and Figure 3.13 show the truck simulator.

Figure 3.12 The truck Simulator

Figure 3.13 The truck Simulator

The truck simulator has a cabin in which there is a real truck control panel with real truck equipments (wheel, gear, pedals, speedometer etc.). In the cabin, two indicators are active; speedometer and engine speed indicator. Pedals, gear and wheel are also active and their behavior mimics the originals. The simulator visual system consists of 3-LCD screen and it has 120 degree horizontal field of view. Also, the simulator has 2 degree-of-freedom motion platform, so the vehicle movements are exactly perceived by the driver.

The Pilot Study

The aim of the pilot study was to extract imperfections of the design of the simulator validation study in terms of used instruments and methodology before conducting the real study. Also, it specifically aimed to investigate how much the truck simulator meets the design goals before using it in real training sessions. So, based on the pilot validation study findings, recommendations for the truck simulator improvements were made. In the study, the simulator was validated in terms of 1) how much it represents a real truck; 2) which usability problems the drivers meet while driving it not effectiveness of the training and the contribution of the truck simulator to the instructional side of the study (Instructional Validity). Additionally, two validation approaches, namely, Behavioral Validity and Face Validity and the recommended data collection methods appropriate these approaches were conducted during the pilot study. So, the researcher had a chance to see the relationship between the approaches and how they could be interpreted with a complementary manner. However, as aforementioned, the main aim was to define the problems affected the usability and reality of the truck simulator and made improvements on it.

3.6.1. Methodology

Mixed Method Research was conducted to explain the different facets of the simulator validation phenomena. The pilot study consisted of two main parts as “Behavioral Validity” and “Face Validity”. To use these two techniques were required to apply both quantitative and qualitative research equally. For that reason, the type of the Mixed Method Design of this study was Complementary Mixed Method Design.

3.6.1.1. Sampling

Convenience sampling methods were followed during the pilot study. The truck drivers who had taken training from the training and consulting firm were contacted and 10 of them were volunteers in order to participate to the pilot study. 2 of them participated to the study in order to see imperfections in the design of the experiment and material. So, the sampling of this pilot study consisted of 8 truck drivers. All the participants were male and their age range was between 25 and 40. Only one of the drivers had been driving trucks for 3,5 years, the other 7 drivers had been driving trucks between 12 and 25 years. While 4 drivers had been driving trucks, the other 4 drivers had been driving articulated lorry trucks. Table 3.2 shows the participants’ demographics.

Table 3.2 The Pilot Study Participants' Demographic Characteristics

Driver	Gender	Age	Professional Experience	The Vehicle They Drive
1	Male	40	15	Articulated lorry
2	Male	41	20	Articulated lorry
3	Male	38	15	Articulated lorry
4	Male	46	23	Articulated lorry
5	Male	34	12	Truck
6	Male	40	18	Truck
7	Male	41	19	Truck
8	Male	24	3.5	Truck

3.6.1.2. Process

The pilot study was held under the Philosophy Project on 30th, 31st July and 1st August, 2008. However, the preparation for the pilot study traced back June, 2008. Before conducting the pilot study, the validation approaches and methods were defined according to the related literature and experts' opinions. "Behavioral" and "Face Validity" approaches were selected to validate truck simulator.

Under the scope of Behavioral Validity, one group pretest-posttest experimental design was decided to conduct. In the experimental part of the study, the truck drivers drove the truck simulator three times with a predefined scenario. Also, all drivers navigated through the same scenario in their first, second and third driving sessions. Firstly, they drove it nearly 10 minutes on their own to get used to drive simulator; secondly, they drove it own their own according to their professional life experiences; thirdly, they drove it with the help of a trainer. The selected scenario included driving in two areas as hill (3,5 km) and city (2,5 km) with no loading on the road which had medium vehicle density in sunny weather. Each driver's driving lasted about 25-30 minutes. So, each driver drove the truck simulator about 60-70 minutes in total.

At their first driving, they drove it own their own to get used to the simulator. Secondly, they drove the simulator own their own. Thirdly, they drove it according to the fuel consumption theory with help of the expert from the training and consulting firm. The aim was to see if the truck simulator give the similar fuel consumption amount to the given by real trucks. The criterion was that there should have been decline in truck drivers' second driving parallel to what the theory advocates.

Moreover, under the scope of Face Validity, during the driving, the truck drivers were observed by two researchers, in addition to three cameras which were used to validate the observation notes taken by researchers. After the driving session, a survey was conducted and the truck drivers were interviewed in order to get detailed information about their perceptions on the reality and usability of the truck simulator. The interviews were recorded.

3.6.1.3. Training

In the pilot study, after the truck drivers had completed their second driving on the simulator, the trainer explained basic rules of the fuel consumption theory which enables drivers to reduce fuel consumption of the vehicle. The explanation took a few minutes and contained most important rules as following;

- Try to reach the upper level gearshift in a short time and do not change it unless you have to do
- Climb the uphill in a short time
- Try to keep rpm at the green area on the rpm indicator while driving on straight road
- Try to keep rpm at yellow area on the rpm indicator while driving on downhill
- Try to keep gas level stable during the driving

However, it did not a real instruction because there were no planned activities that an instruction included. Moreover, the trainer coached the participants during the second driving. He directed and reminded them what they should have done to drive the simulator according to economic fuel consumption.

3.6.1.4. Data Analysis

Analyzing the truck drivers' fuel consumption quantity differences between the first and second driving were not meaningful because the sample size was too small. However, in order to get an idea if Behavioral Validity was provided in the truck simulator, the Paired Sample T-test method was applied to analyze data.

The descriptive research was used to obtain information concerning the drivers' perception on the truck simulator reality and usability. To analyze the survey data, the percentage of the given answers to each question by each driver were counted. On the other hand, to analyze the observation notes taken, the categories which were previously defined in the observation form were used. Also, the extra notes on drivers' behaviors which were different than the behaviors defined in observation form were placed in related categories or new categories were defined according to the researchers' agreement. As observation notes, interview notes were categorized according to the categories previously defined in the interview form after being transcribed by the researchers. While analyzing the observation and interview notes, the concepts mentioned in the validation studies were defined as categories. Table 3.3 shows these concepts and their meanings.

Table 3.3 The Categories Used to Analyze Observation and Interview Notes

Categories	Meaning	References
Believability	It investigates if the users have confidence in the models results or not.	Pegden, Shannon and Sadowski, 1995 (as cited in Feinstein and Cannon, 2001).
Usability	It investigates if the model is user friendly or not.	Conceptualized in this paper.
Operational Validity	It investigates if the behavioral data characteristic in real-world are generated in the model or not.	Pegden, Shannon and Sadowski, 1995 (as cited in Feinstein and Cannon, 2001).
Plausibility	It investigates if the model seems to represent real life phenomena. In this paper, it is investigated in terms of user satisfaction.	Boocock, 1972 (as cited in Feinstein and Cannon, 2001).
Educational Validity	It investigates if a valid learning experiences and learning assessment were provided via the simulation or not.	Feinstein and Cannon, 2001

3.6.2. Findings

3.6.2.1. Behavioral Validity

In the pilot study, a one group pretest-posttest experimental design was applied in simulated vehicle. The participants drove the simulator before and after the training. Then, their first and second fuel consumption quantities were compared. The scenario navigated by the participants had two main parts as hill to city center –upward – direction and city center –straight- direction. Since the driver should have to different behaviors at the upward direction and straight direction, their driving were recorded as their pre hill, pre city, post hill and post city. The Paired Samples Statistic was applied to analyze the participants' fuel consumption amounts with respect to the location of the selected scenario. Since the sample size of the pilot study was small to compare the data statically, only the descriptive of the Paired- t test were explained here. Table 3.4 shows the Paired-t test descriptive results.

Table 3.4 Paired Samples Statistics

		Mean	N
Group 1	Hill 1	59.58	8
	Hill 2	44.43	8
Group 2	Downtown 1	33.80	8
	Downtown 2	30.05	8

Table 3.4 shows that 8 participants' first fuel consumption amounts mean during driving at hill and city center were high than their second fuel consumption amounts mean during driving at hill and city center. Also, the analysis showed that while the reduction between the first and second driving at hill were 15.15 percent, the reduction between the first and second driving at city center was 3.75 percent.

3.6.2.2. Face Validity

The findings of the "Face Validity" part consisted of the analysis of data gathered via the survey, the interview form and the observation form. It is aimed to gather data on drivers' perception on the truck simulator reality and usability via survey and interview questions. The interview questions were prepared in order to get in depth information investigated via the survey questions; for that reason, they were based on survey questions. Also, the data on the truck simulator usability were gathered via observation method. The observation data findings consisted of the analysis of two researchers' observation notes in addition to the recordings of three video cameras. The recordings of the video cameras were analyzed and missed driver behaviors were added to the researchers' observation notes. Then each researcher analyzed all the data gathered via the survey, the interview form and the observation form by using the predefined categorization system as "Believability", "Usability", "Operational Validity", "Plausibility" and "Educational Validity". The last version of the categorization system was defined as a result of the researchers' agreement.

According to the study findings the drivers did not have difficulty in recognizing the truck simulator parts as gear, steering wheel, speed indicator, rpm indicator, brake, lambs and signals, gas pedal and so on and stated that the appearance of the simulator was similar to one of a real truck. However, the drivers had difficulty in using the gear, brake and steering wheel of the simulator. For these reasons, they stated that they did some mistakes such as stopping the vehicle, traveling on the wrong road, entering the sidewalk and so on. Although they had some problems while driving the simulator, they pointed out that driving it was very entertaining. Also, they said that they believed in the success of the truck simulator as a tool used to train truck drivers on economic and safety driving. Moreover, the drivers pointed out that the experimental length was too long and they preferred the trainers offered training including the theory of the fuel consumption.

According to the findings of this study, gear, steering wheel and brake of the truck simulator should be checked and redesigned. If the suggestions presented in this study are taken into account, more realistic simulation environment can be created. It is believed that after the improvements the simulator can be used more effectively for the training purposes.

3.7. Implications of the Pilot Study for the Main Study

The pilot study provided precious information about the design and used methodologies for the real study. According to the result of the pilot study the researcher decided to make some differences on the application of the validation study, design of the experiment, used materials as well as to analysis method. Moreover, these changes were not only determined according to data result of the pilot study but also result of the experience of the researcher. All the changes were defined with the guidance of the experts.

The aim of the pilot study was to examine what extend the simulator provided similar measures as explained in the fuel consumption theory, the needed improvements and what the drivers think about the reality of the simulator in terms of appearance, performance of its parts and usability. The pilot study results showed that the drivers complained about the length of the driving sessions and lack of the instruction about fuel consumption. In the main study, the instruction was determined to be provided at the beginning of the project but it did not apply on the pilot study since the aim was to find out whether the simulator had necessary behavioral validity and usability conditions for the success of training. For that reason, the necessity of the instruction part was also pointed out by the drivers in the pilot study. Moreover, the time length of the driving sessions was determined to be shortened by applying some changes with the guidance of expert trainer. In the pilot study, there were three driving sessions; the numbers of driving session were determined to be reduced by not conduction the first driving session. The information about the truck simulator was determined to be provided at the beginning by the trainer. Moreover, in the pilot study each driver driving session was saved separately on uphill and straight road since the uphill and straight road driving techniques changes according to the fuel consumption theory. In the pilot study, since the behavioral validation was extracted from the difference in fuel consumption amounts between driving session they did on their own and with the guidance of the trainer, it was necessary to save their driving separately on uphill and straight road. So, the simulator measures were compared if the fuel consumption amount reduces in the second driving session on uphill and straight road environment. Totally, each driver provided 4 parts of data. In the main study, the drivers' driving session was determined to be not saved separately on uphill, straight road or downhill because the instructional part would have been added to the experiment. So, before and after training performances of the drivers would change with regard to the theoretical part of the training. For that reason, the behavioral validity was determined to be investigated by analyzing the data in terms of how well the main parameters explained the fuel consumption amounts compare to fuel consumption theory (Behavioral Validity). This application would also reduce the time of the experiment since the trainer spent nearly 10 minutes to saving the data and adding a new one of the driver for each area. The

Figure 3.14 represents the experimental design of the pilot study, changes and experimental design of the main study.

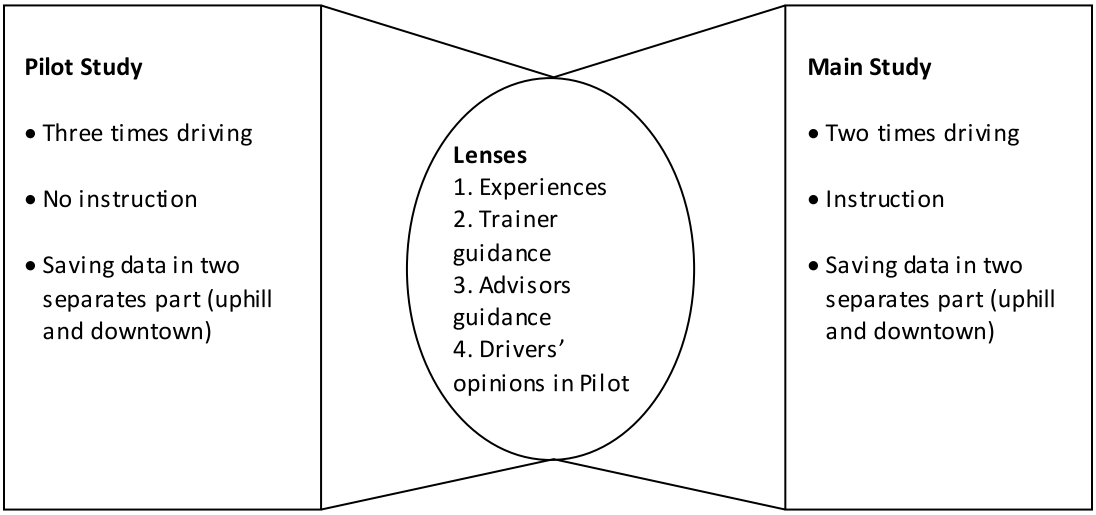

Figure 3.14 Implementation Process (Pilot Study + Main Study)

Moreover, some small changes were applied to the scenario that the drivers navigated while driving the simulator by taking into expert trainers' opinions. In the pilot study, all drivers navigated through the same scenarios as following:

- Selecting vehicle load:
  - from hill to the beginning of the city center –upward-
  - from the beginning of the city center to the end of the city center
- Selecting the starting point:
  - no load
- Selecting traffic density:
  - medium vehicle density
- Selecting the weather:
  - sunny

On the other hand, in the thesis study, the scenario was determined to be changed according to the expert trainer advices. The trainer was asked about the scenario and according to what he decided the scenario. He stated that all drivers navigated through the same scenarios as following:

- Selecting vehicle load:
  - from hill to the beginning of the city center –upward-
  - from the beginning of the city center to the end of the city center
  - from the end of the city center to hill –downward-

- Selecting the loading:
    - with 22-23 tons load
- Selecting traffic density:
    - low vehicle density
- Selecting the weather:
    - Sunny

Moreover he stated that other options about the scenario were not preferred, for example medium-high traffic density, rainy-snowy weather etc., because every driver meets the same situations during the driving. The trainer continued his statement that he realized the benefits of this scenario, especially, at the big companies the training offered. According to him, the current company had a big fleet with 370 drivers and different scenario properties would have probably affected negatively accuracy of the results. Moreover, the information about why the vehicle driven during the training had loading was gathered from the conversation between the researcher and trainer during the training. The trainer stated that the drivers rarely drove trailer with no loading in real life and the loading of the vehicle directly affected the fuel consumption amounts. In order to make the simulator scenario more realistic, he preferred the vehicle with loading. Figure 3.15 represents the changes in the scenario features used in the main study with the reasons.

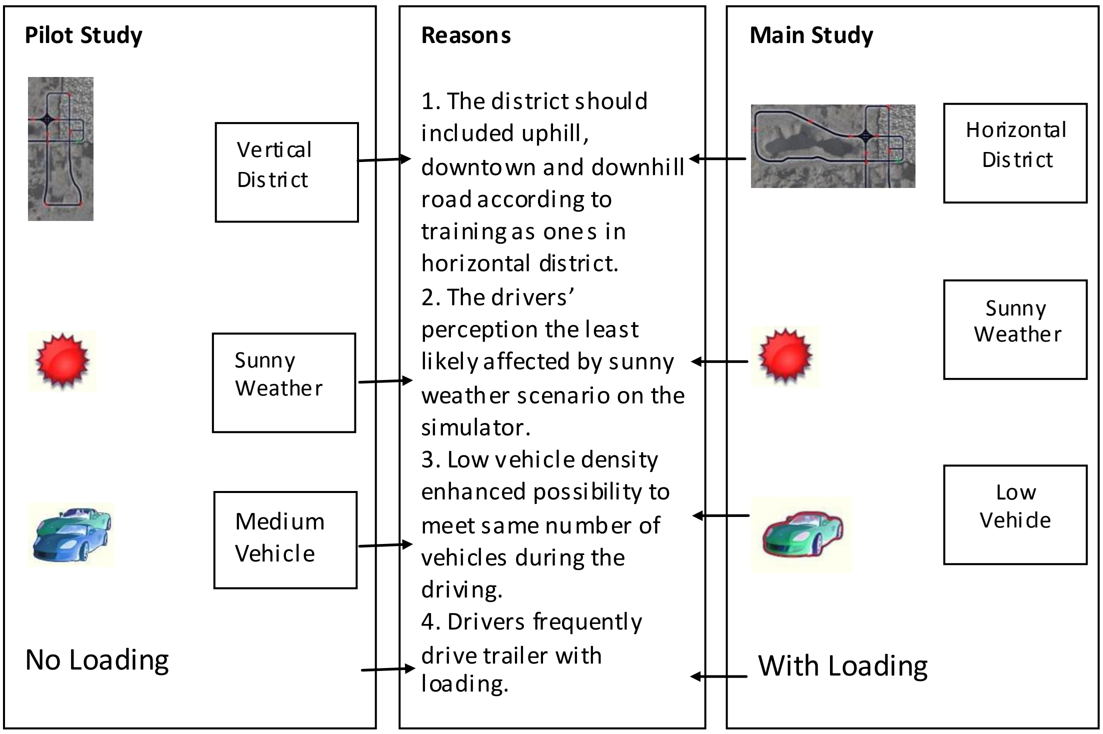

Figure 3.15 Scenario used in Pilot and Main Studies with Reasons to Change Some Features

Another change included the analysis of the quantitative and qualitative data gathered in the scope of the main study. The reason of the changes quantitative data analysis method was the changes applied designed of the study. In the pilot study, there was no instruction on fuel consumption theory and the drivers drove the simulator with the guidance of trainer in their third driving. For that reason, they used the simulator exactly the prescriptions of the fuel consumption theory. For that reason, their performance comparison did not explain the effectiveness of instruction but the data provided by the simulator decreased in the third driving session accordance with the theory. On the other hand, in the main study, there was an instructional part and the performance change between the first and second driving sessions indicated the effectiveness of the training. If there was no change in the drivers' performance could not exactly be attributed the mistakes in the simulator system because it was normal if the simulator did not indicate a decrease in fuel consumption amounts of the drivers who did not applied the fuel consumption theory. In other words, there was no guarantee that the drivers would drive the simulator according to fuel consumption theory. According to the pilot study results, it was found that the simulator indicated decrease in fuel consumption amount when the drivers drove it according to theory. However, how well it represented theory was questionable. For that reason, in the main study, the drivers' fuel consumption amounts before and after training indicated instructional validity of the simulator while it indicated behavioral validity in the pilot study. Moreover, in the pilot study, the behavioral validity result did not show a significant result because numbers of the drivers who participated to the study was not sufficient. Moreover, in the pilot study, the researcher analyzed qualitative data by defining categories according to the simulator validation concept list presented by Feinstein and Cannon (2001). However, she realized that this list categorization directed her to define all categories one or another group. For that reason, she criticized herself and decided to do open coding rather than do coding according to defined categories. So, the characteristic of the validation process could be defined in unbiased manner.

Shortly, the design of the experiment, scenario navigated by the drivers while driving the simulator and some quantitative and qualitative analysis methods were changed in the main study. The reasons were experience in the pilot study and experts' guidance.

3.8. The Main Study

Under this subheading, implementation process, designed case, sampling, data collection methods which consisted of instrumentation and procedures are presented. Moreover, this part includes data analysis procedures and validity and reliability issues of the study.

3.8.1. Implementation Process

The study lasted 11 months period, from October, 2008 to September, 2009. To conduct the study, the researcher firstly arranged a meeting with logistics and transportation company with the help of the petroleum company on the 11th January of 2009. In that meeting, the researcher presented, the aim, implementation and data collection methods of the study. At the end of the meeting, the company managers agreed on giving permission to researcher for conducting the study depending on one condition. This condition was to sign an agreement (Appendix B). According to the agreement, the company would provide documents of the drivers' real fuel consumption amounts 3 months before the training and 3 months after the training and the researcher would not share the documents on public. On the other hand, the researcher had right to acknowledge results of the data. The company also wanted the researcher to ask every driver for permission before collecting data from them. The researcher would collect data on January, February and March, 2009 during the training and on August, 2009 after the training (Table 3.5).

Table 3.5 Implementation Process of the Study

11 January, 2009	**October, November, December, 2009**	**26 January - 10 March, 2009**	**March, April, May, 2009**	**20-21-22 August, 2009**
Meeting with Logistics and Transportation Company and the Petroleum Company	Getting Documents on Drivers' Real Life Fuel Consumption Amounts Before Training	Conducting Study (Data Collected during Training with Simulator)	Getting Documents on Drivers' Real Life Fuel Consumption Amounts Before Training	Conducting Study (Data Collected after the Training)

The study had two main phases: First phase included applications of behavioral, face and one part of the instructional validity approaches during the training; second phase included other part of the instructional validity approach application before and after the training. The researcher actively collected data during the first phase and after the training part of the second phase.

In the first phase, an experimental study was conducted to get information on behavioral validity and instructional validity of the truck simulator. Parallel to this process, the drivers and expert trainer opinion was taken under the scope of face validity.

In the second phase, the researcher got the documents that the company provided her on drivers' real life fuel consumption amounts from October 2008 to January 2009. In a similar way she got the drivers' real life fuel consumption amounts from March to May 2009. Moreover, she collected data on 20th, 21st and 22nd of the August, 2009 by interviewing with drivers and managers. Table 3.6 shows the approaches and implementation dates.

Table 3.6 Approaches and Implementation Dates of the Study

Phase I	Phase II	Phase I	Phase II
October-December, 2008			
Instructional Validity *(Documents provided by transportation company)*	January-March, 2009		
	Behavioral Validity *(Documents provided by simulator)*	March-May, 2009	
	Face Validity *(Survey, Interviews, Observation)*	Instructional Validity *(Documents provided by simulator)*	August, 2009
	Instructional Validity *(Documents provided by simulator)*		Instructional Validity *(Documents provided by transportation company, Interviews)*

3.8.2. The Context of the Study: Designed Case

The thesis study was a part of the project launched by a well-known petroleum company: to investigate whether the TS was a right tool to train the truck drivers on economic driving. For that reason, the training with the TS was only offered the companies which signed contract with the petroleum company. With guidance of this company, the transportation companies which would take training were checked and the most appropriate one was defined. The reasons to decide to contact with the defined logistics and transportation company were:

- The company should give permission to design the context according to the research aim.
- The company should have a big fleet because one part of the experimental design
- The training schedule should include winter terms because the researcher also wanted to investigate transfer of the training by comparing the drivers' real life fuel consumption amounts before and after the training. Since the weather conditions affect the fuel consumption, the researcher wanted to make stable this affect by comparing the drivers' fuel consumption amounts during the spring and fall seasons. The training was offered to the logistics and transportation company in the winter season.
- Moreover, the road conditions, the maintenance of the trucks and the loadings of the trucks affect the fuel consumption amounts. Since the big transportation companies have regular

customer, they assign the same drivers generally same routes with similar loadings. Similarly, these companies give more importance to do maintenance of trucks compare to the small companies.

Since the logistics and transportation company has all the features mentioned above, the researcher contacted with them with the help of the petroleum company and a meeting was arranged on 11th of January, 2009. The Company accepted that the research was conducted during the training. The company had a fleet with 365 trucks. The drivers took the training at the one of the department of logistics and transportation company in Istanbul.

Since the TS was integrated to back part of one of the trailer, it was carried to the training location. The context was designed according to the research aims by researcher and expert trainer. The theoretical part of the training was held at the back part of the trailer. The back of the trailer consisted of two parts: First part was small and included couches, worktop, bathroom and restrooms. The second a part was three sizes bigger than first part and included the TS, a LCD TV and lawn chairs and stove. Figure 3.16 shows the environment during the theoretical part.

Figure 3.16 The Context of the Training

3.8.3. The Sampling of the Study

Defining the sampling is an important step in the research studies because it shows the quality of the inferences made by researcher according to the research findings (Collins, Onwuegbuzie & Jiao, 2006). In the current study, the specific sampling procedure was followed with regard to the research design. Similarly, Collins et al. (2006) emphasized the role of the research design by presenting process steps used for determining the sampling in MMR studies as shown in Figure 3.17.

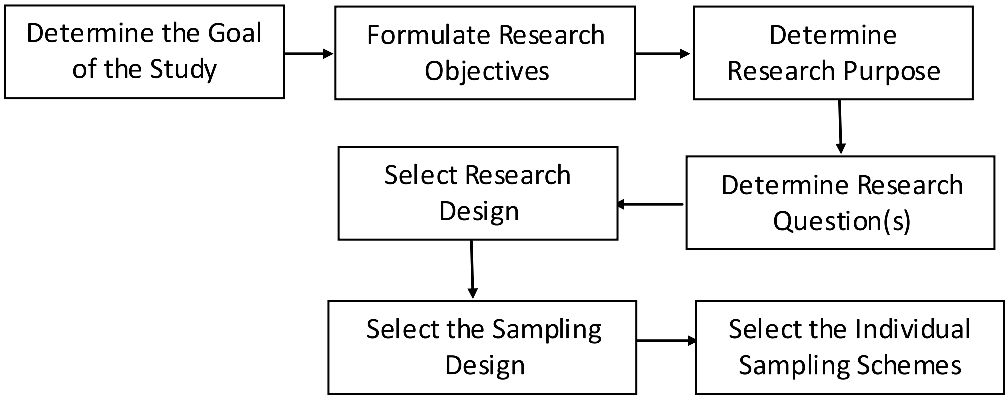

Figure 3.17 Steps in the mixed-methods sampling process (Collins et al., 2006, p.87)

Since the both MMR and Formative Research Methodologies were employed in the study. The quantitative data was gathered to investigate some research questions of the MMR parts of the study while qualitative data was gathered to explain some research questions of MMR parts and questions of the Formative Research part of the study. In other words, both quantitative and qualitative data were gathered in the study and for that reason, both quantitative and qualitative sampling procedures, namely, random and purposeful sampling strategies were employed by the researcher. Similarly, Collins et al. (2006), Onwuegbuzie and Collins (2007) and Teddlie and Yu (2007) support the logic that the researcher used while determining the sampling procedure by stating that the nature of the MMR calls for employment of both QUAN and QUAL sampling strategies. However, the sampling procedures for the studies which included both QUAN and QUAL part were questionable in the literature although some topologies were presented on the issue (Collins et al., 2006; Onwuegbuzie and Collins, 2007; Teddlie and Yu, 2007). Teddlie and Yu (2007) emphasized that sampling is determined beginning of the studies but qualitative data gathering may cause determining sampling during the studies. Similarly, in the study, the researcher firstly defined the clusters as transportation companies that the training was offered. Then, she employed one of the qualitative research approach purpose sampling strategy, namely, the Complete Collection (Criterion Sampling) to define the company the data would be gathered.

Aforementioned, to answer the research question best, the company that the data was gathered should have a big fleet, open to changes done on training and the training should have been offered in winter seasons. The logistics and transportation company was the only company that met all these criteria. Then, the company was defined, the manager who from the education department of the company selected the drivers who would have taken the training randomly during the study. Every day, the manager defined from 5 to 8 drivers who attended the training. The researcher gathered data from the drivers who attended to the training from 11th January to 10th march, 2009. While gathering the quantitative data, the researcher determined the sampling for interviews. The sampling procedure she employed was intensity sampling procedures. According to her observation, she decided to interview with the drivers who were pleased to attend training, ones who were not pleased to attend the training and ones who were not pleased to attend but changed their attitudes toward the training during the study. Moreover, the researcher employed intensity sampling strategy to define the sampling which was the data was gathered 5 months later the training, on 21^{st}, 22^{nd} and 23^{rd} of the August, 2009. The researcher decided to interview with drivers who decreased fuel consumption amounts and one who did not decreased fuel consumption amounts after the training. The sampling procedures used in the study is represented Figure 3.18.

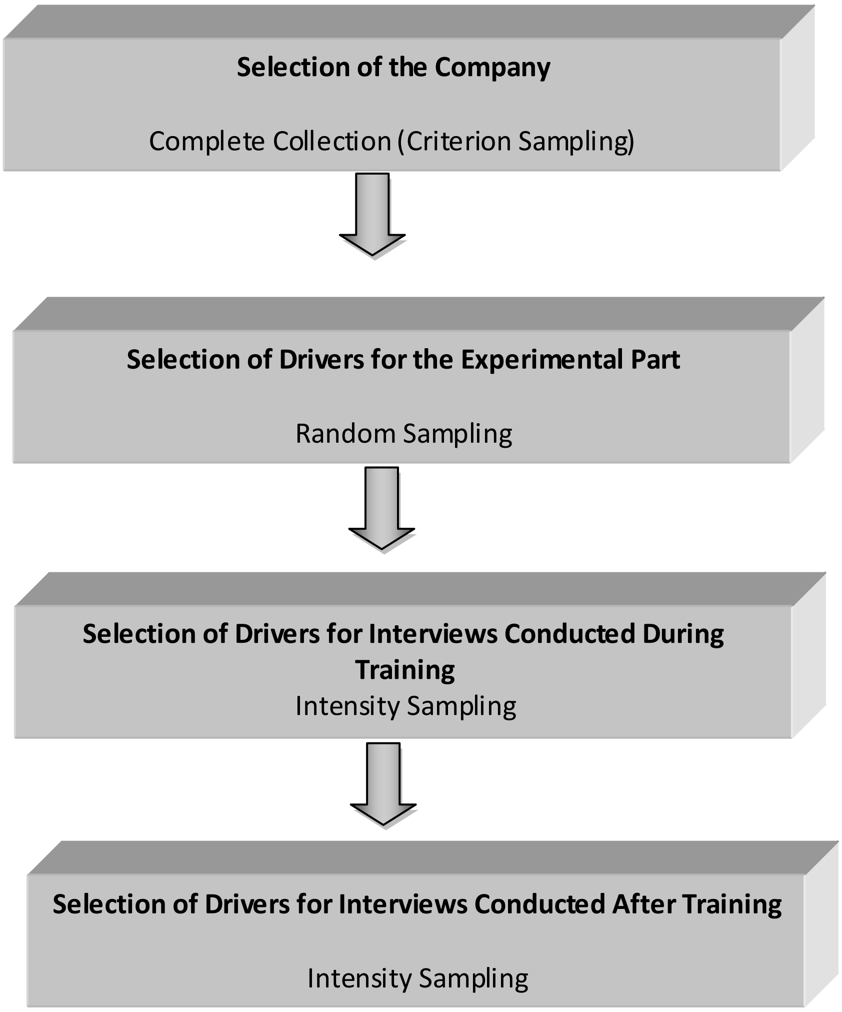

Figure 3.18 Sampling Procedures Employed to Select Truck Drivers in the Study

Moreover, the researcher interviewed the trainer and two managers who responsible for the training given to the drivers. During the study the manager who was from the training department in the company helped researcher to define the drivers who would have been interviewed after 5 months because he followed the drivers' real life fuel consumption difference after the training.

By applying the mentioned sampling strategies the researcher collected data from 110 out of 121 professional truck drivers of the logistics and transportation company; two managers from the same company and the expert trainer. With respect to the research design, the researcher used multi sampling procedures for both quantitative and qualitative part. Moreover, she interviewed with the 38 truck drivers during the training and 22 of them after the training. The data saturation was taken into account to define the number of the drivers who was interviewed.

3.8.3.1. Background Information of the Participants

This part consists of the three subheadings because data were collected from the three groups of stakeholders during the study. One group of these stakeholders was the truck drivers who took the training offered on January, February and March, 2009. Also, the researcher interviewed with 32 of the participants who attended to the study. Other groups of stakeholder were the trainer who also worked with the developers of the TS in the development stage. The last groups of stakeholders were the managers, one of whom was responsible for the educational activities in the company and other one was the fleet manager who knew the drivers well and also top managers' point of view to the training. The researcher took these stakeholders' opinions and discussed the results with one computer engineer worked in a simulation development team. However, this process was related with the validity of study rather than collecting data. For that reason, this engineer's background information was not mentioned.

3.8.3.1.1. Background Information of Truck Drivers

The participants of this study were 110 professional truck drivers, who took training via the TS on January, February and March, 2009. The data collected in two sessions: 1) from 26th January to 7th February, 2009 2) 2nd March to 10th March, 2009. 76 participants attended to the training from 26th January to 7th February and 3 of them did not want to participate to the study. In the second training session which was held from 2nd March to 10th March, the number of attendees was 45 and 8 out of 45 participants' data were not taken into account in the scope of these study. The reasons were: 1) 3 of them stated that they did not want to participate to the study. 2) 3 of them had to take road after the training and did not have time to answer survey or interview questions. 3) 1 of them could not complete the training because of the simulator sickness. 4) 1 of the participant's second driving report was forgotten by the researcher. To sum, 121 participants attended to the training but 11 of them did not participate to the study. Table 3.7 shows the number of truck drivers who attended to the training and ones who participated to the study with time periods. The researcher also interviewed with 32 of these participants 4 months after the training to understand the factors affecting the transfer of the training. These data collection period included the 20th, 21st and 22nd of August, 2009. For that reason, last row of the Time Period column includes also 20th, 21st and 22nd August.

Table 3.7 Number of the Participants Who Attended the Training and Ones Who Participated to the Training with Regard to Time Period.

	Training	Study	Time Period
	76	73	26th January - 7th February
	45	37	2nd March - 10th March
Total	121	110	26th January – 22nd August

The first part of the survey was applied in the study was aimed to collect data on participants' background. The questions were on gender, age, educational level, job experience, what type of vehicle they drove in real life, computer use and whether they have ever used the simulator before the training. The background information of the participants was collected since these factors might affect the results of the study.

Gender and Age

In the study, all of the participants (110) were male (Table 3.8). One manager who was responsible for the human resources in the company was interviewed by the researcher. He stated that in Turkey, there are no female truck drivers in the logistics and transportation sector in contrast to abroad (Yuksel, 2009).

Table 3.8 Frequencies of the participants concerning their gender.

		Frequency	Percent
Valid	Male	110	100,0

Age was an open ended question. For that reason, during the analysis firstly the frequencies of the participants' age are presented. Secondly, the age categorizes which consisted of 5 years intervals in order to give a plain picture about the issue and ease the data analysis step which would be conducted to investigate the age effect on total differences in fuel consumption amount before and after training was presented. The results about the participants' age showed that the range of the participants' age is between 27 and 54. In other words, the minimum age of the participants was 27 while maximum age 54. Moreover, the mean score of the participants' age was 41.07 (Table 3.9).

Table 3.9 Descriptives of the participants concerning their age.

		Statistic	Std. Error
Age	Mean	41,0636	,64127
	Std. Deviation	6,72566	
	Minimum	27,00	
	Maximum	54,00	
	Range	27,00	

The researcher categorized the participants' age in 5 age interval. According to the result, age of 9 participants (8.2%) ranged between 25-30; age of 16 participants (14.5%) ranged between 30-35; age of 21 participants (19.1%) ranged between 35-40; age of 37 participants (33.6%) ranged between 40-45; age of 16 participants (14.5%) ranged between 45-50; age of 11 participants (10%) was between 50-55 (Table 3.10).

Table 3.10 Frequencies of the participants concerning their ages.

			Frequency	**Percent**
Valid	Age	25-30	9	8,2
		30-35	16	14,5
		35-40	21	19,1
		40-45	37	33,6
		45-50	16	14,5
		50-55	11	10,0
		Total	110	100,0

Education Level

According to the output below, 43 out of 110 participants (39.1%) graduated from primary school; 30 participants (27.3%) graduated from secondary school; 30 participants (27.3%) graduated from high school; and 7 participants (6.3%) graduated from university (Table 3.11)

Table 3.11 Frequencies of the participants concerning their educational level.

		Frequency	Percent
Valid	Primary school	43	39,1
	Middle school	30	27,3
	High school	30	27,3
	University	7	6,3
	Total	110	100,0

Job Experience

According to Table 3.12, majority of the participants (n=104 with 94.5%) had more than 5 years job experience. The results showed that 1 participant had 5years, 1 participant had 4 years, 2 participant had 3 years, 1 participant had 1 year experience.

Table 3.12 Frequencies of the participants concerning their experience year.

		Frequency	Percent
Valid	1,00	1	,9
	2,00	1	,9
	3,00	2	1,8
	4,00	1	,9
	5,00	1	,9
	6,00	104	94,5
	Total	110	100,0

Vehicle Type the Participants Drive

The result showed that all the participants drove a truck. It was an expected result since all the participants were from the same Logistics and Transportation Company (Table 3.13)

Table 3.13 Frequencies of the vehicle type that participants drive.

		Frequency	Percent
Valid	Truck	110	100,0

Computer Use

According to the results, 58 of the participants (52.7%) are computer users while 52 of them (47.3%) have not used computer (Table 3.14)

Table 3.14 Frequencies of participants concerning their computer use.

		Frequency	Percent
Valid	Yes	58	52,7
	No	52	47,3
	Total	110	100,0

Also, the data on participants' computer use year and hours in a week were collected in order to get idea whether their computer use proficiency was in a level that affect on total differences in fuel consumption amount before and after training. The results of the analysis showed that 58 participants' experience on computer use ranged between 5 months to 10 years and most of the participants (n=22) have been using computer for two years. Also, the mean score of the computer use year was 1.7 (Table 3.15).

Table 3.15 Descriptive of participants concerning their computer use year.

		Statistic	Std. Error
Computer Use Year	Mean	1,7000	,22081
	Std. Deviation	2,31588	
	Minimum	,00	
	Maximum	10,00	
	Range	10,00	

Since the number of ranges of the participants' computer use hours was 10, the researcher categorized the computer use years in 2 years intervals. According to the output results, most of the participants (n=32) have been using computer for years between >0 and 2 hours ranges (Table 3.16).

Table 3.16 Frequencies of the participants concerning their computer use year.

		Frequency	Percent
Valid	>0-2	32	29,1
	2-4	13	11,9
	4-6	6	5,4
	6-8	5	4,5
	8-10	2	1,8
	Total	110	100,0

The results also showed that the participants' computer use hours in a week ranged between half an hour and 30 hours. According to the output results minimum computer use hour in a week was half an hour in a week while the maximum computer use hour was 30 hours in a week. Mean scores of the computer use hour in a week was 3.79 according to the Table 3.17. It also shows that most of the participants used computer between half an hour and 4 hours in a week.

Table 3.17 Descriptive of participants concerning their computer use hours in a week.

		Statistic	Std. Error
Computer Use Hour in a Week	Mean	3,7864	,54192
	Std. Deviation	5,68374	
	Minimum	,50	
	Maximum	30,00	
	Range	30,00	

Simulator Use before the Training

The output results showed that 79 out of the 110 participants (71.8%) have not used simulator before the training while 31 of them (28.2%) used simulator before the training (Table 3.18). Also, this question was followed up by an open ended question. This open ended question was asked to learn the type of the simulator they have used before the training if they had used one. This question was asked because if the simulators that the participants have used before the training was not a driving simulator or designed for training, this factor might not probably affect the participants' total differences in fuel consumption amount before and after training.

According to the survey results, 29 out of 31 participants used psychotechnics simulator before the training while 1 out of 31 used an instructional simulator developed to train drivers on safety driving with dangerous goods. On the other hand, 1 of the participants used a simulator which was developed to train soldiers on firing. As realized from the result, only 1 driver had used a driving simulator which was designed for training. Other 29 participants used the psychotechnics simulator which was designed to assess drivers' mental skills such as perception, attention, memory, reasoning ability, the speed-distance estimation; ability and skill levels such as reaction-rate, eye-hand-foot coordination; attitudes behavior, habits and personal characteristics such as risk taking, aggression, responsibility, safe driving awareness (Online:Sürücü Eğitim Simülatörleri) before the training. In other words this simulator was very different than the TS in terms of type and aim. Also, the simulator that the other participant used when he was servicing in military also unrelated to the TS.

Table 3.18 Frequencies of the participants concerning their experience year.

		Frequency	Percent
Valid	Yes	31	28,2
	No	79	71,8
	Total	110	100,0

3.8.3.1.2. Background Information of the Trainer

The trainer's background information was collected through interview and videos of the theoretical part of the training. At the beginning of the theoretical part, the trainer was introduced himself to the participants and mentioned his background information in job experience. The trainer began his job career in logistics sector as a truck driver. He stated that he worked as a truck driver during his university years. After the university, he also worked as a manager in different levels at the logistics firms. He emphasized that he has been in the logistics sector for 22 years. During the interview, he said that he started his career as a trainer 6 years ago after he had taken certificates from Germany (DVR-Deutsche Verkehrssicherheitsrat e.V. and BGA- BGA Federation of German Wholesale and Foreign Trade), Austria and Holland Ministry of Transportation. As a trainer, he pointed out that he has been offering training on defensive driving techniques, economic driving, anti-skid driving techniques, off road driving techniques, rollover driving techniques and safety driving to both heavy vehicle company drivers and automotive sector companies. The trainer also said that although he has been offering training economic driving on real trucks, the Truck Simulator was the first simulator he has been offering training with since it was the first simulator which was designed to train professional truck drivers.

3.8.3.1.3. Background Information of the Managers

The researcher also interviewed with two managers from the logistics and transportation Company after the training to take their opinions about the transfer of the training with simulator. Since these two managers were responsible for the training, the researcher selected these managers to conduct interviews purposefully. One of them was fleet managers while the other one was one of the middle manager of the education and employment department.

Background Information of the Fleet Manager

The background information of the Fleet Manager of the company was collected through the interview. The manager started his career as a process engineer in the logistics and transportation Company in 2004 and after one year, he had worked as a project leader at the logistics department for 2 years. Then, he continued his career at the department of process development and worked on the projects about land transportation until 2009. Since February, he has been working as fleet manager and he communicated with the drivers directly from that time. Moreover, he stated that the Vehicle Representation Department was managed by him. The manager emphasized that working in different positions and being promoted slowly provided many advantages to him in the fleet manager position since he knew the theoretical part of the logistics sector thanks to other positions he was.

Background Information of the Middle Manager of Training Department

The background information of the Training Manager of the company was also collected through the interview. He stated that he started his career as a truck driver after high school. After he had worked as a truck driver for 25 years, he was promoted and started to work as a middle manager of the Training Department before 2 and a half year. He said that he was also responsible for the selection of drivers who applied for the truck driver career.

3.8.4. The Data Collection Methods and Instruments

In the study, both quantitative and qualitative data collection methods were employed. The data for the quantitative part was collected through reports provided by the simulator on the drivers' fuel consumption amounts while driving the simulator before and after the training, survey and documents provided by the company on the drivers' real life fuel consumption amounts before and after the training. On the other hand, qualitative data were collected through interviews and observations.

The data was collected in two phases: first one was collected during the training; second one was collected after the training. Under the scope of first phase, behavioral validity, face validity and instructional validity approaches were applied. Under the scope of behavioral validity, a pre-posttest experimental design was followed. The drivers drove the simulator before and after the training. The reports of their fuel consumption amounts were provided by the simulator. The researcher used these reports to investigate important parameters and how well they explained the fuel consumption. Moreover, the trainers' opinions were taken about the behavioral validity of the simulator. For the face validity, the researcher conducted a survey and also interviewed with the drivers and the trainer to find out their opinions about the reality, usability, contribution of the simulator to the training. The field notes were taken to define usability problems and the effects of these problems on the performance of the drivers. On the other hand, under the scope of the instructional validity, reports on the drivers' fuel consumption amounts before and after training performance were used. It was important to emphasize that face validity results were complementary and like a buffer between for both behavioral and instructional validity approaches. In addition, it included many clues about the applied validity approaches, instructional validity process characteristic and factor should be taken into account into the validity studies.

For the second phases of the study, the researcher collected data under the instructional validity approaches thorough documents provided by the company on the drivers' real life fuel consumption amounts in fall and spring months (before and after the training). Moreover, 5 months later the training, the researcher again interviewed with the drivers and managers in order to learn their opinions on the role of the simulator in the transfer of the training and factors affecting the transfer of the training.

The researcher employed both quantitative and qualitative data collection methods during first and second phases. Aforementioned, during the first phase, interview and observation methods as well as experimental research design were conducted. Moreover, the researcher took notes on the validation process. During the second phase, both quantitative and qualitative data collection methods were employed. While statistical analyses were conducted on the participants' real life performances before and after the training, interviews were conducted with the participants and company managers to define the factors that might have affected transfer of the training. Figure 3.19 shows a Cmap on the quantitative and qualitative data collection methods applied in the study with the simulator validity approaches.

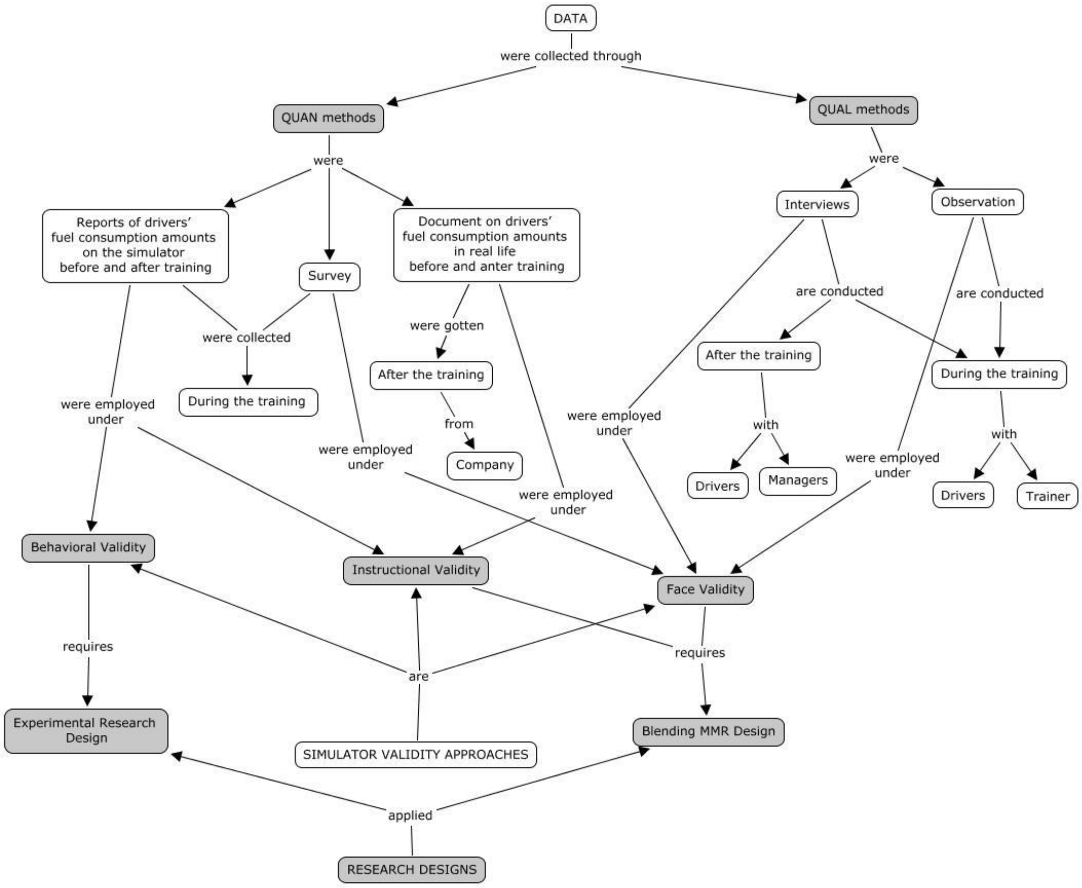

Figure 3.19 Quantitative and Qualitative Methods with Simulator Validity Approaches under the scope of Applied Research Designs

Moreover, the applied research designs were blending mixed methods design and designed case formative research design. The blending mixed methods design is based on the idea that the applied methods aimed to complement each other. For that reason, the complementarity manner which is labeled as Blending Mixed Methods Research Design by Greene (2007) suggested concurrent data collection although it was not a rule. In the study, under the behavioral validity, face validity and instructional validity approaches, quantitative and qualitative methods were employed concurrently during the training. However, the data on one part of the instructional validity, transfer of the training, were determined to be collected according to results of the data collected during the training and investigated after 5 months of the training. The Figure 3.20 shows the data collection methods sequences with the research designs in the study (+ symbol refers to concurrently applied methods, (⇨ symbol refers to sequentially applied methods)

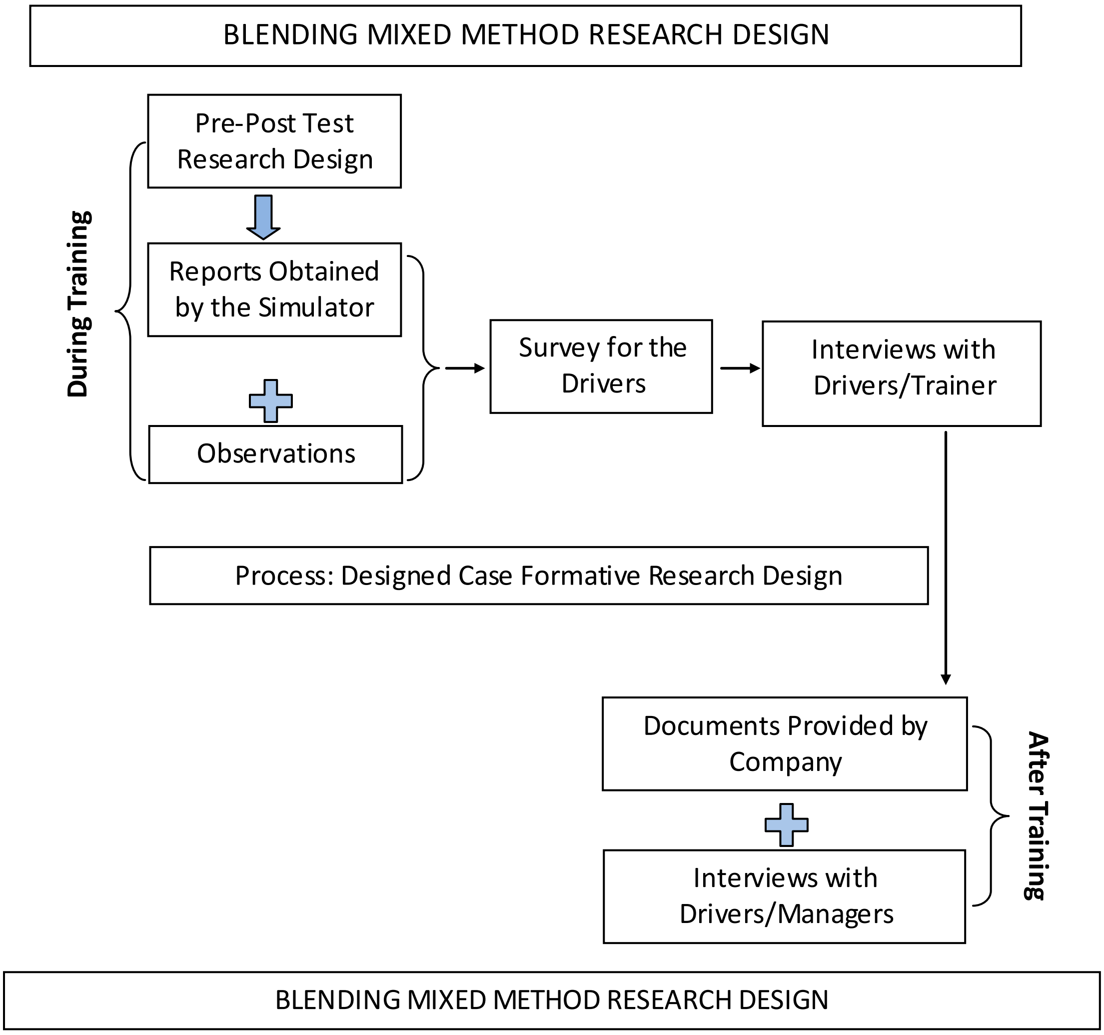

Figure 3.20 The data collection methods sequences with the research designs in the study

Shortly, the researcher applied different simulator validation approaches, namely, behavioral-face-instructional validity during and after the training via reports obtained by the simulator on drivers fuel consumption amounts before and after the training (under pre-posttest experimental design), survey, interviews, observations and documents provided by company on drivers real life fuel consumption amounts before and after the training. The methods were applied both concurrently and sequentially during the study. Moreover, the weight of the each method was equal because they were complementing each others. At the same time, the researcher focused on the process the relationships of the approaches, if there were any other approaches and the factors affected the validity process. For that reason, the data of two research aims were collected parallel during the study. Formative research part had explorative aim while MMR part had explanatory and confirmatory aims.

The researcher prepared survey, interview forms and observation forms before the study. All the instruments were checked by the experts and applied before the study. The last versions of the instruments were conducted to obtain data as following:

3.8.4.1. The Simulator Survey

The survey are the instruments can be used to gather data from large group of people about their feelings, perceptions, attitudes, values, background information, beliefs and so on (Freankel & Wallen, 2000; Johnson & Christensen, 2004).

The survey used in this study was prepared by the researcher. Firstly, the literature was searched and no instrument was found to obtain data on drivers' perception about the truck simulator reality, usability and contribution to the instruction and drivers' satisfaction. However, the questions were developed in the light of the literature. Moreover, some survey statements of an instrument on usability of a simulator were benefitted (Uke, 2006). The survey which consisted of two parts, namely, demographic part and evaluation of the TS was developed. The demographic parts consisted of 6 questions and evaluation parts consisted of 21 statements with 5 point likert type scale. Moreover, at the end of the survey there was an open ended question on the drivers' opinions about the simulator parts that should be improved. This version was checked by the experts. Then, the experts organized the demographic parts and separated some questions from each others. So the demographic questions numbers enhanced 8. Moreover, 2 extra items were added to the evaluation of the TS part by them. After the survey was organized, the experts checked it second time and the researcher applied this survey to 2 drivers before the pilot study. The last version of the survey had 8 demographic data questions, 23 statements to evaluate the TS and 1 open ended question. After it filled by 2 drivers, a grammar mistake was found and corrected. After that the survey was conducted in the pilot study and then main study (Appendix C).

Aforementioned first part of the survey questions aimed to obtain data on participants' demographics and characteristics which may affect validation process of the instructional simulator. This part of the survey has questions to gather information on age, gender, education level, the years they worked as a truck driver, the type of truck that they have driven, the information on if they had used a simulator before and their computer usage of the data sources.

The second part of the survey is consistent on statements about the simulator reality, usability and instructional contribution to the training. The participants are required to choose a response from 5 options, namely, strongly agree to strongly disagree. Table 3.19 shows the options for the response of rating scale.

Table 3.19 Rating scale in the second part of the simulator survey

1	2	3	4	5
Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree

The last question in the survey is an open ended question. This question is aimed to take drivers' opinions about the parts of the simulator that should be improved.

3.8.4.2. Interview Forms

The interview is one of the methods that were followed to understand people's perspectives, sights, feelings, values, opinions and so on in depth (Marshall & Rossman, 2006; Patton, 2002). According to Patton (2002) there are 4 interview types, namely, informal-conversational interview, interview guide approach, standardized open ended interview and closed fixed-response interview. In this study, the researcher used the standardized open ended interview type since as Patton (2002) states all the participants answered specific interview questions in this type of research and this type of research provided a complete picture of the investigated issue in addition to comparability of the responses. Moreover, all interviews were conducted face to face.

The researcher prepared 4 interview forms to collect data from different data sources. All the interview forms were prepared in the light of the literature and checked by the experts. 2 of the interview forms were aimed to gather data from the drivers. 1 of them applied during the training. This form consists of 10 questions on reality, usability of the simulator in addition to its contribution to the training. This form was aimed to get in depth information on the drivers' perception about the simulator. For that reason, it was used to triangulate as well as complement the survey data (Appendix D).

The second interview form which was prepared to gather data from the drivers applied after the training. This interview form aimed to get data about the transfer of the training and factors affecting it negatively or positively. For that reasons, 5 questions were asked to the drivers 5 months later for the training. The drivers were asked about what extend they could apply the training, factors positively affecting the transfer of the training, factors negatively affecting the transfer of the training, the role of the simulator on the transfer of the training and the suggestions about the training design to enhance the training transfer (Appendix E).

The third interview form was prepared to take expert trainer's opinion about the validity of the TS. The expert trainer was interviewed during the training (Appendix F). The last interview form was prepared to interview with company managers. This form was applied after 5 months of the training. The researchers aim to collect data on the company managers opinions about the factors affecting the transfer of the training (Appendix G).

3.8.4.3. Observation Form

Marshall and Rossman (2006) describes observation method as "…the systematic noting and recording of events, behaviours and artifacts (objects) in the setting chosen for the study" (p.98). In the study, observation method was conducted during the training. The aim of using the observation method was to get information about whether the drivers had difficulty in recognizing or using the parts of the truck simulator. Also, what kind of mistakes they would have done and which one (s) of the mistake (s) would have stemmed from the simulator were aimed to be explained through observation. An observation form was prepared to enable researcher to focus on important actions of the drivers while they were using the simulator and revised by experts. The researcher observed the drivers while they were using the simulator according to observation form (Appendix H).

Moreover, the researcher took the field notes of important events and the drivers' and trainer's dialog that might have been important for the validation process interpretation. Observations were conducted in two ways. First one was researcher observed drivers' behaviors according to the observation form since focusing on participants' some behaviors which was important to gather information parallel to aim of the research might have been more beneficial. Second one was using a camera to record drivers' behaviors while they driving the truck simulator. So, some driver behaviors that the researcher might not have paid attention were realized while analyzing the camera records.

3.9. Data Analysis

Both qualitative and quantitative approaches were applied to gather data in the study. However, in this design, the aims of the study were required to apply two different data analysis. First aim was to validate the truck simulator and MMR was the most appropriate research methodology to investigate it. According to Greene (2007) in MMR studies, especially the evaluation studies, research design and analysis purposes can change within the studies. Miles and Huberman (1994) mentioned Greene et al.'s (1989) ideas about the MMR studies and state that the important things are deciding the weight of the quantitative and qualitative parts, their interactivity and sequence of the approaches. With respect to the Blending MMR design quantitative and qualitative data were jointly analyzed and interpreted during the data analysis.

The second aim was to develop a model to validate instructional simulators. With respect to the aim of the study the design case formative research design was applied and qualitative data sets were interpreted differently to do this aim. Moreover, at the end of the study, both methodology results were interpreted together to determine validity of the truck simulator. For that reason, in the study within the aims and between the aims different analyses methods were used. However, one of the linking designs for quantitative and qualitative data suggested by Miles and Huberman (1994) was followed during all these processes: "...fieldwork involves steady, integrated collection of both quantitative and qualitative data as needed to understand the case at hand" (p.41). Under this heading, the analyses methods were explained with regard to the main research questions and participants' demographics.

3.9.1. Participants' Demographic Characteristics

The drivers' demographic characteristics were gathered via the Simulator Survey. Nominal scales were used to report categorical data with the variables as "gender, age", "educational level", "the years they worked as a truck", "the type of truck that the drivers have driven", "the information on if they use a simulator before and "their computer usage". Later, the data were coded for the analysis and frequencies; analyzed via descriptive statistics.

3.9.2. The Similarity of the Simulator and Real Truck Measures: Behavioral Validity

Both quantitative and qualitative approaches were applied to get data on the similarity of the measures of the simulator to real trucks. In the quantitative part, the researcher analyzed the 110 drivers' data about the 4 parameters and fuel consumption amounts. She applied multiple regression analysis to get information about what extend these 4 parameters in the report provided by the simulator explained the fuel consumption amounts. The enter procedure was conducted to predict fuel consumption amounts from the parameters. The parameters were defined with the guidance of the expert trainers and they were:

1. Number of stepping gas pedal
2. Number of changing gearshift
3. Number of not keeping rpm in appropriate level
4. Number of not keeping rpm in appropriate level while changing gearshift

Before conducting the analysis, assumptions of multiple regression analysis were checked. The assumptions were normality, outliers, homoscedasticity and multicollinearity. All the assumptions were provided. All the assumption check results were explained under the title "4.2.1.1. Prediction of the Fuel consumption Amount from the Parameters (Research Question 1.1.1)" in detail.

The quantitative and qualitative parts were analyzed separately. However, the research question about the reality of the simulator measures was interpreted in the light of QUAL and QUAN data results. QUAN and QUAL data parts had equal importance and compementarity each other for this part. Figure 3.21 shows the analysis and linking issues of both approaches.

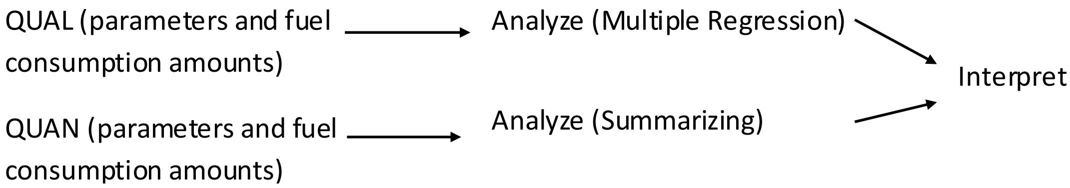

Figure 3.21 The analysis and linking issues of both approaches

3.9.3. The Participants' Perceptions on the Simulator Reality, Usability and Contribution to Instruction during the Training: Face Validity

The data on the participants' perception about the Simulator reality, usability and instructional contribution to the training were collected via the survey and interview methods. The survey was applied to the drivers who participated to the study. Descriptive statistics was used in order to analyze the result of the survey. The frequency of answers for the each question was extracted and the numbers of the participants were given to explain the each question results.

The drivers were also interviewed after the second driving session on the simulator. The aims to use interview method were complementing and triangulating the survey data. In other words, the researcher aimed to get in depth information about the drivers' opinions about the simulator through the interviews. The interview data firstly transcribed and secondly coded via open coding method. Thirdly, the researcher formed a table which had a segment for the each interview question. Then, codes emerged from the all drivers' answers were placed on this table with the drivers' quotations. Fourthly, the codes were reduced and last version of the codes was explained in the thesis results.

Moreover, the usability issues were investigated through the observation methods in addition to survey and interview. The researcher used an observation form and filled this form for each driver while they were using the simulator. A video camera was placed to record each driver's behaviors. For the analyzing data gathered both from observation notes and cameras was coded (Figure 3.22).

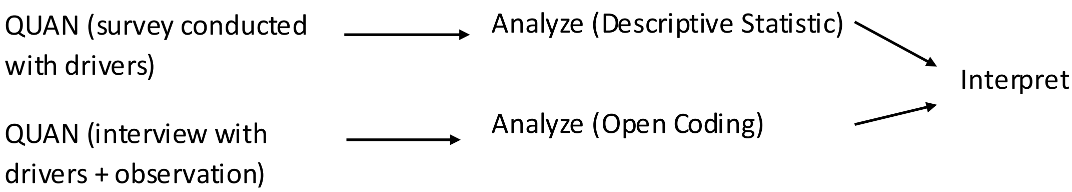

Figure 3.22 The analysis and linking issues of both approaches.

3.9.4. The Participants' Performances Before and After the Training: Instructional Validity

The drivers' performances before and after the training were investigated in two phases. First phase included drivers' performances on the simulator before and after the training. The reports provided by the simulator on drivers' performances before and after the training were used to investigate whether there is a performance difference after the training. To analyze the drivers' before and after training performances on the simulator, Paired t-test was thought to be applied. However, the assumptions of the paired t-test were controlled and since the assumptions were violated, Wilcoxon Signed Ranked test which was a non parametric test was applied.

Second phase included drivers' performances on real truck before and after the training. Documents hold by the logistics and transportation company on drivers' performances were used to compare the drivers' real life performances before and after the training. This phase data were on the transfer of the training. Also, the data for instructional validity were determined to be collected according to the results of the data gathered during the study. To analyze the data of the second phase independent t-test was applied.

Moreover, the drivers and managers were interviewed with to define the factors affecting the transfer of the training. So, the in depth information about the second phase were gathered by the researcher. To analyze the interviews of two managers, firstly the interviews were transcribed and their answers to each interview questions were summarized. To analyze drivers' interview questions, again the interview sessions were transcribed and open coding analysis method were applied. Then, a chart was formed for each driver's data codes with quotations and the reductions were done on the codes. At the end, the last version of the codes was presented in the results chapter of the current study.

3.10. Validity and Reliability Issues of the Study

While reliability refers to the replicability of scientific findings, validity refers to the accuracy of the scientific findings. Toma (2006) states that different strategies are used to establish validity in the qualitative and quantitative research. He separated validity as internal and external validity and named these standards as trustworthiness (Toma, 2006). In this part, the researcher mentioned the validity and reliability issues in the study and copying strategies applied.

3.10.1. Validity and Reliability Issues for Quantitative Part of the Study

Wallen and Freankel (2001) state researchers should focus on collect reliable and valid data and they use instrument to collect data. According to them, for that reason researcher cannot assume their instruments valid or reliable (Wallen & Freankel, 2001). According to them, methods of checking validity of instruments are content-related; criterion-related and construct-related validity. In this study, a survey was conducted to collect data from drivers. The researcher took expert opinion during development of the instrument under the scope of content-related validity. Moreover, language and understandability of the items were check by applying the instrument to 3 participants.

To check the reliability of the instruments, the ways that can be used are test-retest, equivalent forms, internal consistency and observer agreement. In the study, the researcher used statistic to check reliability of the instruments and the reliability coefficient of the survey was found to be 0.86.

Also, Freankel and Wallen (2000) propose some validity strategies to specific on some research designs. In this study, pre-post test experimental research design was applied. The length of the experiments were arranged to avoid the participant's and driver's boredom. Moreover, some strategies were applied to prevent factors affecting the results related to "Implementation". For example, drivers' real life performances during Spring and Fall term months were compared to avoid weather conditions affecting the results. Similarly, the data were collected from a big company to avoid route, loadings, auto maintenance affecting the results.

3.10.2. Validity and Reliability Issues for Qualitative Part of the Study

The reliability and validity measures in qualitative research are concerned with the meaning of the phenomenon and different from the quantitative research. For that reason the reliability and validity takes different names as credibility, transferability, dependability and confirmability (Lincoln & Guba, 1985). The researcher used some strategies to validate that as suggested by the Creswell (1998) in this research study. These strategies are:

1. For Credibility
    1.1. Peer debriefing: A peer can help researcher to look the data collection and interpretation procedure from other perspectives. The researcher discussed the process of the study with the peers during the data collection. Moreover, one of the peer helped to analyze quantitative data, while other one discussed the results of the study with me.
    1.2. Triangulation: Triangulation refers to use multiple data sources, methods, analysis procedure or theories. The researcher triangulated methods by collecting data through survey, interview and observation. Moreover, different stakeholders' (drivers, managers, trainer) opinions about the investigated phenomena were taken during the study.
2. For Dependability

2.1. Dependability audit: Dependability audit helps an external auditor review your techniques. The researcher took other people's comments on the techniques that she used through the research study. Especially, the advisors and expert trainer reviewed whole research study procedures.

3. For Confirmability

   3.1. Confirmability audit: Confirmability audit helps an external auditor the results of data. The results of the study were reviewed by the advisors, expert trainer and a computer engineer who works as a team leader for a simulation company. Moreover, the researcher summarized the interview data that she conducted with the trainer and asked him whether his opinions changed or not.

3.11. Limitations of the Study

The experimental study should have been applied to validate the TS under the scope of instructional validation. The researcher has planned to divide truck drivers who would attend the training into two groups. One group would take the training without simulator (control group) and the other group would take the training with the simulator (experimental group). Then the fuel consumption quantities of the control and experimental group were planned to be compared. However, the logistics and transportation company did not want this type of training arrangement because they stated that the drivers who would not be trained with simulators might have thought that the company did not see them equal with experimental group drivers. For that reason, experimental research part could not be applied as planned.

The truck drivers who would take the fuel consumption training with the truck simulator also entered an exam prepared by the training department of the logistics and transportation company at the same day that the training would have been held. The exam was prepared to assess general driving information about passport control, loading case, safety driving, and the general traffic rules abroad and so on. The aim was to define the subjects that the drivers had inadequate information and train them about these defined subjects. The drivers firstly entered the exam then participated to the training. Most of them said that they were exposed to too much educational events in one day. It was much better if the exam and training would not have been at the same day. Although, the managers were informed about the participants' dissatisfaction, they stated that the drivers who would take the training were determined by their fleet management and taking the permission from the management for the exam were very difficult because the drivers were very busy and if they did not the exam at the same day that the training would have held. This exam caused most of the participants' being unwillingness to attend training at the beginning.

There were two departments in the logistics and transportation company as Domestic and Foreign. The Domestic department drivers were carrying stuff on national roads while the foreign department drivers were carrying stuff on international road. In the fleet of the company, one third of the drivers are working at Domestic department. The logistics and transportation company policy was to employ drivers at the Domestic department in their first year at the Company. Then they transferred them to the Foreign Department. So, the Foreign Department drivers were more accustomed to the Company policy and work conditions. We requested them number of the drivers from two departments be equal as representing their driver population. However, they stated that they made a daily list including the drivers' names who would have participated and they defined them among the drivers who would not carry stuff. For that reason, it was impossible to select them according to the population proportion. Although most of the drivers (96) who participated in that study were from the foreign department, it was not the one to one equal population portion.

According to the expert trainer from the training and consulting company, daily 6 drivers should have participated to the training for benefitting the training effectively. However, some days the number of drivers who participated to the study was 7 or 8. Since the logistics and transportation company managers wanted all the drivers (378) take economic fuel consumption training and their agreement with the Burmah Castrol Company lasted 4 months, they tried to form the groups with 7 or 8 drivers.

It was much better if the drivers could drive the simulator twice before the training. So, they could be accustomed to the simulator at first. Then their second driving before the training and third driving after the driving could be compared. Since they drove the simulator twice and each driver driving lasted about 1 hour, the training lasted about 8 hours. For that reason, there was no time for third driving.

CHAPTER 4

RESULTS

This chapter includes the findings of the current research study with respect to the research aims and questions emphasized in the introduction and methodology chapters. The study focused on validating the Truck Simulator (TS) by combining the approaches (behavioral validity, face validity and instructional validity) extracted from the literature in a complementary manner and investigating validation process during the field trial. For that reason subheadings of the result chapter were labeled according to used validation approaches (behavioral, face and instructional) and the validation model developed based on the literature and data collected through the interviews and observations.

Moreover, this chapter includes the demographics of the participants and background information of the other stakeholders (2 managers who are responsible for the fleet and education department; expert trainer) because the stakeholders' background is necessary to understand the results of the study. For that reason, the researcher presents the background information of all the participants in this chapter under a subheading. Moreover, the effects of the background of participants on their total the fuel consumption amount differences between before and after the training.

With regard to all statements presented above paragraphs, the sub headings of the result chapter are: "Background Information of the Participants", "Behavioral Validation", "Face Validation", "Instructional Validation", and "Behavioral-Face-Instructional Model".

Aforementioned in the methodology chapter, a large amount of data collected through pre-posttest experimental design, survey, interview, observation and document analysis and the result chapter consisted of the researcher's interpretation of data.

4.1. Validity of the Truck Simulator (Research Question 1)

The research question 1 which was related to the simulator validity is the first main research question. The aim of the researcher was to determine to what extend the TS did what was supposed to do. So, the researcher decided to investigate the answer of this question in terms of reality, usability and contribution of the TS to instruction by combining the three approaches categorized according to the literature and her advisors' guidance. These approaches were behavioral validity, face validity and instructional validity. With respect to the categorized approaches, three sub research questions were answered. The first sub question was about the behavioral validity of the simulator and aimed to answer to what extend the TS measures similar to real truck measures. The second sub question was about drivers' and the trainer's opinion on to what extent the TS similar to the real truck in terms of reality and usability. Also, what they think on the instructional benefits of the TS. The third sub question was related to the validity of the TS in terms of its contribution to the instruction and aimed to answer to what extend the TS contribute to instruction what was supposed to do? Since some of the sub research questions required to employ the quantitative data collection and analysis methods while some of them required to employ the qualitative data collection and analysis methods, data was collected thorough performance comparisons of the TS and real truck, survey, interview, observation, performance comparisons of the participants' before and after training and document analysis.

4.1.1. Behavioral Validity of TS

To what extend the driving simulator represents the real model in terms of performance measures is the first and most important issue because the reality of performance measures also affects the users' perception according to Blana (1996a). In the literature, the mostly experimental designs which are aimed to compare users' performances both on simulator and real truck are applied to investigate simulator reality in terms of behavioral validation (Blana, 1996a; Hoskins and El-Gindy, 2006). However, in the literature, it is also emphasized that comparison of users' performances in vehicle and on simulator does not provide an accurate picture for the behavioral validation because providing same conditions for two environments is very difficult (Blana, 1996a). For that reason, in this study, while investigating how much the TS valid in terms of behavioral validation, the techniques on economic driving was taken as a reference. Specifically for determining the behavioral validity of the TS, the relationship between the fuel consumption quantity and parameters that affect the fuel consumption quantity were taken into account under this study. Some parameters in the report about the drivers' performances provided by the TS were taken as a reference. These parameters were determined according to the expert trainer guidance. Moreover, information on economic fuel consumption of the training; trainer's opinion and drivers' opinions were taken on the behavioral validity in order to get whole picture for the behavioral validation of the simulator. During the data interpretation, the researcher discussed the results with the expert trainer and a computer engineer who has been working as a team leader in a simulator development team. Moreover, the researcher sent the trainer what he said about the behavioral validity of the TS and asked whether he thought the same things or his opinions changed in time. All these procedure was conducted to get whole picture about the behavioral validity of the TS and validity/ reliability checking of the current study.

4.1.1.1. Prediction of the Fuel consumption Amount from the Parameters

The main purpose of this analysis was to investigate that to what extend the parameters in the report given by simulator and defined by the expert trainer predict fuel consumption amount was similar to ones presented in the fuel consumption theory. A multiple regression analysis was conducted as the design. The regression analysis was performed using enter procedures to predict participants' fuel consumption amounts from the parameters. In enter regressions; the variables within each category are entered into the regression models according to theory or some expectation about the data. Firstly, the parameters in the simulator report and the trainer's guidance to which parameters should be analyzed were presented. Then, the result of the statistical analysis was explained. The parameters used to analyze data with the guidance of the expert trainer were:

1. Number of stepping gas pedal
2. Number of changing gearshift
3. Number of not keeping rpm in appropriate level
4. Number of not keeping rpm in appropriate level while changing gearshift

Moreover, the number of not keeping rpm in appropriate level and number of not keeping rpm in appropriate level while changing gearshift are the most important indicators that are used to explain fuel consumption amount according to the expert trainer. For that reason, he stated that their prediction percent should be high. The researcher entered these two predictors in one model. In the interview he also stated that number of changing gearshift directly affects the fuel consumption and its prediction percent should be high. In the regression model, the researcher interpreted the analysis output according to these statements.

Table 4.1 Means and Standard Deviations of dependent and predictor variable.

	Mean	Std. Deviation	N
Fuel consumption	30,3284	1,49391	110
Rpm	,7636	1,02203	110
Rpm in gearshift change	2,9182	1,91628	110
Gear	18,8807	5,85564	110
Gas	42,5137	11,86052	110

Means and standard deviations of predictors and criterion are displayed in Table 4.1. The number of stepping on gas predictor has the highest mean and standard deviation *(M=42.5137, SD=11.60528)*, whereas number of not keeping rpm in appropriate level predictor has the lowest mean *(M=0.7636, SD=1.02203)*. Correlation is often used to explore the relationship among a group of variables. According to Tabachnick and Fidell (2001) bivariate correlations between two variables should be less than .7. Table 4.2 shows bivariate correlations between variables.

Table 4.2 Pearson product-moment correlations between measures of fuel consumption.

Pearson Correlation	1	2	3	4
Fuel consumption				
Rpm	,289			
Rpm in gearshift change	,337	,154		
Gear	,548	,112	,512	
Gas	,183	-,166	,219	,353

For normality assumption check; when the shape of the distribution was considered, it was normally distributed. . If "P-P Plots" was considered, values are lining up along the diagonal that goes from lower left to upper right. Therefore the assumption was not violated. Also, outliers were checked from the scatter plot. Although few outliers are observed, the majority of residuals were at the center of the plot. As a result the normality assumption was not violated. The assumption of independence of errors, the Durbin-Watson coefficient test was used and d=1.97. As a rule, d should be [1.5, 2.5] that the assumption was not violated.

The assumption of homoscedasticity is the assumption that the standard deviations of errors of prediction are approximately equal for all predicted dependent scores. Homoscedasticity means that the band enclosing the residuals is approximately equal in width at all values of the predicted dependent variables (Tabachnick, & Fidell, 2001; p.121) and the residual plot of fuel consumption amount showed that the assumption was not violated.

At the beginning of the analysis no missing value was observed. Influential observations were checked by scatterplots, residuals plots, Cook's distance, leverage test and Mahalanobis distance. Scatterplots and residuals plots showed a few outliers. Values of "Cook's distance" were less than 1, values of "centered leverage value" were less than 0.5.

To identify multicollinearity, bivariate correlations, tolerance and VIF (variance inflation factor) values were checked. As it mentioned before bivariate correlation was less than .7, so all variables could be retained. Collinearity statistics showed that values of tolerance larger than .2 and values of VIF less than 10. That means that there was no violation for multicollinearity.

Table 4.3 Summary of hierarchical multiple regression analysis with fuel consumption amount as a criterion

Model	Predictor Variables	R^2	ΔR2	ΔF
1	Rpm	,171	,171	11,034
	Rpm in gearshift change			
2	Gear	,354	,183	30,063
3	Gas	,356	,001	,239

A simultaneous regression was conducted on fuel consumption, using the 3 sets of 4 predictors to examine the amount of variance accounted for by each variable in the model, and the results were displayed in Table 4.3. In regression, rpm and rpm in gearshift change variables entered in the model, then gearshift entered in the second model and lastly, gas was entered in third model. According to the analysis, rmp and rpm in gearshift change explained a significant amount of the variance in fuel consumption, F_{change} *(2,107) = 11.034, p<.05,* R^2_{change} *= .171*. Thus, these two variables explained 17,1% amount of the variance in fuel consumption.

Gearshift change variable were entered in the second model, and motivation was found to increase a significant amount of the variance in fuel consumption by 18,3%, F_{change} *(1,106) = 30.063, p< .05,* R^2_{change} *= .183*.

In the third model, number of stepping on gas pedal was entered and it added 0,1% in explanatory to model, F_{change} *(1,105) =0.239, p<.05,* R^2_{change} *= .001*. Therefore, besides explaining a significant amount of variance when regressed on fuel consumption alone, number of stepping on gas pedal variables were found to contribute to explaining only 0.1% of variance over the other variables. Moreover, all these variables together explained %35.6 of the fuel consumption amount with F_{change} *(4,105) =14.487, p<.05,* R^2_{change} *= .356*.

Table 4.4 Analysis summary for variables predicting fuel consumption (N=110)

Model	Predictor Variables	B	B	T
1	Rpm	,344	,235	2,887
2	Rpm in gearshift change	,034	,043	469
3	Gear	,124	,484	5,061
4	Gas	,005	,042	489

Moreover, Table 4.4 showed unstandardized and standardized regression coefficients. Based on this table, the equation formula was: Fuel Consumption Amount = 27,409 +[Number of Stepping on Gas Pedal (.005)] + [Number of Gearshift Change (.124)] + [Number of not Keeping Rpm in Appropriate Level while Changing Gearshift (.034)] + [Number of not Keeping Rpm in Appropriate Level (.344)]

According to this result if the number of stepping on gas pedal increased 1 SS (in other words 11.86 times) fuel consumption amount would increase .005 standard deviation (1 SD fuel consumption amount was 1.494, when it was multiplied with .005 (1.494 x .005= .007). In other words, in every 11.96 times that the driver steps on the gas pedal, the fuel consumption amount will increase .007 point. Similarly, if the number of changing gearshift increased 1 SD (in other words 5.86 times) fuel consumption amount would increase .124 SD (1.494 x .124= .185). In other words, in every 5.86 times that the driver steps change gearshift, the fuel consumption amount will increase .185 point. If the same formula was applied for number of not keeping rpm in appropriate level while changing gearshift; 1 SD number of not keeping rpm in appropriate level while changing gearshift (1.92 times) will cause .05 point increase in fuel consumption amount (1.494 x .034= .05). Moreover, if the number not keeping rpm in appropriate level 1 SD (in other words 1.02 times) fuel consumption amount would increase .344 SS (1.494 x .344= .51). In other words, in every 1.02 times that the driver does not keep rpm in appropriate level, the fuel consumption amount will increase .51 point.

The researcher asked the expert trainer whether statistical results presented above indicated an accurate picture of the theory via e-mail. The expert trainer stated that although each parameter seemed to explain the fuel consumption amount reasonably, it was hard to say it was consisted with the fuel consumption theory because there were many parameters that effected the fuel consumption. He also gave an example to explain what he meant: Two drivers who drive on the same scenario and used the gas pedal, gearshift, rmp in the same way can also get different results if one climbs uphill quickly and the other do it slowly. Moreover, the trainer advised the researcher also asked the same question to a developer who develop driving simulators.

The same question about the reasonability of the results was asked to a developer who works in a simulation company and develops simulator for training aims. Similarly what the trainer pointed out, he also stated that they used some algorithms while developing the driving simulators which are used for training on fuel consumption and every time there is a difference between the simulator measures and its real model. According to him, what they try to do while developing simulators was to provide its' giving reasonable results rather than exact results of the reality. He said that providing simulators' giving the exact results as ones in real models were impossible with the technology in this century. However, for example if one driver does a lot of mistakes affecting fuel consumption amount while the other does a few mistakes and their fuel consumption amount was similar, it should be said that there was a problem in the simulator measures. For that reason, the expert trainers' opinions about the issue were more important than the statistical results.

4.1.1.2. Expert Trainer's Opinions about the Behavioral Validity of the TS

The researcher took the trainer's opinion about whether the simulator gives the consisted results with the fuel consumption theory through the interview at the second part of the training. The trainer stated that he did not think the simulator give consistent results with the theory. According to him, the loading, gearshift change, rpm and stepping on gas pedal number and their affect of the fuel consumption calculated by the simulator should be checked because he think that there was a problem about the accuracy of results. He also pointed out that he said these according to experiments he conducted on the simulator to check what extend it gave consistent results with the theory. He stated that with the words:

> Trainer: "According to me, procedures namely, simulator's reflecting the loadings as well as gearshift change, errors related to rpm and gas pedal numbers to fuel consumption amounts should be controlled. I mentioned so many parameters but I think that the most important problem was that wrong behaviors or correct behaviors and results of these behaviors is being reflected inconsistent with the theory sometimes. For example, we say that number of times you change the gearshift increases, fuel consumption amounts increase. It is said by the engineers and known all around the world. But on the simulator, the driver who changes the gearshift more than the other driver who changes the gearshift can get a low fuel consumption amount" [1].

The trainer also stated that the only factor that affects the fuel consumption amount was not gearshift change number. However, he said that other parameters such as number of stepping gas, stopping and running the vehicle number, rpm affected the fuel consumption amounts of the simulator reasonably. He also emphasized that it was important to investigate because inconsistent results affected the drivers' perception and the transfer of the theory to real life. He said that,

> Trainer: "The accuracy of information we give during the training is suspected by the drivers when they get inconsistent results with the theory. We give accurate information and when the driver does the same things with the theory, the results should be consistent with it. Otherwise, the absurd results affected both the trainer and the driver" [2].

After the data analysis, the researcher sent an e-mail to the trainer. She repeated what the trainer said during the interview which was conducted at the training and whether his mind was changed in time about the behavioral validity of the simulator. The trainer stated that he continued to say same things about the behavioral validity of the simulator. On the other hand, he said that the inconsistent results might be stemmed from the time length while the drivers were climbing uphill. He stated that,

> Trainer: "The simulator should calculate the gearshift change number reasonably. However, sometimes, it could give different result than I expected. Maybe, the reason stemmed from difference in the time length that the drivers passed while climbing the uphill" [3].

The trainer emphasized that climbing the uphill in a short time is also one of the parameter that affected the fuel consumption amount. However, maybe this affect portion was bigger than he expected. When the developers ideas was asked about the issue, he restated that there could be same bugs in the simulator and this could enable simulator give exact results accordance with the fuel consumption theory. However, according to him, if the simulator calculated a few results unreasonably, it was acceptable.

Summary of the Results of the Data (relationships of the parameters, the experts' opinions taken during the training and during interpretation of the results) Concerning Behavioral Validity of the Simulator

The results of the multiple regression analysis showed that the parameters explained the fuel consumption amounts in 36 percent. During the interpretation of the analysis the researcher took expert trainer's opinions and training simulator developer's opinions. According to them, although the parameters explained fuel consumption amounts accordance with the fuel consumption theory, there were many factors that affected the fuel consumption amounts and both the simulator and real trucks cannot provide them to the researchers. The only way to understand whether the simulator gave consistent results with the fuel consumption theory was to take expert opinions.

The interview results with the expert trainer showed that the simulator did not provide exact results as ones in the fuel consumption theory. Moreover, according to the results some factors, for example driving on the uphill, affected fuel consumption amount more than ones explained by the fuel consumption theory. On the other hand, the simulator provided decrease in the fuel consumption amount if the drivers had driven the simulator according to the theory. Also, expert stated that the similarity of the results consistent with the theory was 30%

When all the results taken into account, it can be said that the TS simulator did not give exact result consistent with ones explained by the theory. However, it provided decrease in the fuel consumption if the drivers drove it according to the theory. Although it was not sufficient in terms of behavioral validity, it did not affect the overall validity of the simulator. Since the design of the simulator was to provide practice for the drivers and enable them to see decrease in fuel consumption amount when they rove according to the theory.

These results provided precious information about instructional simulator validation processes. According to the results, the important thing in the validation process of an instructional simulator was not its similarity to real model. The important thing was that similarity of simulator was sufficient to accomplish instructional aims. For that reason, in the model developed in the current study, the center of the validation process was not behavioral validation but how much behavioral validation was necessary to accomplish instructional goals. These results referred to some underlying principles related to the simulator validation model. First one was “defining the aim(s) of training and role(s) of the simulator in training” since the validity determination could be done according to the instructional goals and the contribution of the simulator to the training according to the results. Second one was “defining the fidelity degree of the simulator” since the necessary degree of fidelity should be determined according to the instructional goals according to the results.

4.1.2. Face Validity of TS (Research Question 1.2)

Aforementioned before Face validity refers to users’ opinion about the reality of the simulator (Feinstein and Cannon, 2001; Blana, 1996a, 1996b). However, Borenstein (1998) states both the designers’ and users’ opinions should be taken into account to determine face validity of the simulator. Since the instructional simulators design aim is different than research simulator or assessment simulator, the users’ and the trainers’ opinions on not only the reality of the simulator but also if it do instructionally what is supposed to do should be taken. In this study, the drivers’ and trainer’s perceptions about the simulator were taken in three main scopes, namely, reality, usability and contribution to instruction. To collect data on drivers’ perception about the simulator, a survey was conducted and 37 of the drivers were interviewed after they had completed their second simulator driving. Moreover, field notes were taken in order to define usability problems that the drivers met while they were driving the simulator in the first driving.

This part explained under two main titles: 1) The drivers' perception about the TS in terms of reality, usability and instructional benefit. 2) The trainer's perception about the TS in terms of reality, usability and instructional benefit. The researcher merged the survey, interview and the field notes results in order to investigate the drivers' and the trainers' perception as well as the usability problems that the drivers met during driving the simulator.

4.1.2.1. Drivers' Perception on the TS

In order to get drivers' perceptions about the TS as a way of drill and practice tool for fuel consumption theory, survey and face to face interviews were applied. The aim was to get idea about what extend the TS accomplishes its design purpose according to drivers. Moreover, the researcher wanted to investigate about the usability issues of the TS thorough interviews and observation. The interviews conducted after the second driving of the drivers and field notes were taken while the drivers were driving the TS. The descriptive statistic was applied to analyze the survey data. To analyze data gathered through interviews, firstly the interview records were transcribed, and then transcribed documents were analyzed by applying open coding method. Also, content analysis method was used to analyze data gathered through observation. All the data were analyzed separately but they were jointly merged while interpreting the results.

Drivers' Perceptions Regarding the Reality of Driving Experience on the TS

The first survey was posed to find out drivers' perception about the reality of driving experience on TS and there was a statement as "While I was driving the simulator, I felt myself as if I was driving a real truck". The more than half of the drivers (n= 64) response to this question that they felt themselves to drive a real truck while driving the TS. However, an important number of the drivers (n=22) answer that they were undecided whether the driving experience on the TS is similar to one they felt on real truck. Moreover, 24 drivers answered that they were not felt themselves driving a real truck.

In addition to survey, the researcher asked the same question to the drivers during the interviews in order to get in depth understanding about their thoughts about the reality of the driving experience. The codes emerging about this question was "reality of driving experiences", "differences" and "similarities". 20 out of 37 drivers start their comments by stating that they think the driving experience on simulator was similar to one on a real truck. According to them, the similarities were "use method of the simulator", "appearance of the simulator parts", "traffic flow" and “simulation environment”. On the other hand, they state that the differences were “performance of the simulator parts”, “not feeling the simulator load” and “screens’ being 3 parts”. One interviewee who had positively responded to the question commented that,

> S7: It is same. The use method is same. There is some, something that are not same. Some, for example, while using the steering wheel, you cannot control the mirrors. Its having three screen makes people confused but people can get used to it in time [4].

Another interviewee emphasized similarities as simulation environment and traffic signs while he mentioned differences as “not feeling the load while driving simulator” and “simulator parts’ performances”,

> S12: Of course, the portion of the simulator reality to a real truck is high. In a real truck the loading is felt as we carry it and the drivers drive the truck according to the loading. The situation is different here. However, it gives the similar driving experience as one in real life; it is not just a computer game. Of course, you can look at environment; even the traffic signs are same to ones in real life. The steering wheel is more sensitive than one in real truck. If it is fixed, the simulator really, will be wonderful. Also, brake and clutch performances are different. There is a time interval between drivers’ stepping on and their Reaction. For example, when I step on the brake, it does not give reaction immediately. It should give reaction, should not it? [5]

On the other hand 12 drivers state that they did not feel themselves as driving a real truck while driving the simulator. However, it was interesting that the similarities and differences they mentioned during the interviews were nearly same things with the drivers who point out that they think the driving experience on the simulator was similar to one on a real truck. According to them, the TS is similar to a real truck in terms of “use method of the simulator” and “appearance of the simulator parts and it is different than a real truck in terms of “performance of the simulator parts”, “not feeling the simulator load” and “screens’ being 3 parts and showing the objects more close than real life”, “road’s coming towards to driver”, “stability of the simulator parts (for example drivers cannot adjust the seat or mirrors according to them)”, “having manual transmission” and “gearshift’s being more far away from the driver seat. One interviewee who criticized the simulator because it did not give sense as driving a real truck stated that,

> S29: About 40%. Now, while driving, there is no vibration that shows you are going. Another thing, another, there is no jump while going on road. In other words, vibration sense. I did not feel anything [6].

The other participant who was criticized the simulator since he did not feel as driving a real truck said that,

> S11: All the issue, ııı. We have difficulty in using the steering wheel. It is not similar to ones in real trucks. If we would drive our trucks like this the trucks were turned around and crashed. There is a problem in steering wheel….I felt that the road is coming toward me. Yes, it is similar to real truck in % 70-% 80 portions in terms of using method but it does not give as one in real truck anytime [7].

Also, 5 people who were interviewed stated that the simulator partly gives feeling of real life driving experience. Like drivers who commented positively and negatively, they also said same things about the similarities and differences that made them feel partly driving a real truck while driving the TS. They stated that the TS was similar to real truck in terms of "appearance (gearshift, clutch, steering wheel, and signals), "rules", "driving method" and "simulator environment". On the other hand, the TS differs from a real truck in terms of "screen", "driver's seat", "simulator sound" and "its' having an artificial environment". One participant with an undecided answer states that,

> S36: 50%.... I answered the survey as undecided as well, anyway the situation is middle. Anyway.….Actually, because it is a computer and because it gives such psychology that you are not n real road. It can be this degree, this degree. Now, we experience many things on roads and for that reason it is degree of reality like that. Of course, the gearshift, clutch, steering wheel, signals are similar to ones of real truck. The vehicles which passed us also give feeling as they are real. It is also normal but it is an artificial environment and I drive the simulator with this psychology [8].

To sum, according to the interview results, it was necessary to say that firstly the drivers who answered undecided part in the survey meant that driving on the simulator is partly similar to ones on real truck. Secondly, all the drivers interviewed pointed out the same things about the reality of driving experience, they only had different interpretation about whether driving experience on simulator could be labeled as similar, partly similar or not similar to ones on real truck. In other words, the drivers who stated that the driving experience on the simulator was similar to one on real truck mentioned also differences between the simulator and real truck. However, according to them, the similarities of the simulator were enough to label it as similar. The drivers who stated that the driving experience on the simulator was different than one on real truck mentioned also its similarities to a real truck. However, according to them, it was not enough to label it similar. Moreover, the drivers who labeled the simulator driving experience as partly similar to real truck emphasized both similarities and differences.

The second survey question sought to whether the road that the drivers navigated provided them to feel as they were driving on a real road and 75 drivers answer this question that the road made them feel they were navigating a real road while 16 of them response vice versa. Moreover, 19 of the drivers stated they were undecided.

Moreover, the interview results showed although it was not specially asked them question about the road of the simulator, that most of the drivers (n=22) mentioned "road" concepts under first question related "the driving experience", third questions related to "similarities of the simulator to real truck in terms of appearance" and tenth question related "satisfaction". 18 out of the 22 drivers stated that road is similar to real one. On the other hand, only 4 of them stated that they did not feel themselves as driving a real road. The drivers who gave negative response emphasized two differences: 1) the simulator road was coming toward the driver. In real life, the drivers drive the truck toward road. 2) they did not fell the vehicle vibration that they always feel on real road because of the holes, small stones etc on road. The following quotas was from two drivers who stated that the road was one of the factor that enhance reality of driving experience on the simulator,

> S9: In terms of appearance, the traffic signs etc. As well as passing the other vehicles, cabin, roads etc. are similar. Anyway, it is nearly similar [9].

One of the participants who responded that the road did not give a feeling of real road stated that,

> S18: Now, here, there is a deception factor compare to real life. That is, buildings, roads. For example, while we are on real truck, it seems that we are going but here, it is coming toward us and for that reason there is a mistaken you want or not [10].

Shortly, most of the drivers (n=22) emphasized the road as a factor that affects the perception of reality of driving experience although there were no specially targeted interview question about the road reality. According to them, road of the simulator gave a feeling of real road and as well as it positively affected the perception of reality of driving experience.

The third statement was "The other vehicles in the simulator environment that I met while I was driving the simulator made me feel as if I met real vehicles" and majority of the drivers (n=87) answers that they were agree with the statement. However, 16 of them response this statement that the vehicle which passed them on the simulator environment did not provide them as a real vehicle passed them. A small number of drivers (n=7) response to this question that they were undecided. Moreover, the researcher asked the participant whether they could feel the other vehicles while they driving the simulator. The codes emerged from the transcript analysis of the drivers were “feeling of other vehicles”, “by seeing”, “lack of communication other vehicle drivers”, “artificiality” and “not being able to pay attention to other vehicles”. The interview results showed that majority of the drivers (n=28) stated that they could feel the vehicles which passed them while driving on the simulator. The drivers who positively commented on the question pointed out that they could clearly see the other vehicles from the mirrors and screen. Also, some of them stated that they were so much felt these vehicles as real ones that they tried to avoid crashes and for that reason, they drove the simulator carefully. The following quotation was belong to one of the participants who gave the question positively,

> S33: Of course, of course, I felt. I felt. How did I feel? I felt the same fear on the simulator, anyway. The vehicles came according to me, I thought they hit. Or they passed me, I concerned whether they would hit. I looked at the mirrors when I decided to overtake. I felt the same things as ones on real truck [11].

4 out of 37 drivers stated that they felt the other vehicles passing them or coming according to them while driving the simulator. However, they also emphasized that this feeling not as one while driving a real truck. One of the driver pointed out that they could not communicate with other vehicle drivers while driving the simulator, for that reason the feeling of other vehicles was not as same as real life,

> S3: I felt but it was not as same as one in real life. When you look at the headlamp you salute other vehicle drivers via selector. You can look at the people and communicate with them. But the simulator cannot present an environment which is alive like that [12].

The number of the drivers who negatively responded to this question was 4. 3 of out of 4 drivers stated that they could not feeling the other vehicles that they met simulation environment because they could not looked at the mirrors in order to not cause a traffic accident. During the interview session, these drivers also complained from the screen and steering wheel. Also, they stated that because of these parts they had to look at the screen and could not look at the mirrors since they lost the control of the simulator. On the other hand, 1 driver stated that he could not felt the other vehicles on the simulator environment because he knew that it was artificial. Also, maybe for that reason, he could not felt anything as real psychologically. The following statement was a negative response example stated by the one of the drivers,

> S1: I could not feel other vehicles. The reason was I just focused on the one screen. In real life, you are in a cabin and you are driving, you can look at the mirrors, you can look at the vehicles coming across road and you can step on the brake if you think that you hit any of them. However, here you cannot look at mirrors or anything; you have to just look at the screen in order to keep the simulator on road lane [13].

Moreover, it was honestly should be pointed out that the researcher forgot to ask the question about reality of the other vehicles to the 24th driver she was interviewed with. For that reason, the researcher investigated whole transcripts of this driver. According to the interview transcript, this driver answered the first question that he partly felt himself driving the simulator as driving a real truck. He complained from the steering wheel and screen during the interview session. Moreover, the driver stated that the side mirrors of the simulator were very small. From this driver's whole interview transcript, it may be said that he possibly would have responded this question as "I felt other vehicles but not as same as in real life" or "I could not feel the other vehicles in simulation environment" if the question had been asked to him.

To recap, majority of the drivers (n=28) stated that they could feel the other vehicles on the simulation environment. They also stated that they used mirrors as they do in real life to realize the vehicles coming back. On the other hand, the drivers who response negatively to the question stated that they could not look at the mirrors because of the steering wheel and screen.

The fourth question aimed to get drivers' perception on what extend the mirrors of the TS give impression that they were the mirrors of real truck. Most of the drivers (n=90) agreed that the mirrors of the TS provide drivers impression that they were real ones. Only a few drivers (n=7) answers this question that they were undecided and 13 of them response they were not agree with the statement.

The interview question which was asked to learn drivers' perception about the field of the view of the simulator was also related to the reality of the mirrors and the screen. Moreover, it was realized that the drivers mentioned the reality of the mirrors while answering the first question related "the driving experience", third questions related to "similarities of the simulator to real truck in terms of appearance" and tenth question related to "usability of the simulator". Despite no specific question about the mirrors, 17 of the drivers mentioned the reality of mirrors during the interviews. The interview results also support the survey results in that majority of the drivers (n=14) mentioned that the mirrors were same as ones in a real truck. On the other hand, 2 out of the 3 drivers who state that the mirrors are not same as ones in real truck stated that the mirrors are too small and far away from the drivers' field of view compared to real ones. Also, 1 driver emphasized that the road lane and other vehicles coming from back were seemed closer from the mirrors although they were not. For that reason, the driver became panic because he thought that he would have made traffic accident. On the other hand, 25 drivers mentioned the reality of the screen of the simulator and all of them pointed out that the screen of the simulator were different than one of a real truck. One of the comments made by the drivers who stated that the screen of the simulator should be redesigned were as following,

> S4: ...when there were two screens. I say like that: We drive the truck on road, when you accept this as the windscreen of the truck, the lines of the wipers is like that. We drive the truck according to this line. There was only one wiper on the simulator screen (Figure 4.1). In that situation it was impossible to fit the simulator on road. If there had been one screen like that (Figure 4.2) and it had had two wipers, it would have been easier and more entertaining. However, it has two screens, drivers have to look at two screens while driving and it is tiring [14].

Figure 4.1 Screens of Truck Simulator:

As seen from Figure 4.1 The windscreen of the simulator was separated on three screens but the wipers of the simulator were on two screens. One of the wipers was on the middle screen while the other one was on the right screen. According to the drivers, they could not determine the simulator situation according to the wipers and for that reason they had difficulty in fitting the simulator on road. Moreover, the drivers who stated that they had headache, eye fatigue and stomach ache while driving the simulator showed the reason of these simulator sicknesses was screen.

Figure 4.2 The LCD Videos of the Middle Screen of Truck Simulator

While one driver is driving the simulator, other drivers could watch the videos of driving session synchronously from the LCD television (Figure 4.2). Most of the drivers showed this LCD TV as an example and stated that if the simulator had one screen like the LCD TV, they would not have had difficulty in fitting the simulator on road lane.

Although most of the drivers shared the same ideas about the reality of the mirrors and screen of the simulator, they made different comments on its field of the view. 14 out of 37 drivers stated that they found the field of view of the simulator very good while 18 of them negatively responded this question. It was interesting that the drivers who responded positively to this question emphasized the reality of mirrors while drivers who responded negatively to this question emphasized the problems related to screens. Moreover, 5 of them started their comments by saying that the field of the view of the simulator was similar to real ones. However, during the interview they emphasized the differences between the simulator and real truck. According to them, although field of the view of the simulator was similar to ones of real truck, it was not same and there are some differences. The codes emerged related to this question were "reality of the field of view", "similarities", "differences", "reasons of differences" and "problems stemmed from differences". The drivers stated that the differences were "artificiality of the simulation environment" and "being narrow". Moreover, they continued their comments by emphasizing that the reason of the field of view's seeming narrow was the simulator's having 3 screens. They pointed out that they had difficulty in fitting the simulator on the road lane.

Shortly, the results showed that most of the drivers found the simulator mirrors similar to ones in real truck. On the other hand, most of them stated that the screen of the simulator was different than ones in real truck. Although the drivers seemed to have common opinions for mirrors and screens of the simulator, they made conflicting comments about the field of view of the simulator. While nearly half of them stated that they found field of view different than ones in real life, other half of them stated the field of view similar to ones in real life.

The fifth question was posed to find out whether the drivers felt themselves as that they were giving signals on a real truck while they were doing it on the TS. 88 of the drivers response that they were agreed with the statement "While I was giving signal on the simulator, I felt myself as if I was giving signal in a real truck.". On the other hand, few drivers (n=5) answer this that they were not agree and 17 of them state they were undecided.

There are no specific interview questions that mainly targeted whether the signals give feeling of reality. However, in the third interview question, the researcher asked what the drivers think about the reality of the signals of the simulator. All the drivers stated that they found the signals of the simulator similar to ones of real truck. Also, any of the drivers stated any negative comments about the use of the simulator signals while answering the fourth question about the usability problems that they met while driving the simulator. The results of these two interview questions indicated that all the drivers who were interviewed had positive thoughts about the signal parts of the simulator. However, by answering the reality of the driving experience of the simulator some drivers stated that they communicated with the other vehicle drivers in real life via signals. On the other hand, while driving the simulator they could not do that.

Shortly, most of the drivers found signals of the simulator were similar to ones in real truck. On the other hand, a few of them stated that they could not use the signals to communicate with other vehicles drivers and it affected their feeling as if driving a real truck while driving the simulator.

Summary of the Results of the Survey and Interview Data regarding the Reality of Driving Experience on the TS

To learn the drivers' opinions about the reality of the driving experience on the simulator, the statements which contained whether they felt themselves as if they were driving a real truck on the simulator in terms of "reality of the driving experience", "reality of the road", "reality of the other vehicles", "reality of the mirrors" and "reality of the signal" were placed.

The survey results showed that most of the drivers thought that "road", "mirrors", "other vehicles" and "signal" of the simulator made them feel themselves as if they were driving a real truck. Moreover, the interview results supported the survey results in that most of the drivers mentioned positively on the reality of "road", "mirrors", "other vehicles" and "signal" of the simulator. On the other hand, a few drivers answered the survey on these parts of the simulator. Similarly, during the interview a few drivers complained the “road”, “mirrors”, “other vehicles” and “signal” reality of the simulator. According to the drivers who negatively mentioned from “road”, the road did not provide a real road feeling because it did not have “holes”, “rocks” and so on. Moreover, they stated that the road was coming towards to the drivers on simulation environment but real life the drivers were driving towards to the road. According to the drivers, who stated that while using the “mirrors” of the simulator they could not feel themselves as if they were driving a real truck, the reason of it was stability of the mirrors. They pointed out that they could adjust the mirrors in a real truck and can easily see the other vehicles from it but in the simulator it was impossible because the mirrors were too far away to drivers and could not be adjusted. Again, a few drivers commented negatively to the question about the reality of the other vehicles. According to the artificiality of the other vehicles and not communicating with other vehicle drivers prevented them to feel as if they were driving a real truck. Actually, there were no drivers that complained from the signals but only a few of them stated that they could not communicate with other vehicle drivers by using signals and they prevented them to feel as if they were driving a real truck.

According to the survey results, although most of the drivers found “driving experience” similar to real ones, an important number of the drivers answered it as undecided or disagree. The interview results also supported the survey results in that most of the drivers mentioned similarity of driving experience to ones on real truck. On the other hand, like survey results, an important number of the drivers stated they think the driving experience partly similar or not similar to real ones. There were two interesting results of the interview question on reality of driving experience. One of them was that all the drivers made the same comments on the reality of driving experience while they labeled it differently as similar, not similar or partly similar. Second one was that there were no undecided answers but partly similar answers to this question. For that reason it may be said that the undecided answers of survey referred to partly similar. According to the drivers, “use method of the simulator”, “appearance of the simulator parts”, “traffic flow” and “simulation environment” made driving experience more similar to real ones. On the other hand, “performance of the simulator parts”, “not feeling the simulator load” and “screens’ being 3 parts and showing the objects more close than real life”, “road’s coming towards to driver”, “stability of the simulator parts”, “having manual transmission” and “gearshift’s being more far away from the driver seat” distracted them while they were driving the simulator.

The screen of the simulator was the most negatively mentioned parts of the simulator by drivers. Most drivers stated that since the simulator screen had three parts and the wipers were placed both on middle and left screen, they had difficulty concentrated on driving. Moreover, most of the drivers pointed out that they had difficulty in fitting the simulator on the road lane due to the screen. A few drivers who suffered from the simulator sickness stated that the screen's artificiality and having three parts were the reasons.

The results of the interview question about the similarity of the field of view of the simulator showed that while half of the drives commented on it negatively, half of them commented on it positively. Also, according to the results, the drivers who think that the field of view of the simulator was different than ones of real truck emphasized the difference of the screen on the simulator. On the other hand, the drivers who pointed that the field of view was similar to ones of real truck emphasized the reality of the mirrors and their seeing the other vehicles from the mirrors easily.

To sum, the survey and interview results showed that the most of the drivers found "driving experience", "road", "mirrors", "other vehicles" and "signals" similar to real ones. On the other hand, most of them mentioned from the screen reality negatively. The drivers' comments on the field of view was conflicting because about half of them stated that it was not similar to real ones, others stated it was similar to real ones. Table 4.5 shows the survey statement concerning the reality of "driving experience", "road", "mirrors", other vehicles" and signals" with the number of drivers who answered them as "strongly agree", "agree", "undecided", "strongly disagree" and "disagree".

Table 4.5 Survey results with frequencies regarding the reality of driving experience

	Reality of Driving Experience	SA	A	U	D	SD
1.	While I was driving the simulator, I felt myself as if I was driving a real truck	25	39	22	17	7
2.	The road in the simulator environment made me feel as if I was driving on a real road.	23	52	19	14	2
3.	The other vehicles in the simulator environment that I met while I was driving the simulator made me feel as if I met real vehicles.	24	63	7	15	1
4.	The mirrors on the simulator made me feel as if I was using a real truck mirrors.	35	55	7	12	1
5.	While I was giving signal on the simulator, I felt myself as if I was giving signal in a real truck.	28	60	17	5	0

Drivers' Perceptions on Reality of the Simulator and Simulation Environment Appearance

The first question was asked to get drivers' perception whether they think the parts (gearshift, brake, rpm indicator, speed indicator, steering wheel, lambs, signals etc) of the TS were the similar to ones of real truck. Most of the drivers' (n=90) responses this statement that they were agree with the similarity of the parts of simulator to ones of real truck in terms of appearance. On the other hand a few drivers (n=10) answers that they were undecided and again a few of them (n=10) answers that they were not agreed with the statement.

Moreover, the researcher posed an interview question to learn drivers' perception about the reality of simulator parts in terms of appearance. All the drivers (n=37) stated that they found the appearances of the simulator parts (gearshift, brake, rpm indicator, speed indicator, steering wheel, lambs, signals etc) similar to ones of a real truck. In addition to the simulator parts, drivers also pointed out that "road, simulator' having loadings, motor sound and traffic signs" were similar to real model during the interviews. However, 5 of them also pointed out that although the parts of the simulator similar to ones of a real truck in terms of appearance, there were small differences between them. These differences were "size of the rpm indicator (small), size of steering wheel (to big), place of the rmp indicator (more down) and place of the gearshift (more right)". Also, 1 out of 5 drivers criticized the TS in terms of that the driver's seat, steering wheel and mirrors were not adjustable. Similarly, other one driver stated that although the TS were similar to a real truck in terms of appearance, it did not represent the truck they drive in real life, since their truck was with automatic transmission not manual one like the TS. The following two quotations were belong to two participants, who explained their opinions about the reality of simulator parts appearance,

> S16: Gas pedal and clutch are similar. Also, gearshift is similar. In other words they are similar to real ones. Road situation, the simulator's having loadings, the simulator is with tonnage. It has 20-22 tonnage. Similar, in other words, it is similar to real [15].

To sum, survey and interview results showed that the drivers found simulator similar to real trucks in terms of appearance. On the other hand, only a few of them stated that gearshift place, rpm size and place in addition to steering wheel size were not similar to ones in real trucks.

The second statement was "The engine sound of the simulator was similar to one of real truck" and examined what the drivers think about the reality of engine sound. According to the survey results 76 of them agreed with the statement while 18 drivers were not agreed with it. Moreover, 16 out of 110 drivers answer this statement that they were undecided.

Although there was no specifically targeted interview question on the reality motor sound of the simulator, only 5 out of 37 drivers criticized the motor sound of the simulator. According to them, the motor sound of the simulator was stable and did not change according to the drivers' movements such as stepping on the gas pedal. One of the drivers positively mentioned the motor sound,

> S2: It was same as a real truck, there was no difference. Brake and motor sound was same. The road, mirrors was same. The images on the screen were same. There was gearshift; I felt same, same things as I did on real road [16].

The following statement belongs to one of the drivers, who criticized the sound of the simulator,

> S30: The motor sound of the simulator was different, deceiving people. It was electronic and more, how can I say, deceiving the people. We can hear the sound of our own trucks more. Maybe the reason was that it was the first time we used the simulator [17].

Shortly, according to the survey and interview results, the drivers commented on the reality of the engine sound of the simulator positively. The interview results showed that the drivers were surprised because the simulator had a sound and liked this property. On the other hand, a few drivers stated that due to the stability of the sound, it was not similar to one of real truck.

The third statement sought to get the drivers' perception about the reality of the traffic signs in the in simulation environment and the statement was "The traffic signs that were in the simulation environment were the same with ones in real life environment". Majority of the drivers (n=98) responses this statement they were agreed with this statement. On the other hand, a few drivers (n=3) answers that they were undecided and again a few of them (n=9) had a negative response for this statement.

During the interview, only 1 out of the drivers complained from the traffic sign about the speed limitation for the downtown road. According to this driver, the downtown speed limit was not 40 in the Europe countries and for that reason, it was wrong. Except this driver, any driver made negative comments on the reality of the traffic signs. On the contrary, while answering the question about the reality of the driving experience, the drivers stated that the traffic signs represented the real models.

To recap, the drivers commented on positively on the traffic sign on the simulation environment according to both the survey and interview results. Only one driver stated that the traffic sign of downtown speed was wrong and it should be 50 instead of 40.

The fourth question was posed to find out what the drivers think about the reality of "buildings, vehicles, people etc." on the simulator. Most of the drivers (n=89) responded positively to this statement while a few drivers (n=13) answered negatively to it. 8 out of 110 drivers, on the other hand, stated that they were undecided about the reality of the "buildings, vehicles, people etc." on the simulator.

The researcher did not ask a question about the reality of simulator environment including buildings, vehicles, people etc., however, the interview question which was posed to learn whether the driver felt other automobiles passing them also related to one part of this question. As aforementioned, 28 out of 37 stated that they felt the automobiles on the simulator environment. On the other hand, 11 out of 37 drivers complained from the artificiality of the simulation environment. According to them these artificiality distracted them while driving the simulator. Also, according to the drivers who suffered from the simulator sickness, the reason was artificiality of the environment. Moreover, only 1 driver mentioned negatively about the simulator environment and stated that it looked like a movie. The other drivers pointed out that they found the simulation environment realistic. One of drivers made positive comments,

> S19: The thing that I liked is what it can be that. The image of the computer was very nice. The environment, vehicles were similar to real ones, also people were similar. Thanks for the simulator [18].

Briefly, the survey results showed that most of the drivers found the simulation environment similar to real road environment. The interview results also supported the survey results in that most of the drivers mentioned the positive effect of the reality of the simulation environment on making their driving experience more realistic. Moreover, most of the drivers stated that they thought the other vehicles on the simulation environment were similar to real models. On the other hands, 11 drivers mentioned the artificiality of the simulation environment as a distracting factor.

Summary of the Results of the Survey and Interview Data regarding the reality of Truck Simulator and Simulation Environment Appearance

The reality of the simulator parts and simulation environment appearance were investigated through the questions on “similarity of the simulator parts”, “ similarity of the motor sound”, “similarity of the traffic signs” and “similarity of the buildings, vehicles, people and so on” compare to real models. The survey and interview results showed that the drivers found simulator parts and motor sound similar to real ones. Moreover, most of them stated that traffic signs and buildings, vehicles, people on the simulation environments was not different than real models. On the other hands a few drivers complained the place of the gearshift, size of the steering wheel, size of the rpm indicator and stability of the motor sound. Again a few drivers criticized the simulator environment because it was artificial. Table 4.6 presents the survey statement concerning the reality of simulator appearance and simulation environment with frequency of the answers.

Table 4.6 Survey results with frequencies regarding the reality of simulator parts and simulation environment appearance

Reality of the Simulator and Simulation Environment Appearance	SA	A	U	D	SD
6. The parts of the simulator such as "gearshift, brake, rpm indicator, speed indicator, steering wheel, lambs, signals and so on" were same with ones of a real truck.	25	65	10	10	-
7. The motor sound of the simulator was similar to ones of a real truck.	21	55	16	13	5
8. The traffic signs on the simulation environment were same with ones on real road environment.	45	53	3	8	1
9. The buildings, vehicles, people and so on the simulation environment were same ones on real environment.	26	63	8	10	3

Drivers' Perceptions on the Reality of the Simulator Parts Performance

The first question was posed to find out whether the gearshift of the simulator has the same degree of performance in terms of the gearshift changing with a real gearshift. Majority of the drivers (n= 81) response that they think the gearshift changing performance degree in the simulator is the same with a real gearshift. On the other hand, 16 of the drivers answer that they were undecided about this statement and 13 of them give negative response to it.

According to the interview results, 14 of the drivers stated they had problems related with the gearshift use but none of them pointed out the performance problem with the gearshift. According to 12 drivers, the reasons are "their not getting used to manual transmission" or "their not getting used to drive simulator" and 1 out of 12 drivers also stated that there is no splitter gear lamp on the screen and for that reason he could not understand the gearshift degree of the simulator. Moreover, 1 out of 14 drivers stated that the reason was his feeling very excited because of the test environment and other driver said that he had problems related with the gearshift because the place of the gearshift was far away to the drivers' seat. Although 3 drivers stated that the place of the gearshift was different than one in a real truck, only this driver stated it caused the problems related with gearshift use. As realized from the interviews, any of the drivers mentioned performance problems related with the gearshift. One of the drivers who positively mentioned from the gearshift performance stated,

> S33: In terms of technical, it is nearly same. But there are small differences because it is a machine...For example, gearshift is the same and comfortable, there is no difference [19].

The following statement belonged to a driver, who stated that the gearshift changes were not felt,

> S10: The gearshift is far away, it should be here, it is far. We have to reach ahead to grasp the gearshift, then I lose the control of the vehicle….About gearshift, in terms of feeling the gearshift change, there is a difference here, as you're pushing a stick without feeling [20].

Shortly, the survey and interview results showed that more of the drivers found the performance of the gearshift similar to ones of real truck. On the other hand, there were problems related gearshift uses according to the interview questions. These problems were not related with the performance difference of the gearshift than ones of real truck but drivers could not get used to it at the beginning of the simulator driving. Since the real trucks which the drivers drove had automatic transmission, the drivers stated that they had difficulty in using the driving simulator with manual transmission.

The second question was about the brake system performance accuracy and it was asked to get drivers' opinions about the performance accuracy of the brake system. 65 out of 110 drivers responses that the brake mechanism of the simulator has the same degree of accuracy with the one of a real truck while 26 of them response negatively to the statement. Moreover, 19 drivers answer that they were undecided to this statement.

The interview results supported the survey results in that 11 of the drivers stated that they found brake system inaccurate. All 11 drivers emphasized that reaction time length of the brake system was very long compare to one of a real brake system. The drivers complained that they did traffic accidents and errors due to late reaction of the brake system to driver's movement. One of the drivers stated that,

> S35: I had a traffic accident because the brake did not react on time. It was not my fault. But if it had been real life, I would have died. As I aforementioned, the brake is not sensitive. At the traffic lights, I stepped on the brake, but no brake, it was in the lap of the God. I stepped on it with my two feet; it did not stop [21].

To recap, the survey and interview results showed that most of the drivers found the brake system performance similar to ones of real truck. On the other hand, an important number of drivers complained the performance of the brake of the simulator. The some drivers stated that the reaction time was very long compare to brake of a real truck during the interviews.

The third question examined whether the steering wheel mechanism sensitivity of the simulator is the same to one of a real truck. Half of the drivers (n=56) answers that they were agreed with the statement. Moreover, 24 drivers response that they were undecided to this statement and 30 of them state they were not agreed with it.

The interview results were parallel to the survey results. 19 drivers stated that they experienced problems related to the steering wheel. They explained these problems by labeling them as “not handling”, “not controlling the simulator”, and “not fitting the simulator on road”. However, 4 out of 19 drivers emphasized that since they have not used a simulator before, they did not get used to drive it firstly and they met problems. On the other hand, 15 drivers stated that they found the steering wheel of the simulator more sensitive than one of a real truck. These drivers pointed out that they had difficulty in controlling the simulator and made traffic errors because the steering wheel was too sensitive to drivers’ reaction. One of the drivers who complained the sensitiveness of the steering wheel stated that,

> S14: As if there is a wheel gap in the steering wheel. There is a gap. I changed the way right to the left lane frequently. Really, such things did not happen real life [22].

To sum, while half of the drivers found steering wheel sensitivity similar to ones of a real trucks, other half of the drivers stated that they were undecided or disagree of the similarity of the steering wheel sensitiveness of the simulator to ones of a real truck according to the survey results. Parallel to survey results, half of the drivers who were interviewed stated that the simulator steering wheel was too sensitive.

The fourth question was about the similarity of gas pedal performance of the simulator to one of a real truck. 80 out of the 110 drivers’ responses were that they think the gas pedal performance of the TS was similar to ones of a real truck. On the other hand, 13 of them answers that they were undecided on this statement and according to 17 of them performance of the gas pedal in the TS different than one in a real truck.

The interview results showed that 10 out of 37 drivers stated that they had problems related with the gas pedal. These problems were “not arranging the gas”, “exceeding the speed limit” and “not driving the simulator economically” and according to them, since the gas pedal gave late reaction to drivers’ movement, they experienced these problems. One of the drivers who had problems due to the gas pedal stated that,

> S20: When you step on gas pedal in real truck, you can feel it immediately. But you do not feel this. Also, it gives late reaction to drivers’ movements. In other words, when you want. I think it happens because it is computer [23].

Briefly, the survey and interview results showed that most of the drivers found the performance of the gas pedal similar to one of a real truck. On the other hand, the drivers who commented on performance of the gas pedal negatively stated that they exceed the speed limits and could not driving simulator economically due to the late reaction of the gas pedal.

Summary of the Results of the Survey and Interview Data regarding the Reality of the Simulator Parts Performance

The performance similarity of the simulator was investigated thorough 4 statements, which included gearshift, brake, steering wheel and gas pedal, in the survey. Although no specific question was asked about the simulator performance during the interviews, the drivers mentioned the performance of the simulator parts frequently while answering interview questions about the usability of the simulator and reality of the traffic mistakes done while driving the simulator.

According to the survey and interview results, most of the drivers complained the steering wheel sensitivity. According to the interview results, because of the steering wheel sensitivity, the drivers had difficulty in fitting the simulator to the road lane. Moreover, the drivers stated that they made serious traffic errors such as controlling the simulator and hitting the pavement due to the sensitiveness of the steering wheel. On the other hand, the brake, gearshift and gas pedal of the performances mentioned by small number of the drivers.

Moreover, the drivers who had problems related with the gearshift stated that the reason was not performance difference of the gearshift but their not getting used to drive trucks with manual transmissions. A few drivers pointed out that while they were driving the simulator, sometimes the brake of the simulator was out of order and for that reason they had traffic accidents. Some drivers stated that the reaction time of the brake was long compare to one of a real truck.

A small number of the drivers complained the late reaction of the gas pedal of the simulator. These drivers emphasized that due to the late reaction of the gas pedal to drivers' actions, they had difficulty in driving simulator economically or arranging the speed of the simulator. Table 4.7 shows the survey statement concerning the simulator parts performance similarity with frequency of the answers.

Table 4.7 Survey results with frequencies regarding the simulator parts performance similarity

Reality of the Simulator Parts Performance	SA	A	U	D	SD
10. The gearshift of the simulator and one of a real truck were similar in terms of changing performance.	29	52	16	9	4
11. The brake mechanism of the simulator and ones o a real truck were similar in terms of reaction sensitivity.	16	49	19	22	4
12. The steering wheel of the simulator had a similar degree of sensitiveness to one of a real truck.	22	34	24	22	8
13. The gas pedal of the simulator and one of a real truck were similar in terms of sensitiveness degree.	18	62	13	14	3

Drivers' Perceptions on the Usability of the Simulator

First question was posed to find out whether it was easy to understand how to use the TS was easy for the drivers. Majority of the drivers (n=90) answer that understanding how to use the TS was easy for them. On the other hand, a few drivers (n=10) response negatively to this question and 10 of them response that they were undecided whether it was easy to understand how to use the TS.

Second question was "gearshift, brakes, speed indicator, speedometer, steering, lights and signals, etc." of the simulator parts are used in the same way in ones of a real truck. Most of the drivers (n=93) answer that they were agreed with the statement while a few of them (n=14) response negatively to it. Moreover only 3 of them answer that they were undecided.

The third question examined whether the drivers had difficulty in using the parts of the simulator such as "gears, brakes, speed indicator, speedometer, steering, lights and signals, etc." While 74 drivers answer that they did not have difficulty in using the simulator part, 30 of them response that they did. On the other hand only a few drivers (n=6) response that they were undecided about the statement.

First, second and third survey questions about the usability of the TS were asked in one interview question. Most of the drivers also mentioned similarity of the simulator parts in terms of appearance and use method. However, the interview and survey questions about the performance of the simulator parts showed that more than one of third portion of the drivers found the performance of the simulator different than their real models.

The interview question about the usability of the simulator also support the survey and the interview question results about the performance of the simulator parts in that 22 out of the 37 drivers mentioned that they had difficulty in using some simulator parts. The parts were steering wheel, gas pedal, gearshift, brake and screen. It should be noted that 4 out of 22 drivers stated that they had difficulty in using the gearshift because they could not get used to the simulator at first.

Moreover, 2 of the drivers pointed out that they had difficulty in using mirrors and screen. The reasons were because of their not getting used to artificial environment. Totally, it should be said that while 16 out of 37 drivers stated that they had difficulty in using the simulator parts, 15 of them stated that they did not have difficulty in using them. Other 6 drivers pointed out that although they had difficulty in using the simulator parts, it was not because of the simulator but because of their not getting used it at the beginning.

Moreover, according to the interview results, the mostly mentioned simulator part that the drivers had difficulty in using was steering wheel. 15 drivers stated that they had handling problem because the steering wheel of the simulator was too sensitive. The codes emerged during the analysis of the interview question were "not difficult", "having difficulty in using (steering wheel, gas pedal, gearshifts, mirrors and screens)" and "reasons (not getting used to manual transmission, not getting used to the simulator at the beginning, sensitiveness of steering wheel, stability of the mirrors and the simulator's having artificial environment". The following quotation belonged to one of the drivers, who stated that he did not have any difficulty in using the simulator,

> S37: I did not much problem related to using the simulator. At the beginning, I did not get used to it, I had little difficulty but it was not important to mention, I just say it because you specifically asked me [24].

The following quotations belonged to three different drivers, who pointed out that they had problems while driving the simulator,

> S28: You manage the simulator here, you have control but the degree of control is questionable. The steering wheel is not similar to real one; I have difficulty in using it [25].

Briefly, the survey and interview results shows that while the drivers thought the using the simulator was easy and use methods of the simulator parts was similar to ones of real truck parts, they had difficulty in using some simulator parts because the performance of these parts were different than ones in real truck. The mostly complained parts of the simulator were steering wheel.

The fourth question sought to whether the drivers do different mistakes while using the simulator than while using a real truck. 76 out of 110 drivers answer this statement that they did different mistakes while using the simulator. On the other hand, 24 of them response this statement that their mistakes on the simulator were not different than ones they did on a real truck. Moreover, a few of them (n=10) state that they were undecided on the issue.

The interview results also supported the survey results in that 31 out of 37 drivers stated that they did different traffic errors while driving the simulator than they did while driving a real truck. 1 out of 31 drivers said that he does more traffic errors on real truck because the working condition of the company wanted them to take the goods to the target point in a limited time. For that reason, he cannot obey the traffic rules in real life.

On the other hand, only 2 out of 37 drivers pointed out that they did same traffic errors, exceeding the speed limit, while driving the simulator and 1 drivers stated that his traffic errors nearly same with ones in real life. Moreover 2 drivers stated that they had difficulty in changing gearshift at the beginning but they did not experience this problem along the simulator driving. On the other hand, 1 driver pointed out they he did not do any traffic errors.

The codes emerged from this interview question were "closeness of driving errors done on simulator (same driving errors, different driving errors and nearly same driving errors)", "type of driving errors (low rpm error, not stopping at the traffic lights, lane violation, not controlling the simulator, hitting the pathway, error on changing the gearshift, exceeding the speed limit, cut –stopping the simulator-, not running the simulator at the beginning, high rpm, not fitting the simulator to the road lane, going off the road and so much closing to the pathway or traffic lights" and "reasons of traffic errors (feeling excited because of test environment, having not driven a simulator before, not getting used to drive truck with manuel transmission, steering wheel, late reaction of gas pedal, brake's not working, screen's being 3 parts, images' seeming more close from the mirrors, not understanding necessary gas level to run the vehicle at the beginning, artificiality of the environment, knowing that the traffic errors do not result in dead or damage".

It was important to state that most of the drivers complained the steering wheel and said that because the steering wheel was too sensitive, they did many traffic errors such as lane violation, not controlling the simulator, hitting the pathway, not fitting the simulator to the road lane and going off the road. Moreover, an important number of the driver stated that they have not used a simulator before and they could not get used to it at the beginning. Because of this reason, they did some traffic errors such as not running the simulator at the beginning or cut –stopping the simulator-. Also, according to all the drivers who pointed out that they did traffic errors related to the gearshift change, the reason was their not get used to drive truck with manual transmission. Some of the drivers stated that they did traffic errors such as so much closing to the pathway or traffic lights or not fitting the simulator to the road lane because the simulator had 3 parts and middle screen shows only a half of the road. Some drivers said that because the gas pedal gave late reaction to their movements, they exceeded the speed limitation and got high or low rpm warning from the simulator. Only 1 of the driver claimed that the traffic rule about the speed limitation was different than one in real life and for that reason, he exceeded the speed limitation. Only 1 out of 37 drivers stated that he did not pay attention to traffic errors because he knew that the errors on the simulator did not result in a dead or damage with the words,

> S31: S17: You do not care the traffic errors here but in real life. You can correct the mistakes here but in real life you cannot correct the result of mistake. For that reason, you should be very careful there....But it does not necessary here. You say that be more careful here when the driver does a traffic accident, there is a chance to fix it. I lost the control on bends. There is no other problem; you drive on the simulator as if it is a real road [26].

One of the drivers who stated that he did different traffic errors than he did ones in real life mentioned the reasons,

> S31: Of course I did. I did mistakes related to steering wheel since I paid attention to steering wheel gap and I could not focus other things. For example, I disturbed the other vehicles on the road, violated lane. I do not violate the lane in real life. I can control vehicle, I do not do such mistakes. There is a wheel gap. Only it is. Except the wheel gap, everything was ok. I lost the control sometimes because of it [27].

To sum, according to the survey and interview results, most of the drivers made much more mistakes than they did in real life. Moreover, they stated that they did not such mistakes in real life. The interview results showed that they mostly lost the control of the simulator and had difficulty in fitting it road lane. According to the interview results, the reason was the sensitiveness of the simulator.

Summary of the Results of the Survey and Interview Data regarding the Usability of the Simulator Parts Performance

The survey and interview results showed that most drivers found use methods of the simulator similar to ones of real truck. Moreover, according to them the use of the simulator was easy but they had difficulty in using some parts. These parts were steering wheel, screen, gearshift, brake and gas pedal. The mostly complained part was steering wheel. The interview results indicated that the drivers had difficulty in controlling the simulator due to sensitiveness of steering wheel.

Moreover, according to the survey results most of the drivers stated that they made different traffic mistakes while driving simulator than they did while driving a real truck. The interview results were parallel to interview results in that most drivers said that they did not make the mistakes that they did while driving the simulator on real truck. The mistakes they made while driving the simulator were "low rpm error, not stopping at the traffic lights, lane violation, not controlling the simulator, hitting the pathway, error on changing the gearshift, exceeding the speed limit, cut –stopping the simulator-, not running the simulator at the beginning, high rpm, not fitting the simulator to the road lane, going off the road and so much closing to the pathway or traffic lights".

Moreover, according to them, the simulator parts were reasons of the differences in performances. They stated that the steering wheel, gas pedal and brake system were really problematic while they said that the gearshift was not. They emphasized that they had experience the problems about the gearshift because they could not get used to it. The survey statement concerning the usability of the simulator with frequency of the answers is shown on Table 4.8.

Table 4.8 Survey results with frequencies regarding the simulator usability

Usability of the Simulator	SA	A	U	D	SD
14. To understand how to use the simulator was easy for me.	29	61	10	10	-
15. The use method of the "gearshift, brake, rpm indicator, speed indicator, steering wheels, lambs and signals and etc." which are parts of simulator is similar to ones of the real models.	31	62	3	14	0
16. I had difficulty in using the "gearshift, brake, rpm indicator, speed indicator, steering wheels, lambs and signals and etc."	9	21	5	55	19
17. I did different traffic errors that I do not do in real life while driving the simulator.	29	47	10	18	6

Drivers' Perceptions on the Contribution of the Simulator to the Instruction

The first question examined that whether the drivers think that they drove the simulator economically. 78 out of 110 drivers responded this statement that they thought that they could drive the simulator economically. On the other hand, 18 of them answer that they were not agreed with the statement and 14 of them answer they were undecided.

The interview question about whether the drivers think they drove the simulator economically did not target specifically. The researcher's aim was to not limit the drivers and enable them to mention their opinion about first / second driving sessions, training and simulator contribution to the training. According to the trainer, the role of the simulator in the training was to provide drivers compare their fuel consumption amounts in first and second driving and realize that they can drive truck more economically if they use information given the training. For that reason, whether the drivers mentioned from the difference in fuel consumption amounts between their first and second driving session was focused during the interviews.

29 out of 37 drivers stated that they think that they could drive the simulator economically. The codes emerged from the interview question were “economic use of simulator (not economic and economic)”, “difference between first and second driving in terms of fuel consumption”, “similarity of fuel consumption amounts on the simulator to ones on real life”. 18 drivers stated that there is a difference between the first and second driving in terms of fuel consumption because they tried to use according to what the trainer said. For example 1 driver stated he drove the simulator faster on uphill as the trainer said and for that reason he drove it more economically. Other one stated that,

> S12: I used it more economically in the second driving session because I drive it according to the training. However, I do not drive economically in real life. In other words, in this company economy…what I mean…we do not care of economic driving. Our driving changes according to tonnage of the truck, how much time we had to take the goods at the target point. However, we have not express load, we think the economy [28].

The other drivers emphasized the fuel consumption amounts difference between first and second driving with the words:

> S22: I drove economically. Fuel consumption amount of first driving was 37 and ones of second driving were 31. There is a 6 point difference; of course it means % 18 or 19 difference. It means that when you take this training, if you apply it while driving a real truck, you will use it economically [29].

On the other hand 12 drivers stated that they cannot drive real truck economically because they had to drive real truck faster to take the goods to the point in time. For that reason, they pointed that they had to ignore traffic rules and economic driving. On the other hand other 3 out of 12 drivers stated that the driving conditions in real life were different (weather, tonnage of truck, road conditions and etc) and for that reason their fuel consumption amount was changing according to these conditions. Only 2 out of 12 drivers pointed out that although they believe that they drove the simulator economically, they drive real truck more economically than the simulator since gas pedal and screen deceives the drivers.

6 out of 37 drivers said that they could not used the simulator economically because of “ not getting used to driving simulator”, “driving habits”, “not feeling as driving a real truck” and “its being artificial”. 2 of the drivers stated that they do not drive economically also in real life because

they like to drive fast and similarly, they drove fast the simulator. On the other hand, 2 out of 6 drivers stated the screen and the artificial environment distract them and for that reason, they could not focus on driving economically. Similarly, 1 driver pointed out that he could not concentrate to drive economically because he could not feel driving as real truck and the other 1 driver said the same things by emphasizing that the reason was his not getting used to drive simulator. Also, 4 drivers stated that they cannot drive economically in real life as well while 2 of them stated that they drive real truck more economically than simulator. These 4 drivers pointed out that they have express loading generally and for that reason, they cannot drive truck economically. One of the drivers who stated that he cannot drive simulator and real truck economically said that,

> S8: The fuel consumption amounts that I had was more compare to ones that other drivers did. The result was 32, well, it was a lot. My real fuel consumption amounts are more than others. I drive at a full speed because I am express driver. Well, I drive the simulator similar to real truck in terms of economy. However, there would be a difference after the trainer offered the training definitely [30].

Moreover, 1 out of the 37 drivers pointed out that he nearly drive the simulator economically and the fuel consumption amounts that he has on real truck are lower than simulator. He stated that, he could not concentrate to drive simulator due to the computer environment. Similarly, other 1 driver stated that he was used the simulator moderately economic and he learnt how to drive economically from the training with the words,

> S32: Well…I do not say that yes I drove the simulator economically or I did not. I tried to drive it economically as I could. However, I can say that I do not drive real truck like that. In other words, I asked also, the trainer, for example I have not driven the real truck while the rpm is on yellow point. I do not know it. After the training, I learnt to drive truck while the rpm is on yellow point, in real life I have not driven like that [31].

To recap, the survey and interview results showed that the drivers' believed they could drove the simulator economically. Moreover, 18 of them compared the fuel consumption amounts they got from their first and second driving and stated that they provided decrease in fuel consumption amounts because they used strategies offered the theoretical part.

The second question was asked to learn about what the drivers think about the suitability of the simulator as a practice tool. Majority of the drivers (n=96) response that the truck simulator was a suitable practice tool what they learned in the training. Only a few drivers (n=10) answer that according to them the simulator was not a suitable practice tool and again a few drivers (n=4) point out that they were undecided on the statement.

The third question sought to find out whether the drivers think that the feedbacks provided for the drivers' mistakes were beneficial. Most of the drivers (n=103) response that they were agreed with the statement while only 1 driver response that he was not agreed with it. Also, only a few drivers (n=6) answer that they were undecided on the benefit of the feedback provided for their mistakes.

The fourth question was "Using the simulator may help person gain economic and safety driving habits". According to 100 out of 110 drivers, using the simulator may help person gain economic and safety driving habits. On the other hand, only 2 drivers responded negatively to this statement and again only a few of them answer that they were undecided.

The second, third and forth survey questions were followed up in one interview question which was "What do you think about the contribution of the simulator to the training about economic and safety driving". The all the drivers started to their comments by emphasizing contribution of training to their professional life, not the contribution of the simulator to the training. In other words they more focused on knowledge they gained rather than the tools they used. For that reason, the researcher had to repeat the interview question with the words "What do you think if this training had been offered without the TS, what degree of the contribution of the training would have changed? What was the role of the TS according to you"? Since the firstly all the drivers mentioned about the contribution of the training the codes emerged from this interview question were related to both "contribution of the training to the drivers' professional life" and "contribution of the TS to the training".

The codes related to "the contribution of the training" were "effective", "beneficial", "learning new things", "competing imperfect knowledge", "providing the decrease in fuel consumption amounts in real life", "impossible to apply knowledge gained due to work conditions". All the drivers stated that they found the training effective and beneficial. Moreover, all of them pointed out that they learned new things about the economic driving or completed their imperfect knowledge about the subject matter. All of them stated that they believed if the knowledge gained from training was applied while driving the real trucks, it would provide decrease in fuel consumption amounts. One of the drivers emphasized this belief with the words,

> S9: After the trainer gave lesson, there was a difference definitely. The things I did not know, for example I completed my imperfect knowledge related to retarder. It was better now. While driving a truck with manual transmission, I learnt to change gearshift in low level. It was beneficial for me. I definitely believe that it will be

> effective in %100. I believe that the things we learnt here will provide decrease in the fuel consumption amounts in real life, on real truck, definitely [32].

However, majority of them (n=33) seemed to assess contribution of the training to their professional life according to the difference in fuel consumption amounts between before and after training, a few of the drivers (n=4) stated that although they found training beneficial, they decided whether it contributed to their professional life after applying the knowledge gained on real truck. Some of them state that they would decide the effectiveness of training after they saw the difference in fuel consumption amounts on real truck. One driver states that,

> S23: I do not know if it is really beneficial unless I apply it on real truck but now, I think that it is successful in 80% percent. Moreover, the simulator contribution was to provide practice for us. We had chance to apply what we learned [33].

Moreover, they conflicted about whether they could apply the knowledge to real life. While some of them pointed out that the knowledge would be applied in real life, some of them stated that they did not believe that they could apply the knowledge gained to real life due to work conditions. According to them, since they had to take goods in a limited time to target point most of time, they could not apply the knowledge. Moreover, some drivers stated that they could not say whether the economic driving training knowledge was applied on real truck. The one of the drivers who believed the knowledge would be applied on real trucks said that,

> S22: It will provide decrease in fuel consumption amounts on real truck. Also, the simulator provide us an example about how we could apply the economic driving on real roads, how could we decrease fuel consumption amounts, the traffic errors we did. I believed that it will cause decrease in fuel consumption [34].

One of the drivers who pointed out that he found the training beneficial but not believe it's being applied on real truck due to work conditions state that,

> S20: Of course the training was beneficial. But in %50 portion because we would not decrease out fuel consumption amounts in real life. When we get out of here, again the manager would say, "Drive fast captain. Take the goods in time captain". You have to drive fast, there is nothing? For that reason you cannot provide economy in fuel consumption [35].

The codes related to "the contribution of the simulator to the training" were "practicing", "permanency of knowledge", "providing visuality", "making abstract knowledge to concrete", "having mathematical results and realizing the effectiveness of training", "bringing entertainment to training", "providing their active participation", "providing individual training", "providing a safety environment to practice", "shortening the knowledge gain length compare to apprenticeship learning", and "making training suitable to 21 century –innovation-". The interview results supported the survey question 2, 3 and 4 in that 35 out of 37 drivers stated that the simulator positively affected the training.

According to the drivers, the simulator providing an opportunity to apply what they had learned during the training and they could actively participate to training by driving the simulator. Moreover, they stated that they believed practicing the knowledge would made knowledge permanent. One of the drivers emphasized these contributions of the simulator to training with the words,

> S26: The simulator contributed to training in %100 because it happened at the time of training. In other words, the theoretical and practicing together make knowledge permanent [36].

The drivers also stated that the simulator supported theoretical part of the training by providing visuality and helping them convert abstract knowledge to concrete one. One of the drivers stated that,

> S10: The visuality is an advantage. When you place yourself a person who does not know the subject matter, visuality enables person to understand deeply the subject matter. Without visuality, with only listening make people ask questions themselves such as "how could I apply this knowledge in real life?", "What is the relationship between this and that?" etc. We have chance to practice with simulator. Do you understand? It is more concrete with simulator [37].

One of the unexpected results of the interview in that most of the drivers pointed out that they could get mathematical result thanks to the simulator. They also stated that if they had taken this training with a real truck, they would not have gotten so accurate mathematical result because the real truck cannot give feedback about their performance and their errors. One of the drivers pointed out these issues with the words,

> S5: We could compare the mathematical results. I got %36 fuel consumption during my first driving, then it decreased %29, now. How can I say there is no difference? What does the simulator provide? You could not get these results without simulator. If you had driven a real truck, you cannot get these results [38].

Some of the drivers mentioned the contribution of the simulator to the training by emphasizing they could practice the knowledge in a safety environment thanks to the simulator. They stated that if they had taken training on a real truck, they would have to drive a truck, which would have been they do not get used to, on real traffic flow. One of the drivers said the advantage of taking the training with simulator,

> S11: Without the simulator, it would have been worse. If you ask why? I have driven a real truck with automatic transmission for 5 years, it is fist one. Now, they wanted me to drive a DAF (a model of truck like Reno, Mercedes etc.), I would have failed. It would be worse. For example, you drive Reno, suppose that they wanted you to drive a Mercedes or another model of truck, of course it took time to get used to drive this model of vehicle. Also, you would have had to drive this big vehicle in real traffic flow. How could you have driven it, it would have been very dangerous. Now, at least, I could realize my mistakes in a safety environment [39].

Also, the drivers stated that they could learn from traffic errors done on the simulator. According to them, they could realize more clearly the errors and discussed how they could correct them. They pointed that they could try again and again to correct the errors. In addition to, the warning system of the simulator which is an immediate feedback on their errors was very beneficial according to the drivers. One of the drivers pointed out that they could learn from their errors with the words,

> S37: Without the simulator, it would have been worse because at least, you can realize, feel something, experience something. Now, we seat and watch the drivers' performances. We discuss their errors and how he should have done. At least, we can drive our trucks with a few errors instead of many [40].

According to the drivers, another contribution of the simulator to the training was to provide individual training to them. They stated that the theoretical part was offered all the drivers together. However, they used the simulator own their own and every driver realized their own errors. One of the drivers emphasized this contribution of the simulator with the words,

> S24: Without the simulator, the training would have not been so effective. Simulator provided reality, more individualism in terms of practice. In other words, it provides special (individual) training to people [41].

The drivers stated that they could have chance to participate in the training with thanks to the simulator. One of the drivers emphasized the advantage of active participation,

> S20: But the training was better with simulator. It was passive without simulator. In another words, we actively participated to training [42]

Moreover, the drivers pointed out that the simulator made the training more entertaining. They stated that they enjoyed during the training because they have a chance to drive a truck on the computer environment. According to them, it was like playing the game in other words learning by entertaining. One of the drivers mentioned this contribution of the simulator,

> S24: I think that the training affected on the fuel consumption amounts…Without the simulator, training would have been more difficult. At least, we can talk about our performance now. If it had not been, we would just have talked during the theoretical part and gone home. How was it? Now, it is more entertaining. [43]

There are also unexpected results of the interview: 1) the drivers also stated that the simulator shortening the knowledge gained length compare to apprenticeship learning. 2) According to them, most of the new drivers do not learn the truck driving from experience truck driver in a way of apprenticeship. For that reason all new generation truck drivers should take training. The following driver emphasized that,

> S25: The visuality is important. There is a difference between applying the knowledge to real life by not practicing and applying the knowledge to real life by practicing, even it is a prototype. Simulator is very beneficial tool in terms of that. I learnt this job from my masters. Moreover, my masters learnt the job from their masters not on the simulator. However, the necessity of the century is changing. I spent my years to learn the job. I think that the effort and time I spent cost very much. But the simulator shortens this time. The simulator is different. Why? Because it provides practicing in a safety environment. It provides us seeing our traffic errors, comparing the results about economical driving etc. It is an economic tool [44].

On the other hand, only 2 drivers out of 37 participants stated that the simulator did not support the training. They also pointed out that the training would have been effective without the simulator as much as it was with simulator. Moreover, one of them stated that the simulator had an negative effect on training while other one mentioned the contributions of the simulator as it’s providing practice and mathematical result although he emphasized the effectiveness of the training was independent from the simulator. The drivers who pointed out negative eff ect of the training said that, S6: The fuel consumption amount of the first driving was %34, 5. But after the training, it decreased %30, 2. There is an effect of the training. But as I said before the simulator was different than real truck. I had difficulty in driving it. The road, environment was so different. If this training had been offered without the simulator, nothing would be changed. Even, it had negative effect on training because it made the training difficult. We had difficulty in driving it because it had an artificial environment, screen. It was different than real truck [45].

Shortly, the survey and interview results showed that the drivers found simulator suitable for training truck drivers on economic fuel consumption. They mentioned many contributions of the simulator to the instruction. The codes related to "the contribution of the simulator to the training" were "practicing", "permanency of knowledge", "providing visuality", "making abstract knowledge to concrete", "having mathematical results and realizing the effectiveness of training", "bringing entertainment to training", "providing their active participation", "providing individual training", "providing a safety environment to practice", "shortening the knowledge gain length compare to apprenticeship learning", and "making training suitable to 21 century –innovation-".

Summary of the Results of the Survey and Interview Data regarding Contribution of the Simulator to the Instruction

The survey results indicated that majority of the drivers found themselves successful in terms of driving economically the simulator. Also, the interview results supported the survey results in that most of the drivers said they could drive the simulator economically. Moreover, 18 of them mentioned the decrease of their fuel consumption amounts after the training. On the other hand, small number of drivers stated that they could not drive the simulator economically because of "not getting used to driving simulator", "driving habits", "not feeling as driving a real truck" and "its being artificial". Only two drivers said that they moderately drive the simulator economically.

During the interview the drivers mentioned from whether their real truck driving in terms of economy. 12 drivers stated that they could not drive real trucks economically because the system of the company made it impossible. According to them, the company had express service and for that reason they had to take goods in a limited time to the target point. Since the time was limited, they had to drive fast.

Similarly, majority of the drivers made positive comments about the contribution of the simulator to the instruction according to the survey and interview results. Most of them stated that the simulator was a suitable practice tool for the economic fuel consumption training. During the interviews the drivers pointed the contribution of the training, namely, "practicing", "permanency of knowledge", "providing visuality", "making abstract knowledge to concrete", "having mathematical results and realizing the effectiveness of training", "bringing entertainment to training", "providing their active participation", "providing individual training", "providing a safety environment to practice", "shortening the knowledge gain length compare to apprenticeship learning", and "making training suitable to 21 century –innovation-". It was important to point out that the drivers said the training with simulators was more beneficial for novice drivers because they were lack of apprenticeship learning of the truck driving. Table 4.9 presents the survey statement concerning contribution of the simulator to the instruction with frequency of the answers.

Table 4.9 Survey results with frequencies regarding the simulator usability

Contribution of the Simulator to the Instruction	**SA**	**A**	**U**	**D**	**SD**
18. I think that I was driving the simulator economically.	23	55	14	15	3
19. I think that the simulator is appropriate tool to apply what learned during training.	37	59	4	6	4
20. I think that the messages given by the simulator when I did a traffic error are beneficial.	42	61	6	1	-
21. A person can get a habit to drive economically by practicing on simulator.	43	57	8	2	-

Drivers' Satisfaction about the Simulator

The first question was posed to learn whether they found the driving experience on the simulator was entertaining. Majority of the drivers (n=93) response this statement that driving experience on the simulator was entertaining for them. On the other hand, a few drivers (n=10) answer that they were undecided and again a few of them (n=7) response they did not find the driving experience on the simulator entertaining.

The second question was asked to if the drivers liked the appearance and comfort of the simulator. 83 out of 110 drivers answer that they liked the appearance and comfort of the simulator while 15 of them answer that they were not agreed with the statement. Also, 12 drivers' response they were undecided on the issue.

In addition to survey, a follow up interview question was asked to get in depth understanding about drivers' opinions about what they liked related to the simulator. First and second research question was examined in one interview question. The codes emerging about this question was "entertaining", "practicing", "having opportunity to drive during the training", "safety" and "similarity of the simulator to real truck". 36 out of 37 drivers said one or more things about the things they liked about the simulator. Only 1 of the drivers stated that the simulator was not bad or good but so so. When asked what he meant with the words “so so”, he stated that everything related with the simulator was middle for him and for that reason, he could not say “I really like this or that”. On the other hand, “entertaining” was the mostly mentioned word by 36 drivers when asked them what they liked about the simulator. These drivers stated that practicing what they learned on the computer environment gave a feeling of playing game and they could not bored during the training. One of the drivers pointed out that,

> S16: Because it is a computer environment, it is entertaining like playing atari [46].

Other thing that the drivers liked related to the simulator was that it gave a chance to practicing and learning new things by doing. Moreover, they stated that they liked driving and the simulator enabled them to drive during the training. It made the training more attractive according to them. One of the drivers stated that,

> S9: The thing that I liked, well, I think that my friends also liked it. I say definitely that if it had not been, people would not have been so affected. We had a chance to practice [47].

The other driver emphasized the simulator’s providing diving opportunity,

> S15: It was nice. We have chance to drive. To drive was very entertaining although some unreal things on the simulator made me bored [48].

Moreover, some of the drivers stated that they liked to practice what they learned in a safety environment. According to them, knowing that there would have been any bad consequences even they did a traffic accident was the most beautiful side of the simulator. One driver emphasized this with the words,

> S29: What I liked. I liked to feel that nobody would be injured even if I did a traffic accident. If you had hit the vehicle, there would have not been any damages on it, it was also good. It prevents any economic damages or any injuries; it is nice [49].

Another result of this interview question was also related to the second survey question about whether the drivers liked the appearance and comfort of the simulator. Some of the drivers stated that they liked the reality of the simulator and environment when the things they liked about the simulator was asked. One of the drivers stated that,

> S7: What did I like, ıı, I liked everything about simulator. It looked like a real vehicle, a real truck. It has steering wheel, gearshift, and motor sound [50].

Briefly, according to the survey majority of the drivers found driving on the simulator was entertaining and the comfort of the simulator was good. Like survey results, interview results showed that mostly mentioned thing about what they liked related to the simulator was its being entertaining.

The last question in the survey was an open ended type which was asked to examine the drivers' opinion about parts of the simulator that should be improved according to them. Although this question was heavily about the drivers' satisfaction, it also included many clues on their perception related to simulator reality, usability and contribution to training. 44 out of 110 drivers answered this open ended question. While 23 out of 44 drivers pointed out more than one thing that should be improved in the simulator, 18 of them pointed out only one thing that should be improved in the simulator. Moreover, 3 of them just stated that the training should be repeated or they found the training beneficial. For that reason, the researcher firstly extracted the keywords from the data then she ranked them from most mentioned to the least mentioned. The codes emerged from the data were "problem related to screen", "problem related to steering wheel", "problem related to brake", "problem related to gas pedal", "problem related to gearshift", "problem related to driver seat", "problem related to sound system", "reality of the simulator" and "cabin".

The mostly mentioned part of the simulator that should be improved was the screen of the simulator (It was mentioned 21 times). The drivers stated that the screen causes eye fatigue because the road between the middle and right screen. Also, the drivers stated that they looked at the windscreen in the real truck but in her the windscreen was between the two screens and it disturbs them during the driving. On the other hand, some of the drivers stated that the screen was too close to the driver seat, it should be placed a bit far and the mirrors should be arranged able by the drivers.

The steering wheel was secondly most mentioned part of the simulator that should be improved (It was mentioned 19 times). The drivers complained the sensitiveness of the steering wheel. They also stated that they lost the control of the simulator easily because of it. Moreover, some of the drivers pointed out that it should be arrangable by the drivers. On the other hand, only 1 of the drivers complained from the size of the steering wheel and he suggested that changing it with a smaller one.

The brake (It was mentioned 8 times), gas pedal (It was mentioned 7 times), gearshift (It was mentioned 6 times) were the thirdly, fourthly and fifthly most mentioned part of the simulator that should be improved according to the simulator. While drivers complained about the late reaction of the brake and gas pedal, they did not complain about the performance of the gearshift. They complained the place of the gearshift and suggested that it should place more close to the driver seat. Moreover, only 1 driver suggested that the simulator should be redesigned with automatic transmissions because their real trucks have automatic transmission. On the other hand, the drivers pointed out that they did traffic errors because of the problem in brake and they had difficulty in keeping rmp in appropriate level because of the problem in gas pedal.

Moreover, the drivers stated that if the driver seat had been adjustable, it would have been better for them (It was mentioned 6 times). This result was also, related to the second research question because 6 drivers stated that the driver seat made them feeling uncomfortable because they could not adjust it according to their height and weight.

The simulator should have a cabin according to the drivers because a cabin made simulator more realistic in terms of appearance (2 times mentioned). Moreover, other 2 drivers complained about simulator's being unrealistic but they did not suggest anything what should be done to make it more realistic. On the other hand, the simulator was criticized because of the sound system (2 times). The drivers who complained about the simulator sound system did not give any suggestion what should be done to improve it. Lastly, only 1 driver stated that the rpm indicator was small. He suggested that it should be redesigned to make it bigger.

The open ended survey question was repeated with an interview question to get deep understanding about drivers opinions on what parts of the simulator should be improved according to them. This research question was important according to the researcher because she expected that the results would make clear many things related to the face validity of the simulator. The researcher thought that the information about the things that should be improved according to the participants also would contain information about their dissatisfaction related to the simulator and this dissatisfaction affected their perception about its reality, usability, contribution to training.

The interview results supported the open-ended question in the survey in terms of that mostly criticized parts of the simulator were steering wheel (25 times) and screen (20 times). According to the drivers steering wheel should be improved because it was very sensitive and cause their losing control while driving the simulator. One of the drivers stated that,

> S17: There is a wheel gap in the steering wheel and the brake is out of order. We hit the other automobiles. I do not know how you could fix it. The wheel gap in the steering wheel should be fixed; I got sick –a stomach ache. I was not comfortable. As I said before the gap in the steering wheel causes problem [51].

On the other hand, while only 1 driver complained the size of the steering wheel, other one criticized its being stable –not adjustable. The drivers, who stated that the size of the steering wheel too big, emphasized that the steering wheel size did not cause any problem during driving but this part of the simulator represented the steering wheel of the trucks that belonged to 20 years ago. The other driver suggested that the steering wheel should be adjustable because the drivers wanted to feel comfortable themselves and its being stable limited the drivers' movements. He said that

> S35: ...Well, driver's comfort is important. While one of the drivers drives steering wheel like that, the other one drives it by taking on his lap. You cannot drive the truck as the driver who is bounded.... [52].

Drivers criticized the screen of the simulator because according to them, the problem related to it caused the eye fatigue. The drivers stated that the road on the simulator environment was in the middle of the middle and right screen and since the drivers looked at the middle screen, they lost the control of the vehicle in addition to suffer from eye fatigue. Some of the drivers suggested that the screen should have one part instead of three. One of the drivers stated that if it was designed as one that showed the front part of the vehicle, the drivers might not confused the road and can drive according to front part. Another thing that some of the drivers complained about the screen was its being so close to them. The drivers suggested that it should be placed as a bit far away from driver seat. One of the drivers stated that,

> S12: The steering wheel is more sensitive. If it is fixed, I will be really very nice. For example when I stepped on the brake, it did not react. It should react and make the vehicle stop. Another thing is that you also ask this question on the survey, I could not write anything on the survey because I think that the developers knew the best. However, now, I can say that screen is a bit problematic. It has 3 screens. I think that they designed it like that to place mirrors on the side screens. I had difficulty in driving because of it. Maybe it should be better, if there is one screen instead of three. Now, I'm watching my friends' performance from the LCD screen, I think that it would have been better if it had had one screen [53].

The drivers also complained from the side mirrors being stable (5 times). According to them, the drivers should adjust the side mirrors according to their field of view. They stated that they had to turn their heads to look at the side mirrors but in real truck, they just move their eyes not heads to look at the mirrors.

The other parts of the simulator that the drivers criticized were driver's seat (6 times), gearshift (5 times), brake (5 times) and gas pedal (5 times). Similar to the survey results, the drivers stated that the driver's seat should be adjustable. According to them, since it was stable, they could not feel themselves comfortable. One driver stated that,

> S1: But if we had sat like that for example more comfortable. For example I am a bit fat, could I explain? I should feel comfortable in the place I sit. Everything should be comfortable and in my hand. There is not problem for me whether the truck with automatic or manual transmission. But, it should be comfortable. [54].

The drivers mostly stated that the place of the gearshift caused a bit problem. They pointed out that when they wanted to change the gearshift, they had to look at to find it because it is a bit far from the place that it should be. Moreover, 2 drivers stated that they would prefer if the simulator had automatic transmission. One of the drivers who complained the place of the gearshift stated that,

> S5: According to me, the gearshift is a bit far away. I think it should be more close [55].

Moreover, some drivers stated that the brake of the simulator did not work or react late to drivers' movement and for that reason they had traffic accident. Similarly, they complained the late reaction of the gas pedal. One of the drivers said that these two parts should be improved with the words,

> S33: We cannot feel that we draw our feet from the gas pedal. It reacts lately. The problems stemmed from it a bit…I could not feel the brake. It is different. Brake and gas pedal, except them everything is same as one in real truck. Everything is normal [56].

The other mentioned things were the sound of the simulator (2 times) and the simulator's not having a split gear lamb on the screen (2 times). According to the driver the sound of the simulator is not same as one of real truck. They stated that they were get used to arrange gas level according to the sound of trucks but on the simulator the sound deceived them. Moreover, according to the two drivers, there were a split gear lamb on real trucks but there were not one on the simulator. They stated that they were not get used to drive a truck with manual gearshift and in addition to because it had not a split gear lamb, they confused whether the vehicle were split gear or not. One driver said that,

> S14: There is not a split gear lamb. When you change the gearshift, it lightens on the screen [57].

Moreover, 6 out of 37 drivers stated that they could not say anything about the parts that should be improved on the simulator. According to them, they used the simulator in a limited time and for that reason they could not get an accurate idea on the question. They stated that the comments they made might have been stemmed from their not getting used to drive the simulator. Also, 1 driver stated that he could not say anything because he was not an engineer and because he could not place himself in the foot of an engineer; his comments might have been biased. On the other hand, 1 driver stated that everything was perfect and there was nothing to say. One of the drivers who did not say anything because he used in a limited time the simulator,

> S8: Now, something. It is difficult to say it should be improved in such limited use. I think the developers did the best [58].

To sum, most of the drivers, who answered the open ended questions of the survey, complained the screen and steering wheel of the simulator. Moreover, the interview results showed that the driver mostly mentioned they had experience with the steering wheel and screen and lost the simulator control due to the problems of these parts.

Summary of the Results of the Survey and Interview Data regarding Drivers' Satisfaction about the Simulator

The survey results showed that majority of the drivers answered the question about whether they found driving experience on the simulator was entertaining positively. Moreover, according to the interview results, most of the drivers stated that they liked driving the simulator because it was entertaining and like playing a computer game.

The second survey question was about what the drivers thought about the conformability of the simulator and majority of the drivers answered this question they agreed with it. Also, the interview questions supported the survey results in that a few drivers complained about the comfort of the simulator. According to them "stability of the mirrors" and "drivers seat's not being adjustable" made them feel uncomfortable.

The last survey question was open ended and about what parts should be improved on the simulator. 44 out of 110 drivers answered this question as steering wheel and screen. Parallel to survey results, the interview results indicated that the drivers mostly mentioned the steering wheel and screen that the parts of the simulator should be improved or fixed. Table 4.10 shows the survey statement concerning satisfaction of the drivers about the simulator with frequency of the answers.

Table 4.10 Survey results with frequencies regarding the simulator usability

Satisfaction about the Simulator	SA	A	U	D	SD
22. I entertained while driving the simulator.	39	54	10	6	1
23. I liked the appearance and comfort of the simulator.	33	50	12	14	1

4.1.2.2. Trainer's Perception on the TS

The researcher interviewed with the expert trainer to find out his ideas about whether the TS was right tools for fuel consumption training or not. In other words, the aim was to get idea about what extend the TS accomplishes its design purpose according to the trainer. For that reason, 6 questions which included the role of the TS in the training, whether it is a right tool for the fuel consumption training, what extend it created a similar training environment to ones given on real training; the needed improvement on the simulator, the factors affected the scenario selection and design of the training.

The first question was posed to learn about whether the training with simulator accomplished its goals or not. Moreover, during the interview the factors affected the training's accomplishing goals negatively or positively. According the trainer, the training aim nearly accomplished not 100% since using the simulator during the training was new for the trainer, drivers and also developer. He stated that,

> I could say that it is about to accomplish its aim. Since the simulator was new for the country. It is new for the developers, drivers and also trainers. For that reason, the application has been developing continuously. I think it is successful until now [59].

Also, he stated that the factors affected the training's accomplishing the goals negatively were: "most drivers' having a bias toward the training at the beginning" and "the simulator's not providing exact results according to the theory". On the other hand, he pointed out that the most of the drivers changed their minds during the training and this factor turned negative to positive effect on the training. The trainer said that he could not say the same things for the simulators' not giving exact accurate results sometimes. According to him, if the simulator continued to give controversially results to fuel consumption theory, the drivers would start to be suspicious about the accuracy of the training.

He also stated the factors affected the training positively were: "the companies' giving importance to the training", "the simulator's attracting drivers' attention" and "providing the immediate feedback to the drivers". The companies supported to training were a positive effect on the training according to the trainer because they helped them if they need something about the training. Moreover, the company was systematic on defining the drivers who would attend the training. Other positive factors stemmed from the existence of the simulator. First one, the simulator took drivers' attention and made training more attractive for them according to the trainer. Second one, the trainer stated that they could discuss with the drivers about their driving methods and what he should have done or what were their mistakes while they were practicing the knowledge on the simulator. Moreover, he stated that they could discuss the driver's driving methods with other drivers who watched their friend on the LCD TV. The simulator created an immediate feedback opportunity according to the trainer.

The trainer was asked what extent the TS created a similar learning environment to ones given by a real truck in the second question. The trainer stated that it was difficult to say something about the question without compare the success of these two environments. However, he said that if he gave answer to this question according to his experience, the simulator provided a similar training environment to ones offered via a real truck. He emphasized his thoughts about the questi on with the words:

> Actually, giving a mathematical measure was difficult. Of course, measuring it was important but if I say something about the question based on my experience, I may say that the simulator provided similar training environment in 60-70 portion [60].

Moreover, during the data collection the trainer stated that the simulator made training more individual and provides practice opportunity for all drivers. According to the trainers, it was impossible to offer training for so many drivers on real truck because of the time limitation and cost. On the other hand, simulator provided every driver had a chance to practice knowledge offered during the training.

The third question was aimed to discover what the trainers' think about the necessity improvements of the simulator. The trainer answered this question by repeating his words he had made in the second question. According to him, the simulator does not provide exact results consistent with the fuel consumption theory. Moreover, the trainer explained his comments in detail by mentioning the parameters which affected the fuel consumption and the relationship of these parameters on the simulator with the words:

> Actually, I'm making observation while drivers are driving the simulator and also I'm trying the different driving methods myself on the simulator. I can say that the changing gearshift affect was different than one we explained in the theory. I could not understand how much changing gearshift affects the fuel consumption [61].

As aforementioned in part 4.2.1.2 (Expert Trainer's Opinions about the Behavioral Validity of the TS), the trainer did not satisfied the accuracy of the results provided by the simulator. He stated that one of the aims to use the simulator, the drivers' realizing that the knowledge offered during the training was accurate but unless the simulator did not provide it, they could not made drivers' believe the accuracy of knowledge. According to him, a way should be found to fix something about the simulator.

The fourth question was asked to learn about the criteria while defining the scenario. The trainer stated that the scenario was defined in order to lessen affects of the some parameters. Then he pointed out these parameters, namely, the number of the other vehicles' that the drivers met while driving the simulator and the weather condition. He stated that in the scenario, the low vehicle density option was selected. Moreover, the sunny weather option was constant for all the drivers. The trainers stated the reasons with the words,

> Trainer: If you selected medium or high density traffic, the variations enhances. For example, while one driver may meet one vehicle on the crossroad, one driver may meet tens of vehicles. It affects the fuel consumption amount directly and in a high portion. Similarly, weather conditions affected differently the drivers' perceiving the road. Some drivers do not get used to computer environment and they could be affected from the rainy or snowy weather conditions worse than they could do from sunny weather [62].

And he continued his comment by emphasizing the criteria affected the selection of road. He said that during the theoretical part of the training, he mentioned the drivers' economic driving techniques according to the road types. In other words, he emphasized how the drivers should drive on uphill, downtown and downhill during the theoretical part and the route the drivers navigated by chosen according to this criteria. He said that,

> Trainer: The terrain which is 16 km length was selected because it should have uphill, downtown and downhill road to enable drivers to practice fuel consumption theory. In the theory, there are some specific driver behaviors that change according to road types –uphill, straight and downhill". The developers were asked which territory included these three road types and according to their guidance this territory was defined." [63]

Moreover, the trainer stated that the loading option was preferred during the training to make simulator driving more realistic for the drivers. According to him, most of the times the drivers drove their trucks with loaded. He said that whether the trucks' having loading or not also an important factor that affected the fuel consumption amount. For that reason, to enable the drivers to compare their driving method on real truck and simulator, the loading option was selected on the scenario. The fifth and sixth questions were aimed to investigate the important parameters that affected the economic driving according to the fuel consumption theory and what extend the simulator provided the results according to these parameters.

Summary of the Results of the Data (Drivers' and Expert Trainer Perceptions on Reality, Usability and Instructional Benefits of the TS) Concerning Face Validity of the Simulator

The interview and observation results of the study showed that the simulator was similar to real model in terms of appearance. However, according to the drivers the performances of the some parts did not represent the ones in a real truck. These parts were steering wheel and screen of the simulator. Moreover, some drivers complained from the gas pedal and brake system performances. On the other hand, most of them mentioned positively from the instructional benefits of the simulator. Also, again most of them stated that they found driving experience on the simulator entertaining and beneficial. These results also supported the data results of behavioral validity in that the instructional benefits of the simulator were semi bounded the reality of the simulator.

The observation results supported the interview results in that the drivers paid attention to the difference between first and second driving sessions, not to the parameters relationships. In other words, important thing was the simulator's providing consistent results with the instructional part of the training. For that it was not necessary of simulator's being exactly similar to real model.

The trainer also pointed out the similar things in that the simulator did not represent the real truck exactly. However, according to him, instructional they could accomplish their goals because the simulator provided the consistent results with the instructional parts of the training.

Other important implications of the face validity data for the validation model were that there were some factors affecting the validation process. One of them was related with the participants' characteristics such as experience, age of the drivers. Other factor was the trainer characteristics such as the communication manner with the participants, experience of the trainer, how much he knows about the capabilities of the simulator. The last factor was related with the context of the training. The last factor included policy of the company, managers' point of view as well as conditions of the classroom, other participants' point of view to the training.

The above three paragraphs referred to three underlying principles: First one was the importance of "defining fidelity degree according to instructional goals"; Second one was "informing participants' about their performance"; Third one was "defining the factors affecting the participants' performances".

4.1.3. Instructional Validity (Research Question 1.3)

The researcher collected data in three phases in order to determine th e instructional validity of the TS. Firstly, she determined to compare participants' before and after the training fuel consumption amounts as well as to important parameters analyzed in part 4.2.1. These parameters were number of stepping on gas pedal, number of gearshift change, number of not keeping rpm in appropriate level and number of not keeping rpm while changing gearshift. The expert trainer stated that the role of the simulator in this training was to enable the participants realize the effects of the driving according to theory on fuel consumption amount. For that reason, they also help participants drive the simulator according to theory in second driving. With the respect of the expert's opinion and advisors' guidance, the fuel consumption amounts and the differences in numbers of parameters (number of stepping on gas pedal, number of gearshift change, number of not keeping rpm in appropriate level and number of not keeping rpm while changing gearshift) before and after training, paired sample t-test analysis was decided to conducted.

Secondly, the researcher compared participants' real life fuel consumption amounts 4 months before and 4 months after the training. This was a investigation on transfer of the training and these phase data was collected since the result of the data collected from the participants under the scope of face validity of the TS showed that the contribution of the training and as well the simulator cannot be separated according to them. Also, the participants stated that the contribution of the training with the Ts should be investigated by comparing participants' before and after real life fuel consumption amounts. Like the participants, the simulator validation literature also advocates that the transfer of the training with simulator should be investigated to understand instructional validity of simulators. The researcher conducted paired t-test analysis to compare participants' real life fuel consumption amounts 4 months before and 4 months after the training.

Thirdly, the researcher interviewed with the participants and managers of the company to get whole picture of the transfer of training. Moreover, she aimed to investigate the role of the simulator to the contribution if there was a contribution or the factor affecting the transfer of training positively and negatively.

4.1.3.1. Effects of the Training on Drivers' Performances and Role of the TS in Instruction

To investigate the effects of the training on drivers' performances and the role of TS in the instruction, the drivers performances (fuel consumption amounts; number of stepping on gas pedal; number of gearshift change; number of not keeping rpm in appropriate level; and number of not keeping rpm while changing gearshift) before and after training were compared. Also, the trainer and drivers' opinions were collected to get in depth information about the instructional validity of the TS. In order to compare the drives' performances, paired sample t-test were decided to be conducted.

Effects of the Training on Drivers' Fuel Consumption Amounts

Firstly, assumptions of paired sample t-test were controlled. The assumptions of Paired t-test were: 1) The mean score differences between the before and after training measures should be normally distributed 2) Homogeneity of variances should be provided. 3) Independency of observations (for one sample t-tests, it is assumed that the observations are independent). First of all the normality assumption was checked thorough Q-Q plots and Kolmogorov-Smirnov normality. Histogram and Q-Q plots showed that the normality was violated. Moreover, according to Kolmogorov-Smirnov normality test Sig. (p) value=0,001<0,005 and for that reason, the normality of the distribution was violated.

Since the assumptions of Paired Sample t-test were violated, for that reason Wilcoxon Signed Ranks test which is a nonparametric test was conducted. According to Cody and Smith (1991) Wilcoxon Signed Ranks and Mann-Whitney U tests were commonly applied in social science. Also, Zimmerman (1998) and Bajorski and Petkau (1999) state that nonparametric test were more effective than parametric ones when the assumptions of parametric tests were violated. The fuel consumption amounts in the first driving should be higher than ones in second driving to say that the training was effective (fuel consumption before training > fuel consumption after training.

Table 4.11 Analysis of Wilcoxon Signed Ranks Test for Fuel Consumption Amount (N=110)

		N	Mean Rank	Sum of Ranks
Fuel Consumption after Training – Fuel Consumption before Training	Negative Ranks	93(a)	58,98	5485,00
	Positive Ranks	14(b)	20,93	293,00
	Ties	3(c)		
	Total	110		

a fuel_consumption_after_training < fuel_consumption_before_training
b fuel_consumption_after_training > fuel_consumption_before_training
c fuel_consumption_after_training = fuel_consumption_before_training

As the Table 4.11 indicated 93 participants' mean differences between first and second fuel consumption amounts had negative ranks. For that reason, according to the Wilcoxon Signed Ranks Test result the training was effective on decrease in fuel consumption amounts of 93 participants. Moreover, Table 4.12 showed that the differences between before and after fuel consumption was significant because Asymp.Sig.(2-Tailed) p=0,000 < α (significance level)=0,05. The mean score of the fuel consumption amounts before training was 33.175 and the mean score of the fuel consumption amounts after training was 30.328. The minimum value was 28.50 for the fuel consumption before training and it was 27.30 for the fuel consumption after training. Also, maximum value for the fuel consumption before training was 43.60 while maximum value for the fuel consumption after training was 33.80. All these analysis was showed that there was a significance difference in participants' fuel consumption amounts between before and after training. In other words the training was effective.

Table 4.12 The significance level of participants' before and after fuel consumption amounts.

	Fuel Consumption after Training - Fuel Consumption before Training
Z	-8,069[a]
Asymp. Sig. (2-tailed)	,000

a Based on positive ranks.
b Wilcoxon Signed Ranks Test

Effects of the Training on Drivers' Number of Stepping on Gas Pedal

When the assumptions of Paired t-test were controlled it was realized that normality assumption was violated for the number of stepping gas pedal. The normality assumption was checked thorough Q-Q plots and Kolmogorov-Smirnov normality test which indicated Sig. (p) value=0,000<0,005 and the differences between the mean scores before and after training did not normally distributed.

Since the assumptions of Paired Sample t-test were violated, Wilcoxon Signed Ranks test which is a nonparametric test was conducted. The mean score of the number of gas pedal after training should be lower than one of the number of gas pedal before (number of stepping on gas pedal after training < number of stepping on gas pedal before training.

Table 4.13 Analysis of Wilcoxon Signed Ranks Test for Number of Stepping on Gas Pedal (N=110)

		N	**Mean Rank**	**Sum of Ranks**
Gas after Training – Gas before Training	Negative Ranks	108(a)	55,44	5987,50
	Positive Ranks	1(b)	7,50	7,50
	Ties	1(c)		
	Total	110		

a Gas after Training < Gas before Training
b Gas after Training > Gas before Training
c Gas after Training = Gas before Training

According to the result of the Wilcoxon Signed Ranks Test analysis 108 participants' number of steeping gas pedal before the training was higher than after the training (Table 4.13). Moreover, as seen Table 4.8, the mean score was 71.2000 before the training while it was 42.5137 after the training. Moreover, minimum value was 33 for before training and it was 23 after training. According to the descriptive statistic, 142 was the maximum value for before the training while 81 was the maximum value for after the training (Table 4.14). According to the both Wilcoxon Signed Ranks Test analysis and descriptive of the number of gas pedal, the number of stepping of gas pedal decreased. However, for the significance Test Statistics table (Table 4.15) was checked and according to this table with the result of Asymp.Sig.(2-Tailed) p=0,000 < α (significance level)=0,05, the difference in number of stepping gas number between before and after training was significant.

Table 4.14 Descriptives of Number of Stepping on Gas Pedal Before and After Training

	N	**Mean**	**Std. Deviation**	**Minimum**	**Maximum**
Gas before Training	110	71,2000	20,26331	33,00	142,00
Gas after Training	110	42,5137	11,86052	23,00	81,00

Table 4.15 The Significance Level of Participants' before and after Training Stepping on Gas pedal Number

	Gas after Training - Gas before_Training
Z	-9,040(a)
Asymp. Sig. (2-tailed)	,000

a Based on positive ranks.
b Wilcoxon Signed Ranks Test

Effects of the Training on Drivers' Number of Gearshift Change

The researcher controlled the assumptions of paired sample t-test. The first assumption was normality and it was controlled through Histogram, Q-Q plots and Kolmogorov-Smirnov normality test. According to Kolmogorov-Smirnov normality test, Sig. (p) value=0,091 and since Sig. (p) value=0,091>0,005 the normality assumption was not violated. Also, histogram and Q-Q plot of the mean differences of gearshift change number before and after the training showed normal distribution. For that reason, the mean differences were normally distributed. The second assumption, homogeneity of variances, of the Paired t-test was controlled through Levene's Test for Equality of Variances. According to the Levene's Test sig. is .00 that sig. < .05 (Table 4.16). Therefore homogeneity of variance assumption was violated.

Table 4.16 Analysis of Levene's Test for Equality of Variances of Number of Gearshift change

Gearshift Change Number

Levene Statistic	df1	df2	Sig.
37,010	1	218	,000

Although the normality assumption was provided since the homogeneity of variances was not provided, Wilcoxon Signed Ranks test was conducted. The number of the gearshift change before the training should be higher than ones after the training in order to say the hypothesis on the positive effects of training on participants' number of gearshift change (number of gearshift change before training > number of gearshift change before training). According to Wilcoxon Signed Ranks test results, 99 of the participants' number of gearshift change before training was higher than ones after training (Table 4.17).

Table 4.17 Analysis of Wilcoxon Signed Ranks Test for Number of Gearshift Change (N=110)

		N	Mean Rank	Sum of Ranks
Gear after Training – Gear before Training	Negative Ranks	99(a)	59,32	5873,00
	Positive Ranks	11(b)	21,09	232,00
	Ties	0(c)		
	Total	110		

a Gear after Training < Gear before Training
b Gear after Training > Gear before Training
c Gear after Training = Gear before Training

Moreover, the mean of the number of gearshift before the training was 35, 0455 while it was 18, 8807 after the training. The minimum value was 10 and maximum value was 82 for number of gearshift change before training. On the other hand, for the number of gearshift change after training the minimum value was 9 and maximum value was 39.

The significance of these results was controlled via test statistic. The results showed that number of gearshift changes before and after the training was significant. As seen Table 4.12, because of Asymp. Sig.(2-Tailed) p=0,000 < α (significance level)=0,05., there is a significance difference of the participants' number of gearshift change before and after the training (Table 4.18).

Table 4.18 The Significance Level of Participants' before and after Training Gearshift Change Number

	Gear after Training - Gear before Training
Z	-8,413 (a)
Asymp. Sig. (2-tailed)	,000

a Based on positive ranks.
b Wilcoxon Signed Ranks Test

Effects of the Training on Drivers' Number of not keeping rpm in appropriate level before training and after training

The assumption check of Paired t-test which was conducted through histogram, Q-Q plot and Kolmogorov-Smirnov normality test showed that the normality assumption was violated. Histogram and Q-Q plot of the differences in mean scores of the number of not keeping rpm in appropriate level before and after training showed that the distribution was not normal. Moreover, according to Kolmogorov-Smirnov normality test with Sig. (p) value=0,000<0,005 the normality assumption was violated.

For that reason, Wilcoxon Signed Ranks test was conducted. According to Wilcoxon Signed Ranks 66 participants' number of not keeping rpm in appropriate level before the training was higher than one after the training (Table 4.19).

Table 4.19 Analysis of Wilcoxon Signed Ranks Test for Number of not Keeping Rpm in Appropriate Level (N=110)

		N	Mean Rank	Sum of Ranks
Not Keeping Rpm after Training - Not Keeping Rpm before Training	Negative Ranks	66(a)	41,94	2768,00
	Positive Ranks	12(b)	26,08	313,00
	Ties	32(c)		
	Total	110		

a Not Keeping Rpm after Training < Not Keeping Rpm before Training
b Not Keeping Rpm after Training > Not Keeping Rpm before Training
c Not Keeping Rpm after Training = Not Keeping Rpm before Training

Moreover, as Table 4.20 indicated the mean score of the number of not keeping rpm in appropriate level before the training was 2.39 while the mean score of the number of not keeping rpm in appropriate level after the training was .76. These results showed that there was a difference in number of stepping on gas pedal between before and after the training. Moreover, participants' number of not keeping rpm in appropriate level decreased after the training.

Table 4.20 Descriptives of Number of Stepping on Not Keeping Rpm in Appropriate Level Before and After Training

	N	Mean	Std. Deviation	Minimum	Maximum
Not Keeping Rpm before Training	110	2,3909	2,44985	,00	12,00
Not Keeping Rpm after Training	110	,7636	1,02203	,00	5,00

According to the test statistic results, the difference in the number of not keeping rpm in appropriate level before and after the training was significant with Asymp.Sig.(2-Tailed) $p=0,000 < \alpha$ (significance level)=0,05 (Table 4.21).

Table 4.21 The Significance Level of Participants' before and after Training Gearshift Change Number

	Not Keeping Rpm after Training - Not Keeping Rpm before Training
Z	-6,157[a]
Asymp. Sig. (2-tailed)	,000

a Based on positive ranks.
b Wilcoxon Signed Ranks Test

Effects of the Training on Drivers' Number of not keeping rpm in appropriate level while changing gearshift before training and after training

Firstly, the researcher checked the assumptions of Paired t-test. Since the normality assumption checked thorough histograms, Q-Q plots and Kolmogorov-Smirnov normality test (Sig. (p) value=0,167>0,05) was not violated, she decided to check homogeneity assumption through Levene's Test for Equality of Variances . According to the Levene's Test sig. is .00 that sig. < .05 (Table 4.22). Therefore homogeneity of variance assumption was violated.

Table 4.22 Analysis of Levene's Test for Equality of Variances of Number of Not Keeping Rpm in Appropriate Level While Changing Gearshift

Rpm

Levene Statistic	df1	df2	Sig.
25,264	1	218	,000

Since the assumptions of homogeneity of variances assumption of Paired Sample t-test were violated, Wilcoxon Signed Ranks test which is a nonparametric test was conducted. The mean score of the number of not keeping rpm in appropriate level while changing gearshift before the training should be higher than one of the number of not keeping rpm in appropriate level while changing gearshift after the training.

Table 4.23 Analysis of Wilcoxon Signed Ranks Test for Number of not Keeping Rpm in Appropriate Level While Changing Gearshift (N=110)

		N	Mean Rank	Sum of Ranks
Not Keeping Rpm in Gear Change after Training - Not Keeping Rpm in Gear Change before Training	Negative Ranks	86(a)	53,01	4558,50
	Positive Ranks	13(b)	30,12	391,50
	Ties	11(c)		
	Total	110		

a Not Keeping Rpm in Gear Change after Training < Not Keeping Rpm in Gear Change before Training
b Not Keeping Rpm in Gear Change after Training > Not Keeping Rpm in Gear Change before Training
c Not Keeping Rpm in Gear Change after Training = Not Keeping Rpm in Gear Change before Training

According to Wilcoxon Signed Ranks test result, 86 participants' mean score difference of the number of not keeping rpm in appropriate level while changing gearshift before and after the training had negative value (Table 4.23). In other words, the aim of using the simulator to show the the fuel consumption differences between first and second driving was provided for 86 participants. Moreover, the mean score of the number of not keeping rpm in appropriate level while changing gearshift before the training was 6.1091 with SD= 3.19 while it was 2.9182 with SD= 1.916 for after the training. According to the test statistic results, the difference in the number of not keeping rpm in appropriate level while changing gearshift before and after the training was significance with Asymp.Sig.(2-Tailed) $p=0,000 < \alpha$ (significance level)=0,05 (Table 4.18).

Table 4.24 The Significance Level of Participants' before and after not keeping rpm in appropriate level while changing gearshift number

	Not Keeping Rpm in Gear Change after Training - Not Keeping Rpm in Gear Change before Training
Z	-7,292[a]
Asymp. Sig. (2-tailed)	,000

a Based on positive ranks.
b Wilcoxon Signed Ranks Test

Summary of the Results of the Training Effects on the Drivers' Performances and Role of the TS on it

The analysis of the drivers' performances before and after the training indicated two results: First one was the training effect on the drivers' performances; second one was that the other data results concerning the simulator validity in terms of behavioral and face validity were reliable.

According to drivers' before and after the training performance comparison analysis, most of the drivers could provide decrease in fuel consumption amounts, number of using gearshift, number of stepping on gs pedal, number of not keeping rpm in appropriate level and number of not keeping rpm in appropriate level while changing gearshift. This data showed that most of the drivers tried economic driving techniques they learned during the instructional part of the training. This data consist with the drivers' and the expert trainer's statement in that most of the participants used the economic driving techniques in their second driving sessions.

Moreover, this data also validated the data results of the behavioral validity and face validity part since these parts data results showed that although the simulator could not represent the real truck in 100% percent in terms of similarity of the measures, it could provide decrease in fuel consumption amounts if the economic driving techniques were used. These data also showed that there was a decrease in fuel consumption amounts in the second driving.

4.1.3.2. Effect of the Participants' Demographics on their Fuel Consumption Amount

According to the simulator validation literature, there are many factors that may affect the result of the drivers' performances. Some of them related to the experiment environment (Blana, 1996a) and some of them related to participants' characteristics such as age (Hancock et. all., 1990; Blana, 1996a; Rimini-Doering, Manstetten, Altmueller, Ladstaetter and Mahler, 2001; Lee, Drake and Cameron, 2002; Hoskins and El-Gindy, 2006; Minin, Montanari, Corbelli and Iani, 2008), gender (Reed and Green, 1995; Blana, 1996; Lee, 2002; Cunto, 2008), expertise on job (Wallace and Regan, 1998; Emery et. all., 1999; Feinstein and Cannon, 2001; Fadde, 2007; Fadde, 2009). In the scope of this thesis study, the educational level, the type of vehicle that the drivers drive in real life, computer use and before simulator use experience also thought as factors affecting the drivers' performances. For that reason, participants' demographics, namely, gender, age, educational level, expertise, the type of vehicle they drive in real life, computer use and before simulator use experiences were collected thorough the survey.

However, gender, expertise and the vehicle types that the drivers drive in real life did not make sense for the thesis study because most of the participants have common type demographics. All the drivers participated to the study were males and for that reason although the literature indicated that gender is one of the important factors affecting drivers' performance, it did not affect this study. Similarly, since 104 out of 110 drivers have more than 5 years experience on the professional truck job, the expertise of the participants was not a factor affecting the study results. Moreover, all the drivers were from the same company and for that reason all they drive truck in real life. For this study, the type of the vehicles that participants drive was not a factor affecting the study results. Under the scope of the study, the participants' demographics, namely, age, educational level, computer use and before simulator use experiences were checked whether the fuel consumption amounts were different for different age, educational level, computer use or before simulator use groups.

Age

In order to assess the effect of the age of participants on their fuel consumption amount before and after the training, one-way ANOVA is determined to be conducted. The independent variable was age and dependent variable was participants' fuel consumption amounts difference calculated before and after training.

Firstly, the participants were grouped according to their ages. There were 6 groups: 1. Group consisted of 9 participants whose ages ranged 25-30; 2. Group consisted of 16 participants whose ages ranged 30-35; 3. Group consisted of 21 participants whose ages ranged 35-40; 4. Group consisted of 37 participants whose ages ranged 40-45; 5. Group consisted of 16 participants whose ages ranged 45-50; and 6. Group consisted of 11 participants whose ages ranged 50-55 (Table 4.25).

Table 4.25 Number of the participants in each age group

		Frequency	**Percent**
Valid	25-30	9	8,2
	30-35	16	14,5
	35-40	21	19,1
	40-45	37	33,6
	45-50	16	14,5
	50-55	11	10,0
	Total	110	100,0

Then for each age group, differences between the fuel consumption amount before and after training were calculated and the assumptions of one-way ANOVA for each group were checked. The assumptions of one-way ANOVA were normality and homogeneity of variances. To test the normality assumption, Kolmogorov-Smirnov normality test, histogram, "Q-Q Plots" and skewness and kurtosis values of each group was used. The results showed that normality assumption was not violated for all groups except group 3. For group 3, Kolmogorov-Smirnov sig. is < .05. However, it is normally distributed according to the shapes of the distributions and although few outliers are observed in "Q-Q Plots", scores appears to be reasonably normally distributed. Moreover, values of skewness and kurtosis are between [-3,+3] (Tabachnick, & Fidell, 2001; p.72). For that reason, it was assumed the normality assumption was not violated for group 3. The second assumption of the one–way ANOVA, homogeneity of variances, was checked via Levene's Test for Equality of Variances. According to the Levene's Test for Equality of Variances, sig. is .234 that sig. > .05. Therefore homogeneity of variance assumption is not violated.

Table 4.26 The effect of participants' ages on fuel consumption amounts before and after training

Age

	Sum of Squares	**Df**	**Mean Square**	**F**	**Sig.**
Between Groups	65,787	5	13,157	1,698	,142
Within Groups	805,745	104	7,748		
Total	871,532	109			

A one-way between groups ANOVA was conducted to explore the impact of age of participants on fuel consumption amounts. Subjects were divided into 6 groups according to their age (group 1: 25-30, group 2: 30-35, group 3: 35-40, group 4: 40-45, group 5: 45-50, and group 6: 50-55). As Table 4.26 displays, there was no statistical difference between three groups [F (5, 104) = 1,698, p > .05]. Since no statistical difference was found, Post-Hoc comparisons and effect size are not appropriate for this situation (Table 4.26).

On the other hand the averages of the scores showed that there were small differences between the groups in terms of their fuel consumption amounts differences before and after the training. According to the results, age group 1, whose participants ages ranged between 25-30, (M=3.74, SD=1.30) had higher average scores than age group 2, whose participants ages ranged between 30-35, (M=3.52, SD=3.43), age group 3, whose participants ages ranged between 35-40, (M=3.57, SD=2.8), age group 4, whose participants ages ranged between 40-45, (M=2.23, SD=2.88), age group 5, whose participants ages ranged between 45-50, (M=1.68, SD=2.38) and age group 6, whose participants ages ranged between 50-55, (M=3.51, SD=2.98) (M=1.96; SD=1.83). If the age groups were ranked their averages of scores from higher to lower, the ranking would have been as age group 1 (25-30), age group 3 (35-40), age group 2 (30-35), age group 6 (50-55), age group 4 (40-45) and age group 5 (45-50). However, it should be kept in mind that these differences were not statistically significant.

Education Level

The researcher also investigated the effect of participants' educational level on their fuel consumption amounts before and after the training. Majority of the participants (n=43) graduated from primary school. Moreover, the number of middle and high school graduates were equal (n=30). On the other hand, a small number of the participant (n=7) graduated from academy (Table 4.27).

Table 4.27 The educational Levels of the participants

		Frequency	**Percent**
Valid	primary school	43	39,1
	middle school	30	27,3
	high school	30	27,3
	Academy	7	6,3
	Total	110	100,0

One-way ANOVA was applied to check the effect of the educational level on the fuel consumption amount before and after the training. The independent variable was educational level and dependent variable was participants' fuel consumption amounts difference calculated before and after training. Firstly, assumptions of the one-way ANOVA, namely, normality and homogeneity were checked. To test the normality for all educational level groups, histograms, Q-Q plots, skewness, kurtosis and Kolmogorov-Smirnov normality tests were used. According to normality test checking results, the normality assumption is not violated for all the educational level groups. To test the homogeneity of variances which is the second assumption of the one–way ANOVA, Levene's Test for Equality of Variances was used. According to the Levene's Test for Equality of Variances, sig. is .333 that sig. > .05. Therefore homogeneity of variance assumption is not violated.

Table 4.28 The effect of participants' educational level on fuel consumption amounts before and after training

Education Level

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	12,511	3	4,170	,515	,673
Within Groups	859,020	106	8,104		
Total	871,532	109			

A one-way analysis of variance was conducted to evaluate whether the difference of fuel consumption amounts between before and after the training was changing from different educational level groups. The independent variable, educational level, consisted of 4 groups: primary school, secondary school, high school and academy. On the other hand, the dependent variable was total differences between pre-post scores of fuel consumption amounts of each group before and after training. The one-way ANOVA results showed that the difference of fuel consumption amounts between before and after training was not significant, [F (3, 106) = ,515, p > .05] (Table 4.28). Post-Hoc comparisons and effect size are not appropriate for this situation because there is no statistical difference.

Moreover, the average scores of the groups were investigated to explore which group had higher average. Although participants who graduated from middle school (M=3.30, SD=2.92) seemed to have higher average scores than primary school graduates (M=2.72, SD= 3.13), high school graduates (M= 2.78, SD=2.61) and academy graduates (M=1.96; SD=1.83), this result was not statistically significant.

Computer Use

In order to investigate the effects of the participants' computer use situation on their fuel consumption amounts before and after the training, participants' computer use situation was checked. As previously indicated, while 58 participants were computer users, 52 of them were not computer users.

The effect of participants' computer use situations on their fuel consumption amount was checked by an independent samples t-test. Firstly assumptions, normality and homogeneity of variances, of the independent t-test were controlled. Histograms, "Q-Q plots", values of skewness and kurtosis and Kolmogorov-Smirnov normality tests were used in order to check normality assumption for each group. According the test results, while the normality assumption was not violated for the group who were computer user, according to Kolmogorov-Smirnov normality tests result it was violated for the group who were not computer users. However, histograms and “Q-Q plots” showed normal distribution for this group and also, values of skewness and kurtosis were between [-3,+3] (Tabachnick, & Fidell, 2001; p.72). For that reason, it was assumed that normality assumption was not violated for group 2 who were not computer users. The second assumption was checked by using the Levene’s Test for Equality of Variances. As seen Table 4.29, Levene’s Test for Equality of Variances indicated that the population variance of those two groups are equal (F=1.70, p=.68). For that reason, equality of variances assumption was not violated.

Table 4.29 The effect of participants’ computer use on their Fuel Consumption Amounts

		Levene's Test for Equality of Variances		**t-test for Equality of Means**		
		F	**Sig.**	**T**	**Df**	**Sig. (2-tailed)**
Total of differences between pre-post scores of Fuel Consumption Amounts	Equal variances assumed	,169	,681	-,222	108	,825
	Equal variances not assumed			-,222	107,119	,825

The independent samples t-test indicated that there were no significant difference of participants’ fuel consumption amount between group who use computers and who do not use computers, t (108)= -,222, p=.83.

However, non computer user was more successful on the average than computer user group. This difference is very small to discuss. Moreover, if when the computer user group started to use computer and how many hours in a week they used it was taken into account it was realized that user group did not differ from the non computer user group in terms of computer use. The computer use hour in a week of the computer user group was 2 hours and most of them stated to use computer newly.

Simulator Use

The researcher firstly investigated simulator use experience of the participants in order to show simulator use differences in the study. As aforementioned under the “Background Information of the Participants –Simulator Use” heading, while 39 participants (%28,2) have used a simulator before, 79 of them (%71,8) have not used any type of simulator. Moreover, it was important to emphasized that 29 out of 31 the participants have used psychotechnics simulator which was designed to assess drivers’ mental skills such as perception, attention, memory, reasoning ability, the speed-distance estimation; ability and skill levels such as reaction-rate, eye-hand-foot coordination; attitudes behavior, habits and personal characteristics such as risk taking, aggression, responsibility, safe driving awareness (Online: Sürücü Eğitim Simülatörleri) before the training. This simulator was different than the TS in terms of type in that it was an assessment simulator while TS was an instructional simulator used for practice and drill.

Although the participant who have used simulator before have not used a simulator similar to TS, the researcher decided to investigate the simulator use experience of the participants on their total pre and post scores differences of fuel consumption amounts before and after the training. Since the participants who have used the simulator before got used to experimental study design, it may also cause the difference between the groups who have used the simulator before and who have not used the simulator before.

The effect of the participants' before simulator use experience on the total pre and post scores differences of fuel consumption amounts before and after the training, independent t-test was conducted. However, firstly the assumptions of independent t-test, normality and homogeneity of variances, were checked for each group. Histograms, "Q-Q plots", values of skewness and kurtosis and Kolmogorov-Smirnov normality tests were used in order to control the normality assumption of independent t-test. According the test results, the normality assumption was not violated for the group who has used simulator before and the group who has not used simulator before. The second assumption was checked by using the Levene's Test for Equality of Variances which indicated that the population variance of those two groups are equal (F=.39, p=.53) (Table 4.30). For that reason, equality of variances assumption was not violated.

Table 4.30 The effect of participants' simulator use before on their Fuel Consumption Amounts

		Levene's Test for Equality of Variances		**t-test for Equality of Means**		
		F	**Sig.**	**T**	**Df**	**Sig. (2-tailed)**
Total of differences between pre-post scores of Fuel Consumption Amounts	Equal variances assumed	,392	,533	,214	108	,831
	Equal variances not assumed			,232	65,821	,817

The independent samples t-test result was t (108)= ,214, p=.83 and showed that there is no significant difference between the group who has used simulator before and one who has not used simulator before on participants' total of differences between pre-post scores of fuel consumption amounts.

However, when the averages of the scores of two groups were investigated, it was realized that the group who have used simulator before were more successful on the average (M=2.94, SD=2.46) than the group who have not used simulator before (M=2.81, SD=2.97) with a very little mean difference. It should be noted that this small differences between two groups were not significant and for that reason it could be said that the situation of simulator use before did not affect the participants' total difference in fuel consumption amounts before and after the training (Table 4.23).

Summary of the Results of the Factors Affecting Drivers' Performances on TS

Factors affecting the drivers' performances on the simulator can affect both the validity of instructional simulators and validity of the current study. In the light of the literature and experts, participants' demographics, such as gender, age, educational level, expertise, the type of vehicle they drive in real life, computer use and before simulator use experiences were defined as factors affecting the validation process. All data about these factors were collected thorough the survey. The data were analyzed firstly by conducting descriptive statistics. Then the groups defined as a result of the descriptive statistics were analyzed by conducting one-way ANOVA.

Factors, namely, gender, expertise and the vehicle types that the drivers drive in real life did not analyzed in the scope of the current study because most of the participants have common type demographics. On the other hand, the affects of the factors, namely, age, educational level, computer use and before simulator use experiences on the drivers' performances were checked. The descriptive statistics results showed that the groups were slightly different from each other. Despite these results, the researcher decided to analyze data via one-way ANOVA. The results showed that performances of different groups regarding the different factors did not differ significantly.

The researcher advocated that the slight differences between the groups were the reason for these results. For that reason, during the validation process, the researcher also paid attention to the participants' characteristics as well as the trainer's characteristics and context of the study. Moreover, drivers' and trainer's comments showed that especially, expertise and age of the drivers affected the results of the study. For that reason, in the instructional simulation validation model, the factors should be taken into account.

4.1.3.3. Transfer of the Training

Aforementioned, data lost was one of the treat for the validity of collected under the scope of transfer of training. Although it occurred unintentionally, some strategies should be applied to provide validity of the data (Wallen & Fraenkel, 2001). According to Wallen and Fraenkel (2001), one of the strategies to tackle with data lost was showing the similarity between lost and remained participants. To apply this strategy, the researcher firstly analyzed lost and remain data demographics. Secondly, she applied paired t-test to extract whether there was a significant difference between posttest fuel consumption amounts of lost and remain data. According to the similarity strategy, the demographics of the participant should be close each other. Moreover, there should not have been a difference between posttest fuel consumption amounts of lost and remain data.

The similarity of the lost and remain data participants' demographics, namely, gender, age, educational level, experience year and vehicle type were investigated through descriptive statistics. It should be noted that, all the participants were males. Moreover, all of them had driven trucks as vehicle type.

The age characteristics of the participants who continued working in the company after the training and ones who did not are showed in Table 4.31 and Table 4.32. According to the Table 4.31, remain participants' age ranged between 27 and 54. Moreover, the mean score of the participants' age was 41.

Table 4.32 which shows the lost data participants age characteristics, the mean of lost data participants' age was 41.14. Also, their ages were between 27 and 54.

Table 4.31 Descriptives of remain data participants concerning their age.

		Statistic	**Std. Error**
Age-Remain Group	Mean	41,0000	,88336
	Std. Deviation	6,89928	
	Minimum	27,00	
	Maximum	54,00	
	Range	27,00	

Table 4.32 Descriptives of lost data participants concerning their age.

		Statistic	Std. Error
Age-Lost Group	Mean	41,1429	,93904
	Std. Deviation	6,57330	
	Minimum	27,00	
	Maximum	53,00	
	Range	26,00	

The data results of remain and lost data participants' educational level showed that most of the participants from first and second groups graduated from primary schools. Moreover, the numbers of high school graduates were very close to each others: First group had 14 participants and second group had 16 participants from high schools.

Table 4.33 Descriptives of remain data participants concerning their educational level.

		Frequency	Percent
Valid	Primary school	20	32,8
	Middle school	21	34,4
	High school	14	23,0
	University	6	9,8
	Total	61	100,0

Table 4.34 Descriptives of lost data participants concerning their educational level.

		Frequency	Percent
Valid	Primary school	23	46,9
	Middle school	9	18,4
	High school	16	32,7
	University	1	2,0
	Total	49	100,0

According to Table 4.35, majority of remain data participants (n=60 with 94.5%) had more than 5 years job experience. The results showed that only 1 participant had 5 years experience.

Table 4.35 Frequencies of remain data participants concerning their experience year.

		Frequency	Percent
Valid	5,00	1	1,6
	6,00	60	98,4
	Total	61	100,0

Table 4.36 shows that the most lost data participants (n=44 with 89,9%) had more than 5 years job experience. According to the results showed that only 1 participant had 4 years experience, 2 participants had 3 years, 1 participant had 2 years, 1 participant had 1 year experience.

Table 4.36 Frequencies of the participants concerning their experience year.

		Frequency	Percent
Valid	1,00	1	2,0
	2,00	1	2,0
	3,00	2	4,1
	4,00	1	2,0
	6,00	44	89,9
	Total	49	100,0

The demographics data results showed that the lost and remain data participants characteristics about gender, age, experience years, educational level and the vehicle type they drove in real life were similar.

Other validity criteria for two groups were their fuel consumption amounts after the training. These data were provided by the simulator. The researcher firstly separated lost and remain data participants' posttest fuel consumption scores. Secondly, she analyzed the data through independent samples t-test. Firstly, the assumptions of the independent samples t-test, namely normality and homogeneity of the variances were checked. According to Kolmogorov-Smirnov Normality test with Sig. (p) value=0,735>0,05, the normality of the samples was not violated. Moreover, the straight line on Q-Q plot shows that the normality of the saplig was provided. Levene's Test for Equality of Variances indicated that the population variance of those two groups are also equal (F=1.05, p=.31). The independent samples t-test results showed that remained and lost data post test scores concerning the fuel consumption amounts were not significantly different with t (108)= ,808, p=.42 (Table 4.37).

When the averages of the scores of two groups were investigated, it was realized that the posttest scores of the remained and lost data groups were very close. The remained group posttest score on the average was M=30.45 with SD=1.55 while the lost group posttest score on the average was M=30.21, SD=1.46.

Table 4.37 Posttest scores of remained and lost data groups concerning fuel consumption amounts

		Levene's Test for Equality of Variances		**t-test for Equality of Means**		
		F	**Sig.**	**T**	**Df**	**Sig. (2-tailed)**
Total of differences between pre-post scores of Fuel Consumption Amounts	Equal variances assumed	,1050	,308	,808	108	,421
	Equal variances not assumed			,814	105,568	,427

Since the demographics of the remained and lost data groups were similar and since their posttest scores on fuel consumption amounts were not significantly different, the validity of transfer of training data results was provided. Aforementioned, as Wallen and Freankel (2001) say the similarity of the lost and remained data groups not affect the validity of remained group data. For that reason, the researcher conducted paired samples t-test analysis by comparing remained participants' real life fuel consumption amounts before and after the training. Firstly, assumptions of paired t-test, namely, independence of observation and normality were controlled. Independence of the observation was assumed to be provided. Moreover, Q-Q plots showed a straight line and Kolmogorov-Smirnov Normality test with Sig. (p) value=0,996>0,05. So, the normality assumptions were not violated. According to the paired samples t-test results, there was not a statistically significant difference between pre and post test real life fuel consumption amounts of the participants with $t(60)=1.94$, $p>.05$ (Table 4.38).

Table 4.38 Pre-Posttest real lie fuel consumption amounts of the participants.

	Paired Differences							
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		T	df	Sig. (2-tailed)
				Lower	Upper			
Pair 1 Before-After	,42	1,70	,217	-,013	,856	1.94	60	,421

4.1.3.4. Factors Affecting the Transfer of the Training (Research Questions 1.3.3)

In order to identify the factors affected the transfer of the knowledge gained to real work environment, 22 drivers and 2 managers were interviewed with. The drivers who interviewed with were selected according to the intensity sampling strategy. For that reason firstly defined the drivers who decreased fuel consumption amounts and could not decrease. Then, the interview sessions had continued until the researcher decided the data saturated. 2 managers were responsible for the education and they followed the drivers' fuel consumption amounts after the training. For that reason the researcher decided to interview with these managers to get whole picture about the factors affected the transfer of the training positively and negatively.

The drivers were asked 5 questions to learn their perception about: 1) whether they could apply the knowledge gained during the training and which knowledge they applied; 2) the factors supported their transferring the training; 3) factors prevented their transferring the training; 4) role of the simulator in transfer of the training; and 5) how the training should be designed to enhanced their transfer of the training.

Moreover, the researcher to asked same type of questions to learn the managers and indirectly the companies point of view about: 1) whether there was a decrease in fuel consumption amounts 2) what the reasons of the transfer or not transfer were; 3) how the training should be designed to enhanced their transfer of the training. There researcher combined the drivers and managers point of view while interpreting the results. Since the drivers and managers represented the different data source, the researcher labeled the drivers as from S1 to S22 while she labeled the managers as S23 and S24.

The first question that was asked to the drivers was checking what extend they could apply the knowledge they gained during the training and whether their fuel consumption amounts decrease. 11 out of 22 drivers stated that they could apply what they learned during the training. 5 out of 11 drivers pointed out that their fuel consumption amounts were decrease while 3 of them stated that decrease in their fuel consumption was too little. According to these drivers, the reasons of too little decrease in fuel consumption amounts were that there were many factors that affected the fuel consumption on real road. These factors were road conditions, weather conditions and express service system in company. One of the drivers who applied and provide decrease in fuel consumption stated that,

> S7: I want to make a few comparisons. For example, the trainer said that you should not drive the truck without brake while driving downhill and drive it in the high rpm level. On the other hand I had known that when you drove without brake you could provide decrease in fuel consumption amounts before the training. However, it was wrong for new generation trucks and I learned it during the training. I applied this knowledge on the road.....I was the first in the rank on the company list which included 100 drivers who provide least fuel consumption amounts. But before the training I was the worst one in terms of fuel consumption amounts [1].

The drivers who pointed out that the fuel consumption decrease was too little said that,

> S3: The training was beneficial of course but there is difference on simulator and real truck. The simulator was with manual transmission while our trucks were with automatic transmission. For that reason, most of the things explained during the training were adjusted by our trucks such as gearshift change [2].

On the other hand 1 out of 11 drivers stated that the fuel consumption amount did not changed although he applied the knowledge gained during the training. According to this driver, there are too many external factors affecting the fuel consumption amounts. Also, he stated that because he always tried to drive the truck economically, the training did not affect his fuel consumption amount although he applied very little knowledge. He said that,

> S6: There are differences between the simulator road conditions and real road conditions. For example, you depart here and you meet a traffic flow density on the bridge. Yes, I applied the knowledge I gained but the external conditions affected too much the fuel consumption....Actually, there is not a decrease my fuel consumption because I always drive the truck by paying attention the fuel consumption amount. There may be a difference for other truck drivers but there is not for me [3].

The other 2 drivers stated that they were applying the training on real road but they could not say anything about whether there was a decrease on fuel consumption amount. These drivers said that since the company did not care the fuel consumption amount before, for that reason they did not pay attention the fuel consumption amount. Moreover, they emphasized that the company was tracking the drivers' fuel consumption amounts and if there is a problem related to a driver's fuel consumption amounts, they talked with the driver. For that reason, they did not calculate their fuel consumption amounts before the training. For the information about the decrease in fuel consumption, they advised the researcher to talk with company managers who responsible for the drivers fuel consumption amounts.

8 out of 22 drivers stated that they applied the knowledge gained during the training on real road conditions when the conditions were appropriate. According to these drivers, because of the express services they could not apply the economic driving techniques. They said that they had to take the loadings to the target point in a limited time in express services and for that reason they just could apply knowledge gained during the training in normal services. One of the drivers who mentioned the express services affects on economic driving said that,

> S8: Of course you can decrease the fuel consumption amounts to %31. However, you should obey some rules. We cannot obey these rules in %50 percent. Why? Now, if you drive the truck with 80 speed instead of 90, you can provide 1 point saving in fuel consumption. But we cannot go like that. What happenned here? The company says that you have to take this loading to here in two days. Of course, you know if you drive car, you should drive fast in this situation. For that reason, we cannot apply the training in %100 percent on real road [4].

Moreover, 1 out of 8 drivers stated that there was a decrease in fuel consumption amounts. 2 drivers said that the decrease in fuel consumption amounts were very little. However, these three drivers stated that they could provide the decrease in fuel consumption when they applied the knowledge gained from the training. One of them pointed out that,

> S17: I could apply the training sometimes. However, there is not much difference in fuel consumption amounts after the training, because here is Ekol, my sister. We have to drive fast here. Otherwise, there is a decrease in fuel consumption if you apply the training. But, since we have to drive fast, there is not much difference...Under normal working conditions, if we apply the knowledge gained during training, there is a decrease [5].

5 out of 8 drivers stated that they applied the knowledge gained from the training but they did not know whether there was a decrease in fuel consumption amounts or not. According to these drivers the company did not give importance to fuel consumption amounts

On the other hand, 1 out of 8 drivers said that his fuel consumption amount increased after the training although he applied economic driving techniques under appropriate conditions. When this driver's interview transcript was controlled, it was realized that he did not compare his fuel consumption amounts before and after the training. He stated that he did not calculate the fuel consumption amount before the training because the company did not give importance to this issue. According to the transcript of this driver, he compared his performances with other truck drivers' performances. He stated that although his fuel consumption amount was less than other drivers on the simulator, it was more on real road. Moreover, this driver said that since he knew most of the things the trainer said during the training he drive the simulator and real truck with same driving method. According to him, the only thing he learned during the training was driving fast on uphill road and also he pointed out that he applied this knowledge on real road. During the interviews, this driver complained to go express service too much. He stated that he had the express services in %80 percent because his route was Turkey-England. The driver said that his fuel consumption amounts' being more than ones of other drivers might be stemmed from the truck. He pointed out that he was suspicious about the maintenance of the truck. This driver's quotation was,

> S11: My fuel consumption amount increased after the training. I applied the knowledge on real road also I tried to drive economical but it increased. Actually, I did not understand the reason…I had less fuel consumption amounts than ones other drivers had on the simulator but I have more fuel consumption amounts than ones they have on real road [6].

10 out of 11 drivers who said that they applied the training also stated that they could not apply the knowledge sometimes while answering the third question about the factor preventing the transfer of the knowledge gained during the training. Only one of them continued to state that he could applied the economic driving in all situations. For that reason, although 11 of the drivers stated that they could apply the training, they were in the same groups who said that they could apply the training on real road environments appropriate times. For that reason, the researcher merged the answers given all these 18 drivers, except one, while explaining which knowledge transferred by them to the real work environment. The knowledge they applied were "driving more fast on uphill road", "not stopping or running the truck unnecessarily", "leaving distance for using brake – using the truck in a controlled manner", "arranging gearshift change", "adjusting the gas while driving on uphill road", "not stepping on gas unnecessarily", "stopping to drive truck according to the motor

sound" and "driving the truck in high rpm level on downhill". During the training, the trainer emphasized the economic driving techniques according to the road type. The drivers mostly surprised what the trainer said about the economic driving techniques for uphill, downhill road and also how they could use gear, gas and rpm on these types of roads. 5 months later, the drivers mostly mentioned that they stated to drive faster on uphill roads and they use the hand brake while the rpm level was high on downhill roads. Moreover, they stated that they were trying to drive truck by avoiding the unnecessarily stopping and running it as well as trying to be frightened. One driver stated that he gave up to drive truck according to the motor sound because as the trainer said the motor sound on real truck mean different thing compare to old trucks.

Only 3 drivers stated that they did not apply the knowledge gained during the training on the real road environment. 2 out of 3 drivers stated that they had known the economic driving before the training. While one of them stated that his fuel consumption amount decreased after the training because he trying to drive the truck more economically, other driver stated that he did not know whether his fuel consumption decreased because he did not pay attention it before the training. On the other hand, he stated that he only learned they should drive faster on uphill during the training and sometimes applied it. The 1 out of 3 drivers said that he did not apply the knowledge gained during the training because he got used to drive fast. According to this driver, the training was not effective because it did not reflect the reality. He continued to explain his ideas by saying there were many factors affecting the economic driving and also since the company wanted them to drive fast most times, it was very difficult to drive economically. One driver who said that he did not apply the training and had a decrease in fuel consumption explained his ideas about the transfer of training with the words,

> S4: No, I did not apply the techniques we practiced on the simulator, actually. I drove the truck by using my own techniques and my fuel consumption amounts decreased [7].

Shortly, most of the drivers (n=18) stated that they could apply the knowledge they gained during the training in appropriate times while driving the real truck. Only 1 driver said that he could apply the knowledge every time on real truck. While 6 out of 19 drivers stated that they provided a decrease in fuel consumption amounts after the training, 5 of them said that there was too little decrease in fuel consumption after the training.

On the other hand, 1 driver pointed out that his fuel consumption amount did not change after the training. It was important to point that 7 out of 19 drivers stated that they did not know the fuel consumption amount before the training because the fuel consumption amount had not been important for the company before the training. On the other hand other, 3 drivers said that they did not apply the techniques explained during the training. 1 out of 3 drivers pointed out the decrease in fuel consumption after the training, other one mentioned no decrease and other one stated he had not calculated the fuel consumption amount before the training. The chart the researcher created for the qualitative data analysis and emerged codes are shown in Table 4.39.

Table 4.39 Number of the drivers who applied the training/applied it in appropriate times/ not applied it and codes emerged the first interview question

Codes	Applied	Applied in appropriate times	Not applied
1. Transfer of the training	1	19	3
1.1. Decrease in fuel consumption	1 decrease	6 decrease 5 little decrease 1 no decrease 7 not knowing	1 decrease 1 not decrease 1 not knowing
1.1.1. Reasons of no decrease or little decrease 1.1.1.1. Not applying the training much times 1.1.1.2. Express service 1.1.1.3. External conditions 1.1.1.3.1. Road conditions 1.1.1.3.2. Traffic flow 1.1.1.3.3. Loading amount 1.1.1.3.4. Delay in maintenance of trucks 1.1.2. Reasons of not knowing the fuel consumption amount before the training 1.1.2.1. Company's not giving importance to fuel consumption amounts before training 1.1.2.2. Company's calculating the fuel consumption amounts			1.1.3. Reasons of not applying the training 1.1.4. Knowing the knowledge offered the training 1.1.5. Training's not effective for real road environments 1.1.6. The trucks' doing much things own their own that offered during the training because of having automatic transmission
1.2. Applied knowledge 1.2.1. driving more fast on uphill road 1.2.2. not stopping or running the truck unnecessarily 1.2.3. leaving distance for using brake – using the truck in a controlled manner 1.2.4. arranging gearshift change 1.2.5. adjusting the gas while driving on uphill road 1.2.6. not stepping on gas unnecessarily 1.2.7. stopping to drive truck according to the motor sound 1.2.8. driving the truck in high rpm level on downhill"			

The similar question which was "what do you think about what extend the transfer of training is provided after the training?" The results of the interview conducted with managers supported the interview conducted with drivers. Similarly, the managers stated that there were many factors affected the transfer of the knowledge gained during the training and the decrease in fuel consumption amount was little. One of them mentioned the statistical results hold by the company.

This manager said that there was a difference in fuel consumption amounts between inland and abroad drivers. Moreover, this manager pointed out that there was an increase of gas saving in some months while there was a decrease of gas saving in some months compare to other months. He stated these and the reasons of these increases and decreases in gas saving with the words;

> S23:...There is a decrease in our inland and abroad service drivers' fuel consumption amounts after January 2009, then there is a small increase in February. But if we compared to June months with February month, I can say that the mean is 34.2 and there is a 1.3 point gas saving. I think that it is the effect of the training...Inland service drivers can have more fuel consumption amount since they have to driver heavily on downtowns. They have to stop and running trucks much more. There is affect of the training on the fuel consumption. In other words, the training affect on fuel consumption in inland department seems less than one in abroad department. Also, abroad drivers can plan their driving methods because the journey is long. Since there are many stopping and running the truck events, there is not much difference [8].

Other managers were from the training department of the company and mentioned the training effect on fuel consumption based on his conservation with the drivers and observations to them. He pointed out that he talked to drivers who took the training and according to most of the drivers the training was beneficial because there was a deficiency in knowledge to understand the new generation trucks. Also, the manager stated that some drivers decreased their fuel consumption amounts from %35-36 to %27-28, and generally the company saved 16-18 tons gas. On the other hand, he emphasized that the fuel consumption amounts changed according to the work type. The manager said that they calculated the fuel consumption amounts based on the taken km in each month and for that reason, the number of the work did not affect their fuel consumption amount calculation results. He explained all these issues with the words,

> S24: I talked to each driver who you offered the training. All of them has an opinion about driving techniques explained during the training. Among them, there are drivers who think that we know everything about the profession or the electronic device cannot be beneficial. However, most of them think that the training is beneficial. Generally they believe that the technology and our trucks are developing but there is a deficiency in knowledge about the new technology. They say that their driving methods were mistake and when they changed them, they realized the difference in fuel consumption amounts. They understand that although the simulator has an artificial environment, if they applied the knowledge gained from

> the training, the fuel consumption amount decreased….As a result, we provided gas saving. The fuel consumption amounts decreased… Monthly, we provided 16-19 tons gas saving but of course it depends on the work type. We can provide profit this month. The next month, the work can be time-bounded, have heavy tonnage. If there is express service, there may not any profit or very little profit [9].

Shortly, both of the managers stated that there is a little decrease in fuel consumption amounts in the company. Also, according to them, the training was affected on this decrease. On the other hand, they pointed out that there were many factors affecting the fuel consumption amounts and for that reason, the decrease could not be provided sometimes. Table 4.40 shows the codes emerged from the interviews conducted with managers.

Table 4.40 Codes emerged from the first interview question answered by managers

Codes
1. **Transfer of the training**
1.1. Decrease in fuel consumption 1.1.1. Little decrease in fuel consumption amount 1.1.2. Fuel consumption amount decrease's changing monthly 1.1.2.1. Reasons 1.1.2.1.1. Route 1.1.2.1.2. Work type 1.1.2.1.3. Express driving 1.1.2.1.4. Tonnage of loadings
1.2. Applied the training 1.2.1. Believing the effects of training on decrease in fuel consumption amounts 1.2.2. Most drivers' stating that they applied the training 1.2.3. Most drivers' understanding the necessity of training 1.2.4. Most drivers' understanding needs of training

Shortly, the managers stated that there was a little decrease in fuel consumption amounts. Also, they emphasized that there was an effect of the training on that decrease. Also, they said that these decrease depended on the work type, tonnage and route of the services. For that reason, according to the manager, the profit could be provided in one month while it cannot be provided in another month.

The second interview question was asked to investigate whether there were factors supported the transfer of training the training. During the interview it was realized that the drivers mentioned the other factors provide them to have willingness for driving economically undefended from the transfer of training. In other words, the factors were explained in a matter that they wanted to drive economically and the training provided necessary knowledge to do it. Since most of the drivers mentioned more than one factor which supporting the economic driving, the researcher did not give the numbers of drivers for each factors. However, she ordered the factors from mostly mentioned to least mentioned. According to the interview results, 2 out of 22 drivers (drivers who were coded as S8 and S21) did not give answer the factors supporting economic driving. Instead they mentioned the training's benefits and factors preventing the application of it. Moreover, they mentioned the other external factors such as road conditions, loadings, truck maintenance issues on economic driving. For that reason their answers of second question were coded factors preventing the economic driving. The factors supporting the economic driving and application of the training belonged to 20 out of 22 drivers.

Mostly mentioned factor affected the economic driving was the training according to the drivers. Most drivers mentioned positive effect of the training on drivers' driving method. According to these drivers training provided necessary knowledge for economic driving and corrected the some misconception about some driving techniques. For that reason, a decrease, despite little, was provided in fuel consumption amount. They said that without necessary knowledge, they could not provide it even they wanted to drive economically. One driver stated that,

> S1: The decrease in fuel consumption is related to the training. If you asked why? Before the training we drove the trucks by using the method we know and the fuel consumption amounts were high. Then we attended the training and applied it. I realize the difference. Everybody who applies it can realize the difference [10].

On the other hand, a few drivers who stated that they did not apply the training mentioned the positive effects of the training while answering the second question. According to them training made people realize the importance of fuel consumption amount and drivers started to talk about their fuel consumption amounts in real life. Also, these drivers stated that although they drove the trucks according to their own knowledge, they realized the importance of the economic driving after the training.

The secondly mentioned factor was the change in company's point of view on the fuel consumption amount. According to the drivers, the company did not care the fuel consumption amount before but then they changed their point of view. For that reason some of them stated that they tried to drive economically. Moreover, some drivers stated the training effect here again. According to them, since the training provided necessary knowledge, they could drive economically accordance with the company wish. One of the drivers who emphasized the change in point of view about fuel consumption and how it affected him said that,

> S4: The Company arranged a meeting with the drivers but I could not remember when it was arranged. It may before and after the training. The new manager said that the first aim was to decrease fuel consumption amounts. Then I tried to decrease it…..The company follows the trucks via the technology, satellite. They already know where the truck is and how much it consuming the fuel [11].

On the other hand some drivers complained the company's demand which was decrease in fuel consumption. They said that they tried to do what the company wanted but there were many factors affected the fuel consumption. According to them, these factors also should be taken into account when the driver performances evaluated. One of these drivers said that,

> S15: The Company said that applied the knowledge you gained during the training. They wanted us to drive economically. We apply it in appropriate conditions anyway; rather, we try to apply it. However, everything is clear such as road conditions, loading… Here is my work place and of course I wanted to contribute its budget but there are many factors [12].

Moreover, some drivers pointed out that the demand of the company was not consistent with its working conditions. Since the company had many express service orders from the customers, they could not apply the economic driving in many times.

> S6: The Company gives the prizes. Good, very good. But your drivers have express services in much time. I cannot think the prize when you have express driving. Of course when you have time, you drive slowly and by thinking the gas saving [13].

On the hand, the drivers stated that the company had a tolerance on fuel consumption amounts when they had express service. One of the drivers mentioned the company's tolerance in fuel consumption amount if the drivers had an express service with the words,

> S3: There were times that I had high fuel consumption because of express service or road conditions [14].

On the other hand, some drivers he emphasized that the company tried to encourage the drivers by giving prizes or arranging the meetings with drivers about the companies aims, fuel consumption and so on. However, they did not affect them because they tried to contribute the budget of the company for years. These drivers emphasized that they earned money by doing their profession and the stronger company meant the more money they got. Most of these drivers stated that they always drove the truck by paying attention to the fuel consumption. One of them said that,

> S16: The Company is trying to encourage the drivers by giving prizes but if you asked me whether it affected me. No. In other words, they mean that if you step on gas pedal less, you can take the gold. I am continuing to do my job like as I have done for 6 years. I am not doing anything extra [15].

According to the interview results, the applications of the company parallel to their point of views change about the fuel consumption were: 1) The company made a list in which there were 100 drivers having less fuel consumption amount every week; 2) They gave quarter gold coin three drivers who were in first three in the list 3) The new manager arranged a meeting with the drivers on company's aims and pointed that the first aim of the company was to decrease in fuel consumption amounts. 4) The company fleet manager talked with the drivers having much more fuel consumption amounts than it was expected.

Most of the drivers mentioned the positive effect of the prizes that was given by the driver, some complained from it. Moreover, some of the drivers stated that the prize or the company's point of view did not affect them. The drivers who pointed out that they wanted to take prizes and it made them more willingness to drive economically said that the other drivers talked about the drivers who gained the coin and they were more respectful these drivers. In other words, the reason they wished to gain prize was to have more respect. One of these drivers said that,

> S11: Now, we have, there is prize for the drivers who have less fuel consumption, do you know. It is a quarter gold coins. I could not take it until now....People talked about the fuel consumption amount, do you know. They said "do you know who is first in the list" and "how much do you have fuel consumption this month" and something like that. People are affected from list anyway [16].

Aforementioned, some drivers stated that this application affected them negatively because it was injustice. According to them there were many factors affected the fuel consumption amount. These drivers said that the loading situation and the route of the drivers were different. While one driver drives with 5-6 tonnage on the route that is straight heavily, other driver drivers with 20-25 tonnage on the route that is uphill heavily. They emphasized that company did not care these factors and made list according to fuel consumption but they should prepare this list according to performance improvements of the drivers not the fuel consumption.

Moreover, some drivers stated that not the prize but their wishes to contribute company budget effective on economic driving. One of the drivers emphasized unimportance of the prize on his performance with the words, S5: Now, I say that the prize is not very important. Whether I get prize or not does not affect me [17].

The thirdly mentioned factor that supporting the economic driving was “liking the job and doing it well” Actually, this factor was mentioned under the first and second factor that supporting the economic driving. Aforementioned before some drivers stated that their willingness doing the job well and contribute the company budget affected their driving, not the company’s point of view, prize or training. One of these drivers said that,

S14: Actually, every job has strategies to do it well. Also, the people’s opinions affected the style that follows to do job. From the beginning, I love my job and try to do it well. For that reason, I have not any problems since I began the job. Doing the job well and contribute the company are important for me [18].

Last factors mentioned by the drivers as supporting factors to economic driving were the condition of the trucks. According to some drivers, the trucks of the company were new generation trucks and their ages were not more than 3 years. For that reason, the trucks arrange many things about the economic driving themselves. Also, since their conditions were well, their fuel consumption amounts were normal according to company’s working conditions.

Shortly, drivers found the training the most affective factors that provided the economic driving. The drivers who stated that they did not apply the training also mentioned the training positive effect, namely, its providing company drivers’ realize the importance of economic driving. According to interview results, the second important factor that was affected the drivers’ economic driving willingness was the change in company’s point of view. Company’s applications were giving the prizes to drivers who have less fuel consumption, preparing list that included drivers who have less fuel consumption and new manager’s arranging meetings about the company’s goal about fuel consumption amounts. On the other hand, a few drivers stated that the prize negatively affected them or not affected them. The third factors mentioned by the drivers was their liking the job and as a result, their wanting to do it well. Lastly, the drivers stated that the truck of the company was new generation and for that reason, their fuel consumption amount was normal. The codes emerged the second interview question is shown in Table 4.41.

Table 4.41 The codes emerged from the second interview question

Codes
1. Factors supporting the economic driving
1.1. Training 1.1.1. Providing necessary knowledge 1.1.2. Making drivers realize economic driving
1.2. Change in company's point of view on fuel consumption amount 1.2.1. Starting to giving more importance to fuel consumption amount 1.2.2. Giving prizes drivers who have less fuel consumption 1.2.3. Arranging meeting of the goals of company on fuel consumption amounts 1.2.4. Making people realize economic driving
1.3. Wanting to contribute company's budget 1.3.1. Liking the job 1.3.2. Wanting to do job well
1.4. The trucks conditions 1.4.1. Trucks' being new generation 1.4.2. Trucks' adjusting much things about economic driving itself

Moreover, the managers were asked their ideas about the factors supporting the transfer of the training. According to the interview results, the company politics were changed about the fuel consumption amounts and there were some applications to make drivers understand this change. The managers stated that they started to follow drivers who had a high fuel consumption amounts and investigated the reasons of it. Also, they said that they gave prizes to the first three drivers who had least fuel consumption amounts. According to the one manager, the company followed two applications to provide decrease in fuel consumption amounts and these were makes the drivers' realize the change in company point of view by following to drivers' performances, giving prizes to them and providing training to them. This manager pointed out the factors supporting the transfer of the training,

> S23: We are talking to the drivers who have high fuel consumption amounts. For that reason, they know the company's opinion…We followed the drivers who have high fuel consumption. So, the reports are hung. They should drive more carefully to be top in these lists. We gave a quarter gold coins to the drivers who were the list in February, March and April. Our strategies are based on such rewarding system. Other one is warning [19].

Other managers said that,

> S 24: We, as company managers, tried to raise our drivers' awareness and said them that we will continue to do work with the more conscious drivers. We said that we would give prizes the drivers who are successful and we did it [20].

Since the managers emphasized the effects of intervenes of the company o fuel consumption, the researcher wanted to learn about their ideas whether they could reach their goals without the training. Both managers stated that without training, the company could not reach its goal because without the necessary knowledge, the drivers could not provide the decrease in fuel consumption amounts. One of the managers stated that,

> S 23: I think that all these are meaningful together. The drivers' perception could be different. The important thing is their transfer of the training. If the system had three parts as training, following and promotion, we did all. Without training, it could not be [21].

The other managers emphasized the same points with different words. He said that,

> S24: If the company's intervenes are more effective than the training, we now accomplish our goals in %100 percent. The important thing is drivers' believing the training. As I said before, there are drivers who believe the training and one who do not believe the training. If the company intervenes is more effective than training, all of them believe it or we fires these drivers [22].

Shortly, similar to the drivers, the managers stated that the factors supporting the transfer of training were promotion and company's following the drivers' performances. Moreover, they pointed out that all intervenes were meaningful together and without the training, it was impossible to reach their goals which was decease in fuel consumption amounts. Table 4.42 shows the codes emerged as a result of the second interview question with the managers.

Table 4.42 The codes emerged from the second interview question answered by the managers

Codes
1. Factors supporting the economic driving
1.1. Training
1.2. Change in company's point of view on fuel consumption amount 1.2.1. Starting to giving more importance to fuel consumption amount 1.2.2. Giving prizes drivers who have less fuel consumption 1.2.3. Arranging meeting of the goals of company on fuel consumption amounts 1.2.4. Making people realize economic driving

The drivers were asked the factors preventing their transfer of the training to real work environment in the third interview question. The aim was to find out the reason and what extend they affected the fuel consumption amounts negatively thorough this interview question. While mentioning answering the third question, some drivers talked generally by mentioning "the factors preventing economic driving", some talked specifically by mentioning "the factors preventing transfer of the training".

According to the interview results, a few drivers mentioned more than one factors preventing the transfer of training and one of the factor was heavily emphasized by them, namely, express service. For that reason, the researcher presented the numbers of drivers who only mentioned the express service and ones who mentioned other factors in Table 4.43. Also, while explaining the results, she did not give the number of drivers who stated them because a few drivers mentioned more than one factors.

Table 4.43 The factors preventing the transfer of the training with the number of drivers who mentioned them

Factors preventing the transfer of the training	**Number of drivers**
1. Express service	9
2. Express + road conditions (traffic flow, weather, road type)	7
3. Express service + delay in auto maintenance	1
4. Delay in auto maintenance + road conditions (route)	1
5. Delay in auto maintenance + road conditions + difference of the drivers driving method + difference in trucks	1
6. Road conditions (road type) + loading amounts	1
7. No factor	2

According to the interview results only 2 out of 22 drivers stated that there were any factors that prevented their transfer of the training. 1 of these drivers only stated that there was not anything that prevented him to apply training. On the other hand, other driver stated that a driver should always think the economic driving even under the difficult conditions. For that reason he did not say such factor with the words,

> S13: Well, there is not such a factor; you have to think economic driving every time. When you think that, it is beneficial for your company, you and your truck. You have to drive economically [23].

The interview results showed that most of the drivers mentioned “having express service” preventing them to apply the knowledge they learned during the training. These drivers stated that in express services, they had to take loadings to the target place in a limited time. For that reason, they said that they had to drive fast even without sleeping two days. Most of the drivers emphasized that most of the times they had express service because the company was famous its express services. According to them, the express services did not also prevent them to drive economically but also cause traffic accidents since the drivers’ perception weakened because they were tired of driving 2-3 day without stopping. On the other hand only one driver stated that he could even save gas in express driving after the training compare to before the training. This driver emphasized that if he had express service he could not save gas as much as he did in normal service. He continued his explanation by saying that he could save gas compare to fuel consumption amounts in express services before training. One of the drivers stated that having express services affected their economic driving method negatively with the words,

> S2: When we have express service, the application of the knowledge gained from training opportunity is decreasing [24].

Moreover, some drivers mentioned the road conditions negative effects on the economic driving in addition to the express driving. According to these drivers, the road conditions included their route (every driver take the loadings on a specific road), weather conditions and traffic flow. The drivers stated that their route affected the economic driving because some routes have many uphills roads and also the condition of road was not good. According to this drivers, most of the roads they drove on were not expressway and for that reason they had to stop and run the trucks most of the times. They stated that it affected the economic driving very much. Moreover, the drivers stated that traffic flow has the same affect on the economic driving. According to them, especially on downtown road, they have to stop and run trucks too much. The weather was another road conditions that the drivers mentioned sometimes affected the driving method negatively. One of the drivers stated all these factors affect with the words,

> S20: Now, the company is the first in terms of the truck conditions because all of them are new generation. But the road we drive the trucks, actually, the road conditions of the countries are not same. The roads of some counties have very bad conditions. I am trying to do best in terms of gas saving but the roads affected so much. Also, we can apply the techniques learned from training if we had normal services. If we have time we apply the knowledge we gained during the training [25].

The traffic flow affects on economic driving were emphasized by one driver,

> S19: What factors affected the economic driving: traffic flow that affected the stopping and running the trucks, express service, weather conditions [26].

The other factor affected the economic driving negatively in addition to the express service was the delay in auto maintenance according to the drivers. The drivers stated that there were limited personal that were dealing with the auto maintenance and they could not maintain all the trucks in time. Also, some drivers stated that auto maintenance and changing some parts of the trucks were expensive. For that reason, the company made changes in the parts late but they lost the money from fuel consumption on the other side according to them. One of the drivers pointed out the auto maintenance affects on economic driving with the words,

> S8: The personal cannot maintain the trucks in time. The auto maintenance is not perfect here and it affected fuel consumption amounts [27].

Also, some drivers stated that the amount of loading affected the economic driving. A few of them complained from company's offering the prizes because loading amounts and route were different for drivers. One driver pointed out that,

> S12: There is also loading amount factor. For example if you drive between Istanbul and Aksaray with 24 tonnages, you have %37-38 percent fuel consumption amount in the worst case scenario because the road includes uphill heavily. On the other hand, the other man drives between Istanbul and Adana with 5 tonnages. Straight road. Of course, this main has %27-28 percent fuel consumption amounts. [28].

According to the interview results, a few drivers did not mention the express driving but mentioned other factors, namely, delay in auto maintenance, road conditions (type of the roads, weather, and traffic flow), and difference between the performances of the trucks and drivers' driving methods. These drivers stated that some trucks consumed more gas than others. According to them, the maintenance issues as well as difference between the difference truck types (Mercedes versus Duff) caused the differences in fuel consumption amounts. Moreover, these drivers pointed out that the drivers' driving methods were different than each others'. According to them, some drivers love to drive fast and for that reason, it was natural of their having high fuel consumption amounts.

Briefly, the mostly mentioned factor that affected the economic driving and transfer of the knowledge gained during the training was express service according to the drivers. Moreover, some of them complained from the delay in auto maintenance and road conditions (type of the roads, weather, and traffic flow). The drivers stated that there were differences between the trucks and drivers' driving methods and also these factors affected the economic driving. Table 4.44 shows the codes emerged from the third interview question.

Table 4.44 The codes emerged from the third interview question

Codes
1. Factors preventing the economic driving
1.1. Express service 1.1.1. limited time 1.1.2. having to step on gas pedal 1.1.3. being tired
1.2. Road 1.2.1. road types (uphill, downhill, straight, downtown) 1.2.2. road conditions (smoothness, bumpy and so on) 1.2.3. weather condition 1.2.4. traffic flow
1.3. Delay in auto maintenance
1.4. Differences in trucks
1.5. Difference in drivers driving methods
1.6. Loading amounts

The third interview question asked to the managers also aimed to learn their opinions about the factors preventing the drivers' transferring of the training. Parallel to what the drivers said, both of the managers pointed out that express services affected negatively application of the knowledge gained from the simulators. The managers stated that, they wanted the drivers who had express service to drive fast and this made very difficult to transfer of the training. One manager also pointed out excessive loading and route effects with the words,

> S23: Express services or excessive loading. They can affect the drivers' performances negatively because the loadings should be delivering to the customer in a limited time. We press the drivers to drive fast. However, in the training with simulator, it was advised to drive in a specific speed level. As I said before there is a difference between inland and abroad department drivers. The driver who work inland have less decrease in fuel consumption amounts because of the traffic flow [29].

To sum, according to the results of the interviews with managers, the factors preventing the application of training on real roads were express services, route type and loading amounts. The codes emerged from the third interview question asked to managers are presented in Table 4.45.

Table 4.45 The codes emerged from the third interview question asked to managers

Codes
1. Factors preventing the economic driving
1.1. Express service 1.1.1. limited time 1.1.2. having to step on gas pedal
1.2. Road 1.2.1. road types (inland, abroad) 1.2.2. traffic flow
1.3. Loading amounts

The fourth interview was posed to find out the contribution of the TS on transfer of the training. All the drivers firstly mentioned the training effect on the economic driving with this question. Then they talked about the role of TS on application of the knowledge gained from the training. 4 out of 22 drivers stated that they did not want to attend the training but because the company wanted them to attend, they had to attend it. 3 of these drivers pointed out that their negative attitude changed towards positive during the training because they found it beneficial for them. On the other hand, 1 out of 4 drivers stated that although the training was beneficial for novice drivers, it was not doing more than reminding the old knowledge for expert drivers. One driver stated that he changed his negative opinions about the training after attending it,

> S7: While I was attending the training I had thought that the company tried to disturb us. During the training, I realized that the man really explained important things. Now, I advise everybody to attend training. Now, if there is training, I want to attend again to refresh my knowledge [30].

According to the interview results, all 22 drivers stated that they found the training beneficial. On the other hand, while 2 of them stated that the training much more beneficial for novice drivers, 1 of them stated that it should have been offered only novice drivers. 21 of the drivers stated that they learned new things during the training. Moreover, most of the drivers pointed out that they need to develop themselves to drive new generation trucks more efficiently and the training was important opportunity provided them this development.

Shortly, all the drivers mentioned the training before specifically explain their ideas on the role of the simulator on transfer of the training. According to the interview results all of them found the training beneficial. Only 1 driver stated that the training was beneficial but it should have been offered to the novice drivers not experts.

Aforementioned, the fourth question aimed to discover drivers' opinions about what extend the simulator had a role to transfer the gained knowledge during the training to real road environment. While mentioning the simulators role on the transfer of the training to real work environment, the drivers also made comment on the simulator contribution to the training. Only 1 driver did not make comment on the role of the simulator in the transfer of training and only mentioned the contribution of the simulator to the training. For that reason the following results of the third question belonged to 21 out of 22 drivers. Moreover, 4 out of 21 drivers stated that there was no contribution of the simulator in the transfer of the training. 1 of these drivers stated that both the training and simulator did not have affect on his economic driving because he is expert and this training should have been offered to novice drivers. He said that,

> S15: Well, nothing had changed, if the training had offered with the simulator or without the simulator for me. The training did not affect me. As I said before, because I learned the job via apprenticeship [31].

On the other 3 drivers stated that the training was beneficial and they learned something during the training. However, the simulator was not necessary for them because they were expert. In other words, they stated that the theoretical part was sufficient for them.

17 drivers made positive comment about the simulators affect on the transfer of the training. The interview results were consistent with the ones conducted during the training about the role of the simulator in the instruction. Similarly, the most of the drivers emphasized that the practicing opportunity that was provided by the simulator as a big contribution to the training. However, there was only one difference in this interviews because most of these drivers compared their performance on the simulator and on real trucks and continued to explain their ideas by mentioning that the simulator enabled them to remember knowledge easily. In addition, they said that practicing on simulator had made more understandable how to they could apply the knowledge and they could easily apply it on real trucks.

It was interesting that although a few of these drivers mentioned the difference between the simulators, they continued the positive effects on it. According to them, although the simulator did not represent the real truck, it gave opportunity to practice what they learned during the training. Also, they said that they could realize the accuracy of knowledge after seeing the difference in fuel consumption amounts between the first and second driving on the simulator.

1 of them stated that if they had driven trucks with manual transmission in real life, the gas saving portion could have been more because the simulator was with manual transmission. This driver pointed out that,

> S14: Well, as I said before our trucks, anyway, we do not drive trucks with manual transmission. Maybe, our fuel consumption amount would decrease more, if our trucks had had manual transmission since the simulator was with manual transmission [32].

Moreover, another positive effect of the simulator on the transfer of the training was that it proved the accuracy of the knowledge and enhanced the applicability of the knowledge on real trucks. 12 of the drivers stated that they could not apply the knowledge gained from the training if it had been offered without the simulator. According to these divers if they did not see the difference in fuel consumption amount between first and second driving, they did not believe the trainer and continued to drive the truck as they did before the training. These drives stated that,

> S12: Without the simulator, the drivers would have continued to drive the real trucks as they did before the training. There would be no change. Of course, driving the simulator before and after theoretical part affected the drivers. On real trucks, the driving methods are very important. In addition to driving method, loading amounts are really important [33].

Some of the drivers stated that the simulator shortened the application of knowledge gained on real trucks. According to these drivers, since the simulator provided an example how to use the knowledge while driving the trucks, they could apply them easily in real trucks. Also, the drivers pointed out that if the training had not included driving on simulator part, they could apply the knowledge after they developed themselves.

Also, a few drivers stated that the simulator made active the drivers during the training. According to them, they could understand what the trainer meant while explaining the techniques on economic driving during the theoretical part. For that reason, they said that the knowledge became more permanent and effective. One driver pointed out that,

> S16: Of course, it was beneficial to apply the knowledge about engine brake use technique on the simulator. Some drivers are old. Now, I can understand whta the trainer said but some drivers are old. Now, you said something here, they forgot what was said before they went out. It made the training more affective [34].

Some of the drivers stated that another contribution of the simulator to the training was that it made it more entertaining. For that reason, according to these drivers, they could easily remember the knowledge offered during the training and applied it.

Shortly, most of the drivers stated that the simulator provided practice and for that reason the knowledge would be more permanent. Moreover, they emphasized that the simulator proved the accuracy of the knowledge which was offered from the training. The codes emerged from the fourth interview question are shown in Table 4.46.

Table 4.46 The codes emerged from the fourth interview question

Codes
1. Role of the simulator in transfer of the training
1.1. Providing practice made easy to apply knowledge on real trucks 1.1.1. Making knowledge more permanent 1.1.2. Making knowledge more understandable 1.1.3. Making more active the drivers during the training 1.1.4. Making more effective the training 1.1.5. Making more entertaining the training 1.1.6. Shortening the application of knowledge on real trucks
1.2. Enhancing application chance of the knowledge on real trucks 1.2.1. Showing the accuracy of the knowledge 1.2.2. Making drivers' believe the accuracy of knowledge 1.2.2.1. Drivers' realizing the knowledge accuracy after seeing the difference in fuel consumption amount between first and second driving
1.3. No effects of simulator on application of knowledge gained 1.3.1. Simulator's being effective for novice drivers 1.3.1.1. Showing them how to apply knowledge 1.3.1.2. Making training more understandable for them 1.3.1.3. Providing practice opportunity for them

Moreover, the interview question about the contribution of the simulator to the transfer of the training was asked to the managers. Similar to the drivers' interview results, he managers stated that the simulator made drivers' realize the difference in fuel consumption amounts when they drove according to their driving methods and trainer's method. According to them, they became more willingness to apply it on real truck. Both managers also stated that practicing on simulator made the training more effective. One of the managers stated that the driving on the simulator provided their talking each other about their performances and made the training more entertaining. One manager said that,

> S24: According to me, it is very good that there was a device providing the drivers' seeing their own performances [35]

Shortly, the interview results of the data obtained from the managers showed that simulator enhanced the application of the training on real trucks since the drivers realized the difference in fuel consumption if they had driven according to the training. Also, the managers mentioned that the simulator made more entertaining to the training. The codes emerged from the fourth interview question are shown in Table 4.47.

Table 4.47 The codes emerged from the fourth interview question data obtained from the managers

Codes
1. Role of the simulator in transfer of the training
1.1. Providing practice made easy to apply knowledge on real trucks 1.1.1. Making more effective the training 1.1.2. Making more entertaining the training
1.2. Enhancing application chance of the knowledge on real trucks 1.2.1. Showing the accuracy of the knowledge 1.2.2. Making drivers' believe the accuracy of knowledge 1.2.2.1. Drivers' realizing the knowledge accuracy after seeing the difference in fuel consumption amount between first and second driving

The fifth question was asked to discover what changes should be done in the training design to enhance transfer of the training on real work environment. The researcher did not limit the question by asking specifically the simulator since her aim was to understand whether the simulator was seen necessary. Also, the researcher wanted to learn different training designs in that simulator role was different than one in current design.

1 out of 22 drivers stated that he did not want to give answer to this question since he needed to time think about the question. Although the researcher pointed he could think as much as he wanted, he stated that he did not want to answer it. For that reason, the results of the fifth interview belonged to the 21 drivers.

According to the interview results, 16 out of 21 drivers stated that they did not suggest anything for the training design. 1out of 16 drivers pointed out that the training was not perfect but for this time and for this company, it was sufficient. Also, this driver said that after 5 years or 6 years, the change will be necessity in the training. This driver explained his ideas with the words,

> S11: I cannot say that I am giving 4 point over 4 to the training. It should be accepted. For now, it is sufficient. At this time, the training you offered is beneficial anyway. It should be developed in time but now it is not necessary…I give 3 point over 4. For now, I have no idea, anyway [36].

Other 15 drivers emphasized that the current design of the training was good and provided transfer of the knowledge gained. Moreover, most of these drivers stated that the simulator was suitable for the training and driving the simulator two times provided them to realize accuracy of knowledge gained. One driver said that,

> S5: Actually, there is not much things to suggest. In other words, how it could be changed and offered. It offered by providing practice, also the simulator was designed for this training. We could drive it anyway. I cannot say “it should be like that” after all these efforts. Of course according to me. [37].

5 drivers suggested something for training during the interview. However, 3 out of 5 drivers did not suggest any changes in the current training design. 1 of them stated that the drivers’ knowledge on driving and new generation trucks should be refreshed continually, for example via monthly journals. Other one suggested the trainer to prolong the training time. According to him the training time was short. He said that,

> S7: The training was too short [38].

Similarly, 1 out of 5 drivers complained from the shortness of the training time. Also, he suggested that training should be repeated. On the other hand, 1 drives pointed out that it was more beneficial if the trainer explained technical information on real trucks parts. He also suggested that, the drivers already know the road conditions and how the drivers should driver according to these conditions. For that reason, the trainer should eliminate the information about road condition according to him.

Only 1 out of 21 drivers stated that the training should be offered the novice drivers not experts. He said that he learned the job from master driver via apprenticeship and for that reason he knows many things about the profession. He continued that, he drove the simulator because he wondered how to drive it. He said that,

> S4: I do not think that the drivers who have done this job for a long time take into account the simulator. Maybe he wonders it and just try. However, I have applied it [39].

Shortly, most of the driver found the training design was good and sufficient. Also they made positive comments the role of the simulator in the training design. They stated that since they drove it before and after the training, they could realize the accuracy of the knowledge offered during the training. Table 4.48 shows the codes emerged the analysis of the fifth interview question.

Table 4.48 The codes emerged from the fifth interview question

Codes
1. Suggestions for the training design in order to enhance transfer of the training
1.1. No suggestion 1.1.1. Training' being sufficient 1.1.2. Training's being good
1.2. Too short
1.3. Continued with new applications 1.3.1. Monthly journal on trucks

The fifth question was repeated to the managers in order to learn their opinions about what changes should be done in the training design to enhance transfer of the training. Both the managers suggested there should be small changes in the training. On the other hand, their suggestions were different than each others'. According to the one manager, a part of content was not appropriate their company drivers. He stated that some of the content belonged to different technology. He continued to explain his ideas by emphasizing that the drivers complained from that and could not know how to apply this knowledge while driving their trucks. He said that,

> S24: Actually, I want to see this in the training with simulator. I want the content much more appropriate to our trucks. Some content referred to the old technology. For example system X. This system is different than one in our trucks. Our trucks technical properties should be taken into account. Since the drivers learn the knowledge which is consistent with their trucks, the transfer of it is more effective [40].

The other managers suggested that the economic driving techniques should be applied on real trucks after driving on simulator. He stated that the drivers had an opportunity to practice the knowledge on a real truck and it invoked the drivers' willingness to apply the knowledge gained during the training. The manager also mentioned the cost of this design but continued his words by emphasizing that the company could give hostages to fortune to reach its goals. He pointed out that,

> S24: After practicing on the simulator, the opportunity which is stopping, running the truck and maneuvers such those could be provided for them on real truck. So, the captains can compare what learned with old knowledge and behave according to their experiences. It could be added to the training design. Of course, it means extra cost [41].

Briefly, the managers of the company suggested some changes on the training design. One of them advised that some information of the training content should be modified according to the company trucks. Other manager suggested that the drivers should practice the knowledge on real trucks in addition to simulators. Table 4.49 Shows the codes merged from the fifth interview question asked to managers.

Table 4.49 The codes emerged from the fifth interview question asked to managers

Codes
1. Suggestions for the training design in order to enhance transfer of the training
1.1. Extra Practicing on real trucks
1.2. Arranging content according to company trucks' system

Summary of the Results of Data Concerning Transfer of the Training and Factors Affecting Drivers' Performances on TS

This part of data were not planned to be collected at the beginning of the study. On the other hand, the results of data collected during the training showed that the transfer of the training was also parts of the instructional simulator process and there were many factors affecting the transfer of the training. For that reason, with the guidance of the advisor, the researcher decided to investigate transfer of the training. The reports of the company on drivers' real life fuel consumption amounts were analyzed and also managers as well as the drivers' were interviewed.

According to the results of the study, there was not a significantly difference in drivers' fuel consumption amounts before and after the training. This result was consistent with the qualitative data in that both drivers and managers stated that there is slightly difference before and after the training performances of the drivers. According to them, the important thing was the change in the drivers' point of view after the training. Moreover, it should be noted that the expert trainer, drivers and managers stated that there were many factors affecting the transfer of the training positively and negatively. According to them, most important factor affecting the transfer of the training was the drivers' realizing the difference in fuel consumption amounts between the first and second driving on the simulator. Most of the drivers' stated that they wanted to apply the economic driving techniques on real truck since they wondered whether they could save gas in real life vith these techniques. Moreover, the manager stated the positive affects of the simulator on transfer of the training. On the other hand, they stated that there were many factors affecting the transfer of the training and according to them, the most important one was the express service because they had to drive fast on express service.

The qualitative data (interviews with the drivers and manager) provided precious information about the instructional simulation validation process. Firstly, the transfer of the training should be evaluated in terms of the company or drivers' aims not the statistical results. Second one, the factors should be taken into account while interpreting the results of the transfer of the training.

Summary of the Results of the Data Concerning Instructional Validity of the Simulator

The data on instructional validity of the simulator was collected through experimental research design conducted during and after the training. During the training; participants' fuel consumption amounts, gearshift change numbers, stepping on gas pedal numbers and rpm use numbers before and after the expert's presentation on economic driving techniques were compared. The results showed that there was a significant difference between participants' before and after training performances. However, this result was not related directly to the validation of the simulator. The simulators' role in the training should be investigated thorough qualitative research. For that reason, the researcher interpreted these results along with the face validity results in the following part (part 4.2.4)

Moreover, the factors affecting the instructional validity were controlled via statistical analysis. According to the statistical analysis, the differences within the factors were very slight. For that reason, the affects of factors on participants' performances was not significant. This meant that the researcher did not have to take into account factors affects to validity of the TS in this case. On the other hand, there are some factors did not investigated through quantitative analysis. These factors merged during the study and explained in the face validity parts.

The second part of the instructional validity merged the data collection during the training. According to participants, the important thing was transferring the training. For that reason, the researcher broadened the instructional validity scope and investigated the transfer of the training. The results showed that there was not a significant difference in participants' real life before and after training fuel consumption amounts. Interview results supported the quantitative data results in that model of the participants mentioned very slight difference in their performances. However, all of them pointed out that there were many factors affecting the transfer of the training and the important thing was the change in their perspective about the economic driving.

These results had some underlying principles. These are:

-Inform the participants about their performances

-Identify and develop participants' awareness about the benefits of the training with simulator

-Acknowledge clearly company's point of view about the training

-define the research design and methods of validation process (Behavioral, face and instructional validity should be take into account together for instructional simulators).

During the data collection, the researcher realized that the behavioral validity of the simulator (reality, usability) also provides changes in their perception (face validity). Moreover, their perception affected their application the knowledge on simulator and real truck (instructional validity. However, it should be noted that some reality and usability problems were not important for them because there were some other factors affecting the participants' perception about instructional validity of the simulator. For that reason, the "factors affecting the determination of the validity should be defined" during the investigations.

4.1.4. Summary of the Results Concerning Behavioral, Face and Instructional Validity in terms of Simulator Validation Process

In this part, the researcher summarizes the results of the data collected in the scope of behavioral, face and instructional Validity approaches. The aims are to consolidate the results and extract the conclusions for characteristics of the instructional simulator validation process. To do this, the results of the each approach are summarized with an end that includes a conclusion regarding inmplications with validation process.

In the scope of Behavioral Validity, the researcher collected both quantitative and qualitative data. She firstly designed a pre-post test experimental design and analyzed the data by applying multiple regression analysis. The relationships of the important parameters were investigated. The aim was to get information about whether the fuel consumption measures provided by the simulator were similar to ones provided by a real truck. The results of the multiple regression analysis showed that the parameters explained the fuel consumption amounts in 36 percent. The researcher, secondly, interviewed with the expert trainer about the reality of the simulator. The results showed that the expert trainer interpreted the reality of the simulator in tw ways. First one was its fidelity. Second one was its contribution to the training. According to the results, the trainer stated that the truck simulator provided similar measures to real truck ones in 40% percent. After analyzed the quantitative data, the researcher asked the expert trainer and a software engineer bout their opinion on the results of multiple regression analysis. Both of them stated that the results reflected the reality since the fuel consumption amounts were affected by many factors. According to them, the best way to investigate reality of the measures provided by the simulator was asking the experts. These results had many implications for the instructional simulator validation model. These were:

- The validation of instructional simulators process should include behavioral, face and instructional together since the expert trainer mentioned both simulator's fidelity (behavioral validation) and contribution to training (instructional validation. Moreover, he pointed out the importance of taking the expert opinion (face validity).
- Validation of an instructional simulator is partly bounded to fidelity of the simulator. Since the results of interview with the expert showed that there are many factors affecting the fidelity results (e.g. human characteristic, environment).

In the scope of face validity, the researcher took drivers' opinion about simulator reality, usability and contribution to training through survey and interviews. Moreover, she interviewed with the expert trainer about the same issues. The results showed that the drivers did not analyze the fidelity of the simulator in depth. Instead, they mentioned when they drove the simulator accordance with the economic driving strategies, the fuel consumption amounts decreased. Moreover, although they did not find the performances of the simulator similar to ones of real truck, they stated that the contributions of the simulator to training were quite many. The drivers stated that the important thing was the transfer of the training. According to them since there were many factors affecting the transfer of the training, this part should have included these factors. On the other hand, the expert trainer evaluated the fidelity of the simulator in depth and mentioned the parameters' relationships. He also stated that although the similarity of the measures in simulator and real truck were in 40 percent, the simulator did its instructional use aim. These results provided precious information for the instructional simulator validation model:

- The validity of the simulator should be evaluated according to the instructional goals. Since the aim of the simulator used in the study
- Fidelity of the instructional simulators may be low, but despite it, it can be valid tool for an instruction. Since the drivers and expert trainer stated that although the simulator did not represent the real, its contribution to the training could not be ignored. For that reason, the fidelity is necessary but not absolute in instructional simulator validation process.
- The simulator validation process should include transfer of the training nd factors affecting it.

In the scope of instructional validity, the effects of the training on the drivers' performances were investigated. Moreover, the researcher collected the data on the factors affecting the drivers' performances and the transfer of the training. The training effects on the drivers' performance were important since the results were indicators for both the behavioral and instructional validity of the simulator. According to the results of the data, most of the drivers used the economic driving strategies and their fuel consumption amounts decreased parallel to this. These results showed that the simulator provided decrease in fuel consumption amounts when the drivers used economic driving strategies. On the other hand, there was not a significance difference in drivers' real life fuel consumption amounts after the training. The researcher conducted follow up interviews to get in depth information about the issue. The results showed that although there was not a significance difference the company managers and drivers satisfied with the result and mentioned the contribution of the simulator frequently. Secondly, there were many factors affecting the transfer of the training such as work conditions, the training, company's point of view about the fuel consumption amounts, weather conditions, route type, loading amounts and so on. The implications of these results for instructional simulator validation process were:

- The transfer of the training should be evaluated by taking into account the companies and participants' goals.
- The factors that may affect the transfer of the training should be followed up through qualitative methods.

4.2. Validation Process and Implications for the Simulator Validation Model (research Questions 2 and 3)

In this part, the research question 2 and 3 were answered by interpreting qualitative data in terms of implications for instructional simulation process. Actually, the researcher emhasized implications of each result to the instructional simulation validation process at the end of behavioral, face and instructional parts. The aim of the researcher in this part was to combine all these implications and presented the whole pictures about the simulator validation process.

There is not a specific simulator validation model for instructional simulators and for that reason the researcher combined the approaches suggested in the literature in a complementarity manner. Although the literature explained the relationships between the specific approaches each other, it is not even close to explain how they should be applied and what factors affected the validation process are or whether other approaches should be included in validation process.

For that reason, the researcher followed a designed case formative research approaches and tried to find answers all above questions. The data were collected through observation and interviews conducted with the drivers during and after the training. Moreover, trainer and managers were interviewed to investigate validation process of an instructional simulator. Observation notes and interviews with different data sources provided information about many issues not mentioned in the literature, namely, the criteria of the validation of the simulator, effects of system properties on simulator validation process, effects of the usability of the simulator on validity of the simulator. The researcher asked specific questions about the reality, usability of an instructional simulator and its contribution to the training. The comments on these issues also provided many implications about the process and instructional simulator validation model which aimed to be developed in the scope of this study.

The Criteria for the Validation of an Instructional Simulator

During the interviews the trainer and managers of the company stated some criteria used for the validation process of the instructional simulator. The main criterion was to define what purpose the simulator would be used during the training. According to the trainer, the aim of using the TS was to provide practice for the drivers and enable them to realize performance differences between first and second driving.

According to the interview and observation results, the first aim to use simulator was accomplished. According to the drivers who were interviewed with during and after the training, the mostly mentioned contribution of the simulator to training was that it provided practice opportunity knowledge gained. One driver emphasized the practice importance during the training with the words,

> S7: If the training was offered through only lecturing, I would not have taken into account it. Since I attended to UND trainings many times, seminars, also, Turing's seminars. They gave us Turing and UND license. However, I am sleeping at the desk while the uncle trying to teach something. There is no lie. But here, we attended and practice. It is different really [42].

Also, the managers stated the superiority of the practicing on simulator to lecturing. For that reason first instructional aim to use was accomplished in the training.

Second instructional aim was to make drivers realize the accuracy of the knowledge offered the training depended on some conditions related to the simulator. It was important to emphasize that the drivers' perception was the key in order to accomplish this goal. According to the trainer, the drivers who have worked as professional truck drivers for long years generally have a resistance to accept the accuracy of the knowledge offered during the training. For that reason, the drivers drove the simulator before and after the training made them believe the knowledge offered during the training. Actually, this application was designed by the researcher with the guidance of advisors in order to investigate behavioral validity of the simulator. However, the comments of different data sources showed that this design also provided to reach goals in terms of instruction. Also, the trainer said that the simulator should have provided consistent results with the theory. He continued to explain the importance of it with the words,

> "The accuracy of information we give during the training is suspected by the drivers when they get inconsistent results with the theory. We give accurate information and when the driver does the same things with the theory, the results should be

consistent with it. Otherwise, the absurd results affected both the trainer and the driver" [43].

Similarly, drivers pointed out that they believed accuracy of the knowledge gained during the training after seeing the difference in fuel consumption amounts before and after the training. Both interview conducted during the training and after the training they stated that it affected on changing their minds about the knowledge offered during the training.

The results of the interview conducted during the training showed that realizing the difference in fuel consumption amounts before and after the training changed the drivers' minds about the training and enhanced their willingness to apply knowledge on real trucks. The drivers stated that although they found the driving method of the simulator different than ones of real trucks, they would have applied the training since they realized the difference in fuel consumption amounts before and after the training.

Some drivers stated that they had difficulty in using the some parts of the simulator. For example steering wheel and simulator screen mostly complained parts by the drivers. The drivers also said that they had difficulty in using the gearshift since they had not driven trucks with manual transmission for years. However, all these statements were behind of the difference in fuel consumption amounts between their first and second driving of the simulator.

Similarly, the interviews conducted after the training, most drivers stated that they applied the knowledge offered during the training on real trucks because they believed the accuracy of the knowledge and wondered what extend it would affect the fuel consumption amounts if it was applied on real trucks. One of them emphasized that,

> S22: If only the trainer explained something, I would not have applied them on real truck. You will ask why now. For example I had %36 fuel consumption in my first driving but I had %32 in my second driving. I realized the difference by driving the simulator……I applied what we learned on real truck and I benefited it. I had %40 fuel consumption before the training generally but it was %35 after the training. There is a 5 point difference. I experienced it anyway [44].

In other words, the behavioral validity gained an importance according to its contribution to the instructional part. For that reason, although the trainer stated that the relationship between the parameters was different than explained in the fuel consumption theory, the training with simulator reached its goals in %70 percent.

Data collected through observation supported the interview results in that more than half of the drivers were suspicious about the accuracy of the knowledge at the beginning of the training. Most of them discussed the training and commented that they did not need the training because they were experts. Moreover, some of them discussed with the trainer during the theoretical part of the training. The drivers claimed that some knowledge explained by the trainers were wrong. The drivers mostly argued against the knowledge about the driving techniques on the uphill roads. The trainers stated that the drivers should drive fast and shift down slowly on uphill road if they wanted to save gas. The drivers claimed that they should have driven slowly on uphill if they wanted to save gas. However, most of them tried to drive fast on uphill road while driving the simulator. All of them stated that they had less fuel consumption amounts in the second driving on the simulator for that reason. One of these drivers stated that,

> S2: I drove on the uphill road slowly, I lost from it but I compensated it while I was driving on downhill [45].

The drivers who were interviewed after the training also emphasized that they were using the techniques suggested for uphill and downhill roads. One of them said that,

> S3: … If you used the techniques suggested for uphill or downhill roads, the fuel consumption amounts are decreasing [46].

Shortly, according to the interview results and observation notes the aims to use simulator was the key point of the validation process of the instructional simulators. Since the necessary reality of the simulator in terms of results provided on the drivers' performances, appearance and usability of simulators was determined according to the use aim of the simulator. For that study, although the trainer pointed out that the results provided by the simulator did not exactly reflected the fuel consumption theory, the training aim was accomplished according to him. Moreover, although the drivers complained from the reality of the driving method of the simulator and its usability, they stated that they used the knowledge gained during the training. Managers pointed out the drivers' point of view and how the training and practicing on the simulator changed their minds about the economic driving.

As a result, it could be said that the simulator properties should be determined according to the instructional aims to use it. Most of the simulator development process focused on the simulator reality and properties. Also the articles mainly mentioned the more similar simulator to real model means the more success of the training. On the other hand, a few articles pointed out the cost effective ways should be followed by taking into account instructional purposes to use an instructional simulator. For that reason, the validity process, firstly, the researchers should define the instructional aim and then the portion of the reality of the simulator.

Approaches of the Validation Model

According to the results of the observation and interview data, there were four approaches of the validation model. Moreover, the results also gave clues about the relationships of these approaches. The components of the instructional validation model were Use Validation, Behavioral Validation, Face validation, Instructional Validation. Some of the implications of these results were explained also under the Criteria for the Validation of an Instructional Simulator heading with the participants' quotations. For that reason, in this part the researcher interpret the data from another side, namely, the implications for the different instructional simulator validation approach.

According to the observation notes and interviews conducted with drivers and the trainer showed that there were two types of usability issues for the instructional driving simulators. First one was related with the getting used to drive a truck at the beginning. The second one was related with the performance problems of the simulator. According to the observation and interview results, most of the drivers mentioned that time were needed to adaptation the trucks newly used. They also stated that they needed a few minutes to adaptation the simulator. Moreover, they stated that for the expert drivers, this was not an important issue that affected their performance. One of the drivers who was interviewed during the training emphasized this issue with the words,

> S33: The use problem I had is running the vehicle. I could not run the vehicle. The reason is gearshift. Firstly, the gearshift should be pushed to use it, something like that. It is very simple problem, we can find it easily. It is not stemmed from the simulator, it is stemmed from me. [47].

Similarly, the trainer pointed out the same issue during the training. The researcher watched the video records and found that in a video the trainer explained the effect of adaptation process to drivers' performance by saying,

> Now, you need a few minutes to get used to the simulator but it does not an important affect your performance. It may cause 1or 2 points increase in fuel consumption. You are the expert drivers and there is a time adaptation process for every truck [48].

Moreover, some drivers stated that they had difficulty in using the gearshift because the simulator had a manual gearshift but their trucks were with automatic transmission. For that reason, all of the drivers who said that they had difficulty also emphasized that the reason of the problem was stemmed from themselves. On the other hand, they said that this problem caused their doing traffic mistakes and also affected the performances. According to them, they also needed to time to adaptation to the gearshift.

The drivers stated the same things during the interviews conducted after the training. According to them, if the simulator had automatic transmission or their trucks had manual ones; they could have benefitted more from the training. One driver stated that,

> S14: As I said before anyway our trucks are not with manual transmission because they are with automatic ones. Maybe if they had been with manual ones, our fuel consumption amounts would have decreased more because the simulator was with manual ones… [49].

Moreover, one of the managers said that he talked to drivers about the training and they complained the simulator did not represent their trucks. According to the managers, the important thing was their practicing the knowledge.

The second usability problems that the drivers met were related with the performance differences of the simulator than ones of real trucks. The drivers complained mostly steering wheel and screen of the simulator. On the other hand, no one pointed out they these performance differences affected their performances on the simulator. Only a few drivers who complained from the late reaction of the gas pedal stated that they had difficulty in keeping rpm in appropriate level. The trainer and managers did not mention the effects of performances differences of the simulator on drivers' performances. According to the observation results, the trainer stated that the drivers had difficulty in using the steering wheel because it had a wheel gap but they could manage it after they understand the weight of steering wheel. Similarly, he said that the drivers had simulator sickness due to the screen differences. Also he added his comments that if he would be turkey when the screen designed, he tried to prevent its being designed like that.

Shortly, the researcher who investigated the validity of the instructional simulator should take into account usability issues of the simulator. In this study, since most of the drivers were experts, the usability problems were managed easily. Moreover, their performances were not affected from it because of the same reason. However, usability could be an important problem for other instructional simulators or the TS in training sessions offered to drivers who had different level of expertise. Moreover, it is important to point that the usability affected the instructional benefits of the training. For that reason, usability was an independent approach from the other validation approaches that may affect the overall validity determination of the instructional simulators. The use validity of the simulator can be investigated through observation, survey and as well as interviews.

Another approach of the simulator validation process was related to what extend the simulator provided similar results to ones of real trucks. In the literature, this approach is labeled as behavioral validity. To collect data on behavioral validity of the simulator, the advised and appropriate research methodology is experimental designs. Although in this study, the experimental design was applied for the behavioral validity, this design also seemed to contribute to the instructional parts according to the interview and observation results.

Aforementioned under Behavioral Validity of the TS part (4.2.1), the behavioral validity was investigated in terms of parameters relationships. According to the results, the parameters explained the fuel consumption amount in a reasonable portion. On the other hand, the trainer stated that there were many factors affected the fuel consumption and for that reason, just looking at the parameters relationships were not enough to determine behavioral validity of the TS. Moreover, according to him, the TS was valid about %30 portion in terms of behavioral validity. When the trainers mentioned the behavioral validity, he mentioned parameters relationships, the road type, the number of stopping and running the TS. He pointed out the importance of the TS' providing similar results to ones explained in the fuel consumption theory. He said that the inconsistency between simulator and fuel consumption theory caused the drivers' not believing the fuel consumption theory. However, it was interesting that he stated the training with simulator reached its aims about %70 portion although its behavioral validity was %30 according to him.

To discover the reason, the researcher checked the interview data obtained from the drivers and managers of the company. Moreover, the observation notes were checked. According to the interview results, most of the drivers paid attention to the difference in fuel consumption amounts between first and second driving. According to them, the important thing was to realize the difference in fuel consumption amounts between first and second driving sessions, not the parameter and their similarity to ones explained by the trainer. Moreover, the observation notes showed that most of the times, the trainers discussed with the drivers about their fuel consumption amounts and change in number of parameters between the first and second driving sessions. The trainers emphasized the differences in gearshift change numbers, rpm level and gas pedal stepping on number between first and second driving while discussing the results with the drivers. On the other hand, the drivers firstly looked at the fuel consumption differences between first and second driving and not relationships between parameters. The observation results showed that, most of them also talked to other drivers about their performances and just mentioned their fuel consumption amounts because according to them they drove the truck according to what the trainer said. Most of them stated that after they applied and realized the difference between first and second driving they believed the accuracy of the information offered during the training.

Moreover, aforementioned before, one of the managers pointed out the importance of the driver's realizing the difference in fuel consumption amounts between first and second driving sessions. According to him, it provided the drivers applied what learned during the training on real trucks.

Another thing was related with the reality of the simulator was that its similarity to real trucks in terms of appearance. According to interview results, most of the drivers stated that the simulator was similar to real trucks in terms of appearance. However, they complained its artificiality and screen. Although they made negative comments about these two issues, they pointed out that it is beneficial in terms of instructional side.

Shortly, the simulator should be valid in terms of behavioral validity to reach its instructional use aims. However, it was important to emphasize that the behavioral validity portion should be determined according to the instructional aims. This study results showed that the simulator was valid although the behavioral validity was low. Since the simulator's providing less fuel consumption amounts when the drivers drive according to the fuel consumption theory was enough. For that reason the trainer stated that the training reached its goals about %70 portion while behavioral validity level was about %30. It was an important implication for the instructional simulator validation process. Since the less real instructional simulator can also enable instructors to reach their instructional goals. The higher reality means the more cost. For that reason, defining the necessary behavioral validity portion according to the instructional goals provides people save money. This is also important for the researchers who want to investigate the behavioral validity of the instructional simulator in that they should determine whether the simulator valid in terms of behaviorally according to how much behavioral validity necessary to reach the instructional goals.

The third approach was related to the role of the simulator in changing the drivers' mind about the knowledge offered during the training. Aforementioned, the trainer as well as the managers pointed out to the importance of drivers' perception about the training because they applied the knowledge on real trucks if they believed its accuracy. In the literature, this approach was labeled face validity. The data on face validity approach may be collected through attitude questionnaires, interviews and observations. In this study, in the scope of face validity the researcher obtained the data through interviews and observations. Most of the article in the literature mentioned the face validity as a complementary to determination of behavioral validity. However, according to this study results for the instructional simulators, the face validity was also a complementary for determination of what extend the simulator contribute to the instruction because the drivers mentioned reality of the simulator and similarity of results provided by the simulator to ones in fuel consumption theory in terms of instructional benefits of it.

Shortly, the results showed that face validity was another approach that should be taken into account during the validation process of instructional simulators. Moreover, according to the study results, the participants give the importance of both behavioral and instructional side of the instructional simulator. For that reason, here is not sufficient to think the face validity as a complementary to behavioral validity only. It should also a complementary to instructional side of the simulators.

The fourth approach for the simulator validity process was related to the contribution of the simulator to the instruction. In the literature, this validity approached was mentioned by very little articles in the literature. Some articles use the instructional label and some articles use educational name for the simulator developed for instructional purposes. The researcher preferred to label it as instructional since the main purpose to use the simulator was to offer training. For that reason the approach was also labeled as instructional validity.

The drivers, managers of the company and the expert trainers mostly mentioned the contribution of the simulator to the instruction according to the interviews and observation results. Moreover, the results showed that the data sources mentioned two different instructional contribution of the simulator: 1) the simulator contribution to enhance effectiveness of the training; 2) the simulator contribution to transfer to the knowledge gained during the training.

The drivers also mentioned from simulator contribution to the training as "practicing", "permanency of knowledge", "providing visuality", "making abstract knowledge to concrete", "having mathematical results and realizing the effectiveness of training", "bringing entertainment to training", "providing their active participation", "providing individual training", "providing a safety environment to practice", "shortening the knowledge gain length compare to apprenticeship learning", and "making training suitable to 21 century –innovation-".

Actually, the researcher did not think to collect data after the training since the literature she searched did not contain information about transfer of the training as a part of the instructional contribution. Only, in Blana's (1996a) reports, there was a small paragraph of one of the theorist who worked on a simulator validation process about the transfer of the training as a part of the contribution of the simulator to training. According to this theorist the transfer of the training should also be investigated because most of the instructional goals contained transfer of the training even they were not acknowledged obviously. Also, Kihl and Wolf (2007) worked on the transfer of the training of an instructional simulator but this article did not mentioned why the transfer of the training was investigated. In other words, the transfer of the training was always an ignored part in the simulator validation studies. The researcher decided to collect data about transfer of the training since the drivers mentioned the contribution of the simulator to the transfer of the knowledge gained as a part of the effectiveness of the training. According to them, the important thing whether the knowledge gained would provide a decrease in their fuel consumption amounts. On the other hand, some of them continued to be resistant to the training since they believed that the training did not provide decrease in fuel consumption amounts. According to these drivers,

> S14: Now, I drove it as the trainer said and the fuel consumption amounts were %29.9, about %30. It was not reflected in fuel consumption amounts of real trucks. The fuel consumption amounts of Mercedes would have been more than ones of simulator, if you had driven it on the same road…By applying the same method; I guessed that I would have more fuel consumption amounts. However, I cannot say a definite thing unless I complete a service by applying these techniques [50].

The observation results showed that the drivers discussed with the trainer about the transfer of the techniques offered during the training. The drivers pointed out that the simulator was different than real road environment and they were suspicious about whether the knowledge works on real road environment. During the theoretical part of the training, the trainer said that, the techniques explained were tried by him on the real trucks. He emphasized that he had made experiments on real trucks with the help of different drivers. He said that,

> I tried on each technique on real trucks. Sometimes we made experiments on real trucks. I said the driver “yes, now you drive on uphill road fast” and the other time I said “yes now, you drive the same uphill slowly” Then, we measured each driving results. In other words, all the information offered here was based on the real truck measures [51].

The managers of the company stated that they were care about the transfer of the knowledge gained during the training. According to them, the simulator contributed to it by providing the practice for drivers. One of them stated that it provided drivers’ comparing the simulator and real trucks and enhancing the apply knowledge. The other manager stated that most of the drivers’ mind change about the application of the training on real trucks after seeing the difference in fuel consumption amounts between first and second driving.

Shortly, the results of the study showed that the contribution of the simulator to the training and transfer of the knowledge was very important. The instructional goals and whether the simulator help to reach these goals referred to another simulator validation approaches that should be investigated according to the results of the study.

Factors Affecting the Validity of the Simulator

The observation and interview results showed that there were some factors that might affect the validity of the simulator. These factors were "participants' resistance to the training", "participants' expertise", "participants' ages", "instructional method applied during the training", "trainer's characteristic" and "company's point of view", "real life conditions that may affect transfer of the training". All these factors were the different parts of the system that the training with simulator offered. According to the interview and observation results, the system also had an importance to reach the aims of using the simulator. The results of the study showed that the system had 3 components, namely, drivers, trainer and company. It was also important to point out that the simulator use aim was also caused change in the system.

The mostly mentioned factor that affected the simulator's contribution to the training and the transfer of the training was participant's resistance to training. As aforementioned by the trainer, the design of the training which consisted of two simulator driving sessions, one before and one after the theoretical part aimed to break drivers' any possible resistance to the training. Moreover, the managers stated that in order to make drivers apply the knowledge that they gained during the training; firstly their minds about the training should have been changed. According to the observation results, most of the drivers made negative comments about the training and the simulator. On the other hand, they changed their minds along the training due to approach of the trainer and company managers. According to the observation results, the trainer could gain drivers' trust and establish a good communication with them. Moreover, the company supported the training acceptance and transfer by following some strategies. First of all, they wanted all drivers attend to the training. One of the drivers who was interviewed with after the training said that,

> S4: Actually, I attended to the training because the company will ask whether I attend….But I learned something … [52].

Moreover, after the training they followed some strategies to enable drivers apply the knowledge gained during the training. One of the managers stated that,

> S23: We are talking to the drivers who have high fuel consumption amounts. For that reason, they know the company's opinion. We aimed to make them transfer of the training [53].

Another factor that might affect the validity of the simulator was the drivers' ages. While some drivers stated that the old drivers' could not understand the training and will be resistance to apply it. According to them, the simulator made the knowledge gained more clearly for these drivers because it provided practice for them. Moreover, the trainer stated that it was difficult to change drivers' driving habits since most of them were old drivers and have been doing the profession for long years.

The factors affected the simulator validation process was the drivers' expertise. During the training some of the drivers stated that they were experts and this training could be more beneficial for the novice drivers. Similarly, after the training, they also continued to emphasize same issue by saying that they learned something but the training was more beneficial for the novice drivers. One of them interviewed with after the training said that,

> S11: Of course I benefitted from the training, definitely I benefited. I learned something that I had not known before but I said that I have more experience than, since I learned the profession via apprenticeship, other drivers. They may benefit from the training more than me [54].

Moreover, according to the observation notes the trainer stated that the problems related with the reality of the simulator or its having manual gearshift does not affect the drivers' performance much. According to him, since the drivers were expert they could get used to drive simulator in 5 minutes.

The trainer's approach to the drivers as well as its instruction method was appreciated by the drivers and mangers of the company according to the observation and interview results. First of all during the training, the trainer started his training by saying

> You are expert. My aim is not to teach you how to drive trucks. I just want to give information about the new generation trucks and how the driving strategies were changed according to this new generation trucks [55]

Moreover, he emphasized the important things that were changed in the new generation trucks. According to the observation notes, most of the drivers were surprised when he explained the economic driving techniques on uphill and downhill roads. The interview results also supported the observation results that, the drivers stated they had not known the some techniques that might apply on uphill and downhill roads. Aforementioned before, mostly applied knowledge were economic driving techniques on uphill and downhill roads according to the interview data obtained after the training.

One of the manager stated that the trainer emphasized the important techniques during the training. He pointed out that this also attracted the drivers' attention and made them curious whether these techniques would provide decrease in fuel consumption amounts if they were apply on real road.

The factor which was point of view of the company about economic driving affected the simulator validation process. According to the interview results, most of the drivers who were interviewed with during and after the training said that there was a change in company's point of view about the economic driving. The drivers said that the company did not care the fuel consumption amounts before the training. However, the drivers stated the fuel consumption amounts were important for the company now and there were some intervenes to show this change. These intervenes done by the company were: 1) They arranged meetings with the drivers to inform them about their new point of view on economic driving, 2) They provided training on economic driving and, 3) They gave prizes to the drivers. Moreover the drivers pointed out that they wanted to contribute the company's budget and for that reason they wanted to apply what learned during the training. The same issues also repeated by the managers of the company. One of them stated that all these applications aimed to support training. On the other hand, there are some external factors that might affect the transfer of the training and the simulator contribution to the training. According to the observation results, the drivers confused about whether the fuel consumption amounts decreased if they applied the techniques learned during the training. Also, they discussed with each other and with the trainer about what extend the contribution would be because according to them there were many factors that might affect the fuel consumption amounts on the real trucks. These factors were weather conditions, road types, working conditions, trucks' maintenance situation and loadings amount. The drivers who were interviewed with during and after the training stated that all these factors affected the transfer of the training as well as simulator contribution to the training. The same external factors also pointed out by the trainers and stated that their aims to provide decrease in fuel consumption as much as possible. According to him, one driver may not apply the knowledge gain in one service but he may do it in another one. He stated that it also caused a decrease in this driver's fuel consumption amounts compare to his fuel consumption amounts before training. The same issue also emphasized by the managers and they said that they thought that even a small decrease in fuel consumption amounts was important for them. They aimed to step by step improvement on this issue without making any concessions from their customer satisfaction priority approach.

Shortly, the observation and interview results showed that the system components had an important effect on simulator validation process. Moreover, these system components should be thought with their characteristics and factors. The instructional simulator was a man interacted tool and the human role in the validation process cannot be ignored in this type of research.

4.3. Summary of the Results

In this part, summary of the results of the study were presented with regard to the aims of the study. First aim of the study was to validate truck simulator. The results of the data regarding this aim are presented Table 4.50.

Table 4.50 Summary of results regarding the validation of the simulator

	Results	Underlying Principles
Behavioral Validity	Multiple regression analysis result showed that the parameters of the simulator acknowledged %36 of the fuel consumption. According to the expert trainer, the measures provided by the simulator represented ones of the real trucks in 40% per cent. After the data analysis, the expert trainer and a developer were asked to interpret MANOVA result. The results showed that both of them advocated the results reflected the reality. On the other hand, according to them the best way to get information about the behavioral validity of the simulator to take expert opinion.	The behavioral validity and face validity should be taken into account to determine the behavioral validity. The underlying principle was "define the research design and methods of validation process" Moreover, one of the scopes of the validation process should be fidelity of the simulator. The underlying principles about these result was "define the scope of the validation process".
Face Validity	According to the results, the simulator was similar to real model in terms of appearance but not in terms of performance of the parts. However, the all stakeholders stated that when the drivers drove according to the economic driving techniques, it provided decrease in fuel consumption. The drivers focused on the difference in fuel consumption amounts between first and second driving, not how much the simulator represent the real truck in terms of fuel consumption amounts.	The fidelity degree of the simulator should be determined according to the instructional goals. Since although the participants complaint about the fidelity and usability of the simulator, they were satisfied the instructional benefits of the simulator. So the underlying principle is "define the fidelity degree".

Table 4.50 *Continued*

	Results	Underlying Principles
Face Validity	Moreover, the results showed that the environment on simulator scenario was similar to real one. According to the interview and observation results, the drivers had difficulty in driving the simulator. On the other hand, they could get used to it in a short time since they had been doing the profession for a long time according to them. The results showed that the expert trainer found the simulator successful in 70%-75% percent since it could do what he expected instructionally. The interview results showed that the drivers would have used the economic driving strategies since they could realized the accuracy of the information thanks to the simulator. According to the results, the drivers satisfied from the training since the simulator provided practicing the knowledge, made the abstract knowledge concrete, added entertainment to the training, provided individual learning and so on. The results showed that transfer of the training should be investigated since one of the criteria of the participants' about the instructional validity of the simulator was "transfer of the training".	Behavioral, face and instructional validity should be taken into account during the validation process of the instructional simulators. For that reason, "defining the research design and methods of validation" is important in validation process.
Instructional Validity	The results supported the face validity results in that there was a statistically significant difference in fuel consumption amounts of the driver's first and second driving sessions. On the other hand, there was not a significant difference in drivers' real life fuel consumption amounts before and after the training.	The results on the instructional validity showed that social issues related with "identify and develop participants' awareness about the benefits of the training with simulator" and "acknowledge clearly the company's point of view about the training" were two principles important factors affecting the application of the training.

Table 4.50 *Continued*

	Results	Underlying Principles
Instructional Validity	The interview data supported the statistical analysis results in that according to drivers and managers there was not a significant difference in drivers before and after training fuel consumption amounts. However, they did not expect a huge decrease in fuel consumption amounts because there were many factors affecting negatively the fuel consumption amounts on real road. Moreover, the training provided the drivers' and company's reaching the aims since after the training the drivers started to try to drive the trucks economically. The mostly mentioned factor supporting the application of the economic driving techniques was the simulator.	Moreover, the instructional validity should be determined by taking into account participants' and trainers' characteristics. For that reason, "define the factors affecting the instructional validity" was critical for validation studies. Moreover, when the participants informed about their progress, they were more eager to apply what they learned during the training. For that reason, "Informing the participants about their performances" was affecting validation process.

The above results were interpreted differently to investigate the second aim of the study, the characteristics of the instructional simulator validation process. Table 4.51 contains the results regarding the second aim of the study.

Table 4.51 Summary of results regarding the validation process

	Results
Instructional Validation Process	The validation of instructional simulators process should include behavioral, face and instructional together since the expert trainer mentioned both simulator's fidelity (behavioral validation) and contribution to training (instructional validation. Moreover, he pointed out the importance of taking the expert opinion (face validity). Validation of an instructional simulator is partly bounded to fidelity of the simulator. Since the results of interview with the expert showed that there are many factors affecting the fidelity results (e.g. human characteristic, environment). The validity of the simulator should be evaluated according to the instructional goals. Since the aim of the simulator used in the study Fidelity of the instructional simulators may be low, but despite it, it can be valid tool for an instruction. Since the drivers and expert trainer stated that although the simulator did not represent the real, its contribution to the training could not be ignored. For that reason, the fidelity is necessary but not absolute in instructional simulator validation process.

CHAPTER 5

DISCUSSION AND CONCLUSION

In this chapter, the study results are summarized and discussed in the light of related literature. Firstly, simulator validation model extracted from the literature is explained in detail. Secondly, the evolution process of proposed model as Goal-based Instructional Simulators Validation (GISVM) and its underlying principles are presented. The researcher proposed the model by explaining each components of the model in detail under the Principles of the Model heading. Lastly, usage guidelines are presented for those who will conduct simulator validation studies and developers who will develop instructional simulators. Figure 5.1 shows the content of this chapter.

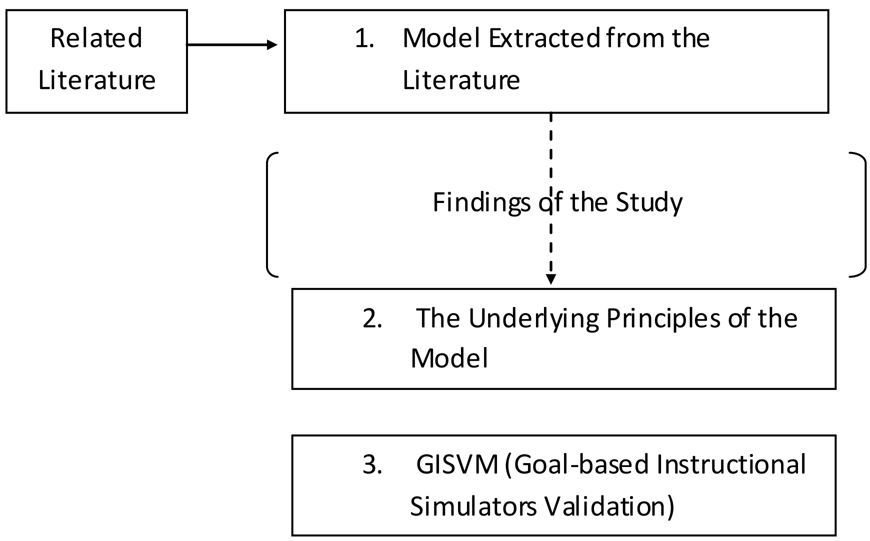

Figure 5.1 The Structure of the Content of the Chapter 5.

5.1. Model Extracted from the Literature

In the IT field, how the technology can be used for instructional purposes and their effects on instructional outcomes are always the center of the debates (Clark, 1983; Kozma, 1991; Clark, 1994; Kozma, 1994). Many studies conclude with failure of using technology in instructional purposes (Reiser, 1987; Reiser, 2001; Van den Akker, 1994). Some authors state we should question the methodology used in these studies while some authors state we should ask "how we should use technology in the instruction" rather than "Does the technology affect the learning?" (Kozma, 1994). Moreover, some authors state that the technology fails because they are not developed for instructional purposes (Reiser, 2001). In the field, some scholars state that not the technology but the method should be center of the instruction (Clark, 1983; Clark, 1994; Cagiltay, 2001). The method may be more effective than technology; but we should not reject the technology and investigate how the technology should be used to enhance effectiveness of instruction (Sancar & Cagiltay, 2008).

Similarly, the first and crucial step for simulators is to define to what extent they satisfy their design aims. Moreover, investigation of "what extend the simulators satisfy their design aims" refers to the validity process in the literature (Blana, 1996a). However, there is no single explanation in the literature reviewed about what a simulator validation process should include. In other words, there is no consensus on the simulator validation process. Moreover, although some authors advocate simulator validation process changes according to simulator types, there is no distinction in most of the research studies. Most of them focus on fidelity degree of the simulator in the validation process. Even for the instructional simulators, researchers firstly investigate fidelity degree of simulators, then they investigate role of the simulators in the effectiveness of training.

It is important to be noted that validation process in the literature includes "Analysis", "Development" and "Evaluation" phases. Although there is no distinction about validation approaches applied accordance with these phases, Borenstein (1998), Hoskins and El-Gindy (2006) and Chang and Ho (2002) point out that their model and research studies include only development or evaluation phases.

In this part, the researcher presents the model she developed in the light of approaches which are based on the above statements in literature (Figure 5.2). These approaches are explained under 3 phases as "Analysis", "Development" and "Evaluation" and the titles as "Physical Validation", "Behavioral Validation", "Face Validation" and "Instructional Validation".

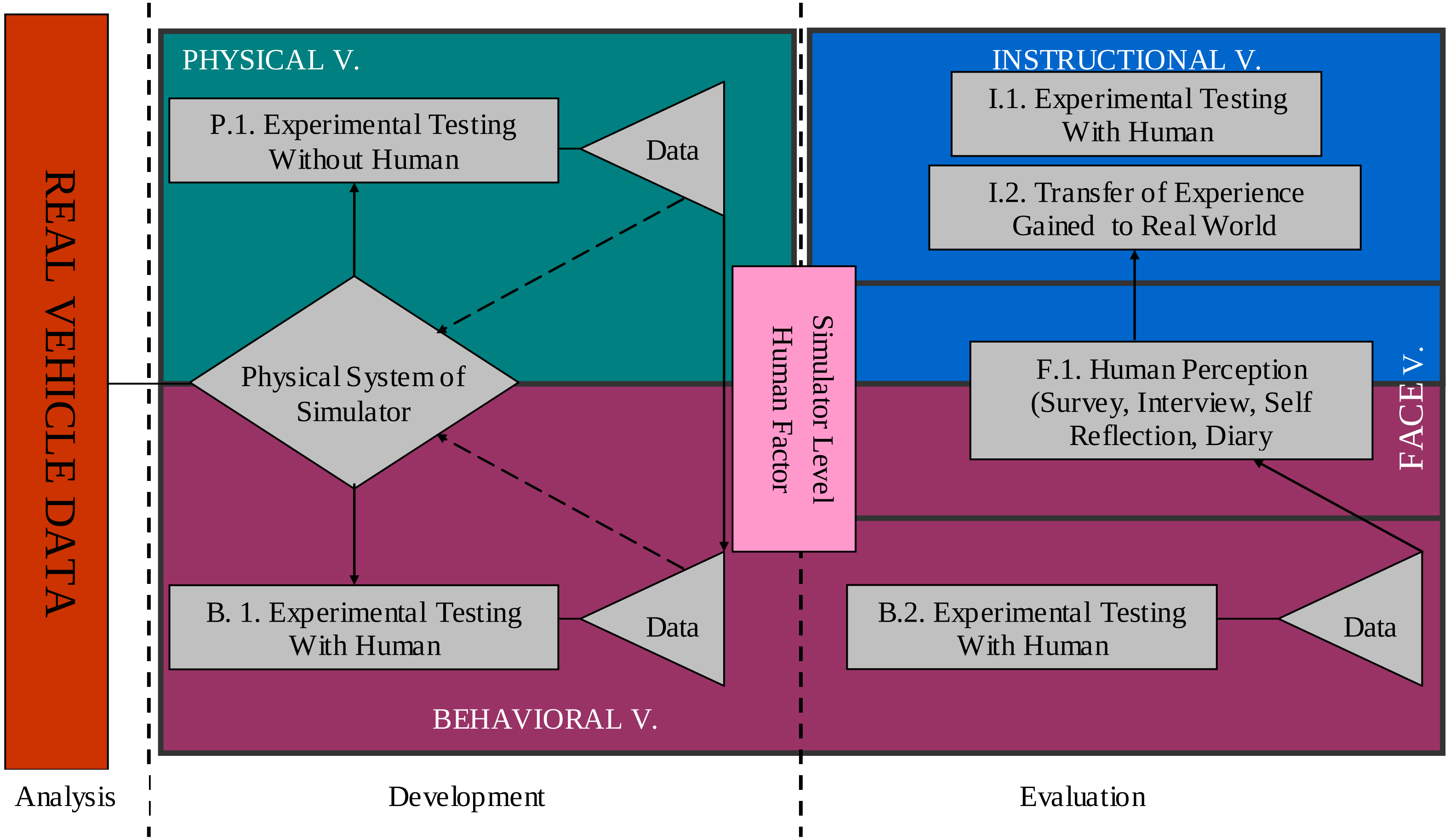

Figure 5.2 The overall instructional simulator validation process needs to be conducted during the analysis, development and evaluation phase

5.1.1 Overall Explanation of the Model Extracted from the Literature

The model extracted from the literature includes 3 phases as “Analysis”, “Development” and “Evaluation”. According to Hoskins and El-gindy (2006), validation process starts before simulator development since simulators are developed according to real model data. For that reason, “Real Vehicle Data” in the model refers to measures gathered from the real model. According to these measures, fidelity degree of the simulator are defined by comparison of real vehicle data and simulator data or how similar main parameters relationships in the simulator to real vehicle data.

In the “Development” stage, “Physical System of the Simulator” is started to be developed. In this phase, there are 2 validation approaches mentioned in the literature. First one is “Physical Validation”. Second one is “Behavioral Validation”. During this phase, there is an ongoing data gathering process to learn to what extend the simulator represents real model. For that reason, “Experimental Testing without Human” is conducted. This testing is in the scope of “Physical Validation” approach. Moreover, data gathered as a result of testing show developers and researchers that the simulator should be improved or not. The data collected through the “Physical Validation” form a base for “Behavioral Validation” part (Blana, 1996a). For that reason, in the model, data which is bounded to “Human Testing without Human” also is bounded to data gathered under the scope of “Experimental Testing with Human” via an arrow.

"Behavioral Validation” approach includes “Experimental Testing with Human” and it is an ongoing process during the development phase. In this part, developers try simulator systems themselves or with a few users. Moreover, “Behavioral Validation” also continues after the “Development” phase. In the “Evaluation” phase, 3 approaches, namely, “Behavioral”, “Face and “Instructional” are mentioned in the literature (e.g. Blana, 1996a; Feinstein &Cannon, 2001; Boreinstein, 1998; Parkes, 2005; Estock et. al., 2008). During the “Evaluation” phase, field tests are conducted. In this study under the scope of “Behavioral Validation”, the researcher conducted “Experimental Testing with Human”. The participants in these studies are real users. The simulator systems are compared to real model accordance with development aims.

Most of the authors such as Cremer et. al. (1995), Blana (1996a), Feinstein and Cannon (2001), Chang and Ho (2002), Kihl and Wolf (2007) advocate that “Face Validity” approach should also be applied in order to get in dept information about the validity of simulator systems. Under the scope of “Face Validity” approach, the researchers gather data on “Human Perception”. In other words, real users’ opinions about simulator systems and testing procedures are collected during this approach. It is important to note that “Human Perception” is affected the results of data gathered under the scope of “Behavioral Validity” (Blana, 1996a). For that reason, in the model, “Data” gathered during the “Behavioral Validity” is bounded to “Human Perception” via an arrow.

The above approaches are common for almost all types of simulators in the literature (e.g. Reed & Green, 1995; Blana, 1996a; Feinstein & Cannon, 2001; Chang & Ho, 2002; Hoskins & El-gindy, 2006). However, some authors state that different validation processes should be applied for instructional simulators (e.g. Cremer et. al., 1995; Blana, 1996a; Feinstein & Cannon, 2001; Kihl &Wolf, 2007; Parkes, 2005; Estock et. al., 2008). On the other hand, there is a controversy about how instructional simulators should be validated. For that reason, the researcher searched educational research methodology, evaluation and simulator validation literature together. The literature review showed that instructional side of a system cannot be separated from its technological part (Foshay & Quinn, 2005). Moreover, qualitative and quantitative approaches should be applied together to get in depth and accurate information about these systems (Foshay & Quinn, 2005). According to Reeves (2003) instructional simulators are one of these systems. For that reason, in the model "Instructional Validity" approach is last step that is placed to the top. Under the scope of "Instructional Validity", the researcher collected data about to what extend the simulator contribute the effectiveness of learning.

"Instructional Validity" consists of 2 parts in the model. First part is "Experimental Testing with Human". Second part is "Transfer of Experience Gained to Real World". Under the scope of "Experimental Testing with Human", researchers design experiments to get information about whether instruction offered via simulator affects participants' performance. Researchers can design experiments which are based on the comparison of two groups' performances; one of them is one group that the training is offered with a simulator and other group that the training is offered without simulator. Moreover, researchers can design pre-post test experiments and so, they can assess whether the participants' performances had improved after the training offered with simulator. However, in the second type of experiments, it is very beneficial to also take participants' opinions about the role of the simulator in the instruction and whether it contributes to training as Foshay and Quinn (2005) advocate. It should be noted that "Face Validity" approaches is complementary to this part of "Instructional Validity" for that reason.

Under the scope of "Transfer of Experience Gained to Real World" part, the researcher collected data on to what extend simulator systems contribute to transfer of the training. Transfer of the training is quite important because any positive transfer of the learning outcomes causes constructive results in the business according to Clement (1982). Most chief executives state that transfer of training is vital component of the training process; however, they believe that only small percentage of what is learned, actually impacts workplace performance (Baldwin & Ford, 1988 as cited in Frash, 2004). Transfer of the training is a bit problematic according to results of Baldwin and Ford (1988) meta-analytic study, only %10 of the expenditures is actually transferred to the job (as cited in Frash, 2004). Driscoll and Carliner (2005) state that use of simulators is based on

Experiential Learning Theory and according to this learning theory, providing real life experience for the learners is crucial for learning. Moreover, Driscoll and Carliner (2005) state that for that reason, simulation environments can enhance transfer of knowledge. According to Kihl and Wolf, simulators' contribution to transfer of the training should also be investigated. To do this, researchers can collect data on participants' real life performance before and after the training. It is important that researchers should collect data on the factors affecting the transfer of the training since undefined factors could affect the study results.

In the model, there is also a box in the middle between "Development" and "Evaluation" phase. This box has two parts as "Simulator Level" and "Human Factor". These two parts refer to important factors that may affect validation process. "Simulator Level" part refers to fidelity of the simulator. Especially, the validation determination in "Development" phase is affected from the fidelity of the simulator. Moreover, "Human Factors" such as participants' experience, age, gender and so on may affect validity results (Blana, 1996a; Fadde, 2007).

Shortly, the model extracted from the literature shows that the validation process starts from "Analysis" phase and the base of simulator validation process is "Fidelity Level of Simulator System". Moreover, researchers should pay attention to factors (stemmed from simulator system or stemmed from participants' characteristics) that may affect simulator validation process.

5.1.2 Simulator Validation Approaches in the Model Extracted from the Literature

Since there are contradictory views about the validation approaches, the approaches in simulator validation literature are classified according to applied methodologies. Then, the ones that refer to same things are labeled under the most common label. Under this title, four main simulator validation approaches, namely, Physical, Behavioral, Face and Instructional are explained. It is important to be pointed out that these four approaches in the model are placed according to the relationships described in the literature. According to the literature, "Physical Validity" approach is firstly applied and forms a base for "Behavioral Validity". Similarly, "Behavioral Validity" approach, "Face Validity" approach and "Instructional Validity approach is applied orderly. However, all these approaches are complementary to each others. Especially, in the "Evaluation" Phase, "Face Validity" approach should be thing a buffer between the "Behavioral" and "Instructional Validity" approaches.

Physical Validation

Cunto (2008) describes Physical Validation as "Simulators' reliability and physical validation refer to how accurate the simulator represents vehicle dynamics and the visual environment surrounding the traffic scenario" (p.36). Hoskins and El-gindy (2006), Reed and Green (1995) and Blana (1996a) state that physical validation includes simulator dynamics, visual system, geometry of control and their response characteristics in simulators. Also, all these characteristics of the simulators compared with the real vehicle being modeled during the development stage. Mostly, experimental research designs with no human are applied to determine physical validation (Hoskins & El-gindy, 2006; Chang & Ho, 2002). Instead of real human, a device was used to measure the data gathered from simulators and real vehicles (Hoskins & El-gindy, 2006; Chang & Ho, 2002). In this thesis study, Physical Validation was not taken into account since it should be applied during the development of the simulators. However, this study included the last phase, impact evaluation phase, of The Philosophy Project which was launched after the development of the Truck simulator.

On the other hand, it should be noted that the physical validity of the simulators are base for behavioral validity of simulators according to the literature (Blana, 1996a). Since physical validity refers to what extend a simulator system could provide similar measures to real model, it also guaranties behavioral validity in some part (Blana, 1996a). It affects behavioral validity partly but not completely since behavioral validity is also affected by human characteristics factors (Blana, 1996a; Feinstein & Cannon, 2001). All of them refers to that there is a relationships between the validation approaches and for that reason "defining the scope of the validation model" and "defining the research design and methods of validation process" accordance with the applied validation approaches are important to reach accurate information about the validity of the simulators.

Behavioral Validation

Jamson (1999) describes "Behavioral Validation" as a simulator's ability to induce the same response from a driver as would be performed in the same situation in real life" (as cited in Hoskins & El-gindy, 2006). Experimental research design is used to determine behavioral validation (Cunto, 2008; Blana, 1996a; Hoskins & El-gindy, 2006; Desel, 2000; Borenstein, 1998). Unlike the physical validation studies, the behavioral validation studies are conducted with users during and after development of simulators (Hoskins & El-gindy, 2006; Chang &Ho, 2002).

For the behavioral validation, researchers advocate the research designs in which the users' behaviors in a driving simulator and real vehicle modeled are compared (Blana, 1996a; Hoskins & El-gindy, 2006; Desel, 2000; Borenstein, 1998; Chang & Ho, 2002). However, they also state that the simulator cannot represent the real vehicle (Feinstein & Cannon, 2001). Also, Blana (1996a), Hoskins and El-gindy (2006) and Cunto (2008) point out that behavioral validation is more complex, because there are many factors which may affect the validation results such as low motivation, temporary disposition of the subjects or a distracting and uncomfortable testing environment. For that reason, Blana (1996a) states that the comparison of real model and simulated model measures cannot give the whole picture of the simulator validation process and advocates to take participants' opinions about the simulator validation. Figure 5.3 shows the behavioral validation approach and research design extracted from the literature.

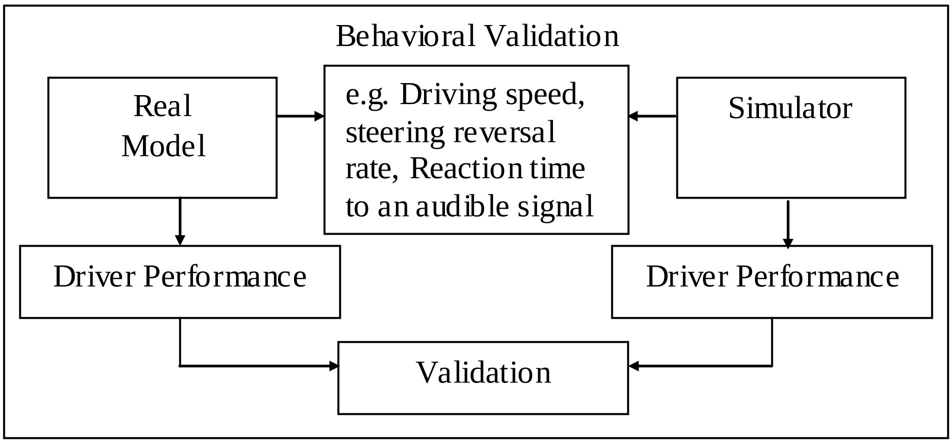

Figure 5.3 Representation of Behavioral Validation

According to the literature, there may be some factors affecting the results of experimental testing and indirectly the validity of the simulators. Wallen and Fraenkel (2001) present some strategies to tackle with factors affect on experiments. However, the researchers should apply these strategies and also determine how much these factors affect the behavioral validity of simulator. In other words, "defining the factors affecting the participants' performance" is important in validation studies.

Moreover, as literature indicates not only the behavioral validity but also face validity should apply to define these factors (Blana, 1996a). For that reason, the importance of "defining the scope of the validation process" and "defining the research design and methods" are results of literature on behavioral validation.

Face Validation

Borenstein (1998) describes face validity as "consistency between the designer's view and the potential user's view of the problem in a timely and cost-effective way." (p.229). Face validation approach is based on taking users' opinions on whether the simulator represents the real vehicle (Feinstein & Cannon, 2001; Blana, 1996a, 1996b). Martis (2006) states that with this approach, the researchers can find the answer of questions such as "Does the model structure looks like the real system? Is it a recognizable representation of the real system? Does a reasonable fit exist between the feedback structure of the model and the essential characteristics of the real system?" (p. 42).

Nilsson (1989) points out that the participants' subjective opinions and evaluations can be detected via questionnaires and interviews (as cited in Blana, 1996a). Similarly, Borenstein (1998) states that the potential users may be interviewed and they may fill questionnaires under the scope of some validation approaches. Moreover, he states that a number of observations and controlled data procedures should be conducted during the quantitative tests (Borenstein, 1998).

The results of the literature show that face validity should be applied together with the behavioral validity. Moreover, the literature shows that face validity is also a base for instructional validity (Feinstein & Cannon; Blana, 1996a). However, it does not guarantee the instructional validity of the simulators. As a result, it could be said that there is a relationships between behavioral, face and instructional validity. The Figure 5.4 illustrates "Face Validation" and used Research Methods both in the literature.

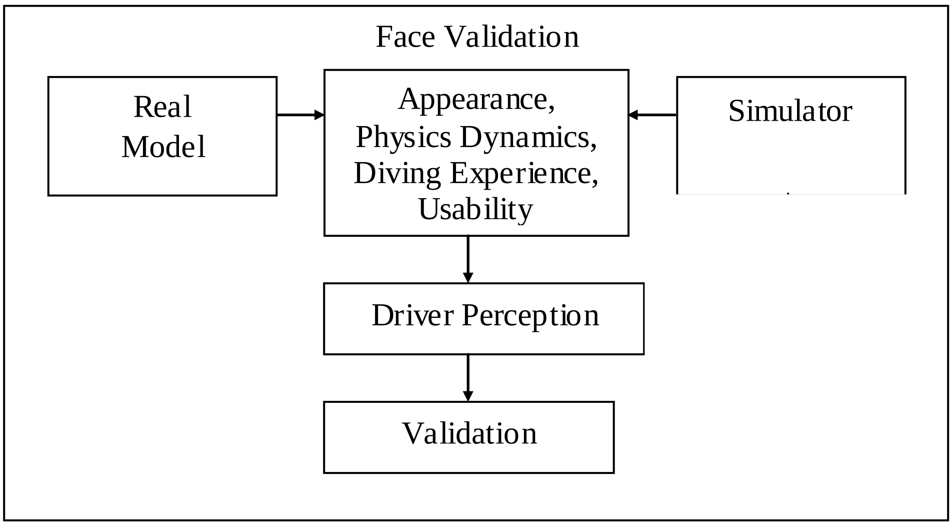

Figure 5.4 Representation of Face Validation

Instructional Validation

Some authors state that we should define the validation according to instructional aims for instructional simulators (Emery et. al., 1999; Lee, 1999; Parkes, 2005; Kihl & Wolf, 2007; Tarr, 2006; McDougall et. al., 2006; Estock et. al., 2008). Also, Feinstein and Cannon (2001) labeled this approach, namely, educational validity. According to them, educational validation refers to what extend the simulator can provide expected learning experiences and/or assessment of learning (Feinstein & Cannon, 2001). Moreover, they stated that researchers who aim to investigate educational validity of a simulator try to answer whether the simulation provides a valid learning experience and/or assessment of learning (Feinstein & Cannon, 2001). In the literature, there are limited numbers of studies which investigate the role of simulators in learning activities. Moreover, the researchers who mention about "instructional validity" do not explained it broadly and how they conduct the instructional validity study.

Researchers do not agree on extend of the instructional validity of simulators. According to Blaauw (1982), transfer of the training is a part of validation of simulator which is designed for educational purposes (as cited in Blana 1996a). Wallace and Regan (1998), Cunto (2008) and Schmitz and Maag (2009) mention the transfer of training offered via simulators. On the other hand, Blana (1996a) states that transferability should be investigated under the evaluation concept not validation concept. Parallel to others, Feinstein and Cannon (2001) state that simulators can be used implementation or evaluation purposes during the instruction and transfer of the training refers to external validity of simulators.

In the early, the roles of the tools on learning are investigated via experimental studies (Foshay & Quinn, 2005). Since the simulators are man interacted systems (Reeves, 2003), the question asked about the instructional validation should be related to the learning experiences and/or assessment of learning. For that reason, Foshay and Quinn (2005) and Revees (2003) suggested use of multiple method while investigating instructional facet of technologies used for instructional purposes. All these issues and expert opinions were taken to shape the instructional validation approaches applied in this study. The researcher separated the instructional validity issue into two parts as suggested by Feinstein and Cannon (2001). First part included the methods conducted during the implementation of training. According to Feinstein and Cannon (2001) it is related to internal validity. Second part included the methods conducted after the training. According to Feinstein and Cannon (2001) it is related to external validity.

Shortly, there is no agreement about the simulator validation process in the literature. Moreover, there is no specific validation model for instructional simulators. Most of the literature focus on the behavioral validity of the simulators and not mentioned the instructional side of it. For that reason, this study aimed to develop a validation model by analysis and synthesis of literature and qualitative data results.

5.2. The Underlying Principles of the Model

The underlying principles of the model were developed from the results of the study. The researcher investigated the characteristics of the validation process for the instructional simulators during the study.

5.2.1. Principles Related to Instructional Issues

1. Define the Aim(s) of Training and Role(s) of the Simulator in Training:

The data results gathered under the scope of behavioral, face and instructional validity facets showed that defining the aim(s) of the training and role(s) of the simulator in this training is the first step in the validation process. The results of the interviews conducted during and after the training showed that the overall validity of the simulators should be determined according to instructional goals. In other words, what extend the simulator enables trainer to accomplish instructional goals should be base in validation process. There is limited number of studies which investigate the role of the simulator in learning activities in the literature. Moreover, most of the simulator validation studies take into account the fidelity of the simulator as a criterion in simulator validation process (Chang & Ho, 2002; El-Gindy & Hoskins, 2006; Blana, 1996a; Feinstein & Cannon, 2001). In other words, the higher fidelity simulators are the higher valid ones according to these studies. So, there is a controversy about the validity of the simulator in the literature.

This study's results supported the claims of the authors who advocate that validation process should be defined according to instructional goals, not according to fidelity level of the simulators. In other words, the overall validity of an instructional simulator was semi-bounded to the fidelity. For example, the trainer stated that although the simulator data on drivers' performances were similar to ones in real truck in 30-40% percent, it had an important role to reach instructional aims. According to him, the simulator did what expected from it and the training was successful in 70-75% percent. Moreover, the drivers stated that although performances of the simulator parts were not the similar to ones of real truck, the driving experiences on it were very beneficial. Both the drivers' who interviewed with before and after the training pointed out that after they had seen there had been a decrease in fuel consumption amounts in the second driving on the simulator, they believed the accuracy of the information offered during the training. Similarly, the managers emphasized that the simulator provided a driving experience for the drivers and all the drivers had a chance to try economic driving techniques on the simulator.

Observation results were parallel to interview ones in that the drivers mostly discussed the difference between the first and second driving fuel consumption amounts with other drivers and trainer. According to the observation results, they did not pay attention how much the measures of the simulator were similar to ones of real trucks.

So, in the instructional simulator validation process, the first step was to define instructional aim(s) and the aim(s) of using the simulator in the instruction. According to them, the fidelity of the simulator should be defined. The results of the data showed that for the current study, the fidelity of the simulator was necessary but this fidelity should not have to be in 100 percent. Even, 30-40% percent fidelity was sufficient to accomplish the training goals.

2. <u>Define the Factors Affecting the Participants' Performances</u>

Both face and instructional validity facets data showed that simulator validation process may be affected from many factors. These factors also are mentioned in the literature. They are namely, conditions of the training environment (Blana, 1996a) and participants' characteristics such as age (Hancock et. all., 1990; Blana, 1996a; Rimini-Doering, Manstetten, Altmueller, Ladstaetter & Mahler, 2001; Lee, Drake & Cameron, 2002; Hoskins and El-Gindy, 2006; Minin, Montanari, Corbelli and Iani, 2008), gender (Reed and Green, 1995; Blana, 1996; Lee, 2002; Cunto, 2008), expertise on job (Wallace & Regan, 1998; Emery et. all., 1999; Feinstein & Cannon, 2001; Fadde, 2007; Fadde, 2009). According to Blana (1996a), simulators are man-interacted systems and for that reason the effects of human characteristics should not be ignored.

Parallel to the literature, the result of the study showed that participants' age, expertise level were important factors affecting the simulator validation process. According to the results, the drivers could easily get used to drive simulator since most of them have been professional truck drivers for many years. In other words, the drivers' expertise level could tolerance some inefficiency in the simulator. For example, usability problems or reality problems related to the simulator parts' not performing as the real truck's ones did not cause a problem due to the drivers' expertise. All the data sources pointed out that usability and simulators' parts' not reflecting the reality did not much affected the study results because the drivers could able to get use to the simulator due to their expertise. Moreover, drivers pointed out that age was an important factor to understand and apply what learned during the study. For them, role of the simulator in the instruction was very important since it made abstract knowledge concrete for the old drivers. So, they could easily understand what they learned.

Moreover, according to the study results, other factors affecting the simulator validation process was "instructional method applied during the training", "trainer's characteristic", "company's point of view" and "real life conditions affecting the transfer of the training". As Cagiltay (2001) stated the role of the tool was determined according to the method used during the instruction. Moreover, results of the data showed that the trainer preferred to use the simulator as a practice tool. Moreover, he made drivers to use this practice tool before and after the training. The aim was drivers' seeing the decrease in fuel consumption amounts when they drove the simulator according to economic driving techniques.

The trainer's manner and communication style with the drivers was another factor affected the drivers' attitude toward the training. Some drivers stated that they were pleased from the training due to the trainer's communication manner with them. The trainer pointed out that he preferred to introduce himself and informed about his background to the drivers since the drivers felt more comfortable themselves when they realized he also had same background. According to the observation results, the trainer listened what the drivers said, he also tried to involve them to the instruction with questions, and talked to them about different things other than training. In other words, most of the drivers started talking to the trainer as he was one of their friends in time.

The factors, namely, "company's point of view" and "real life conditions that may affect transfer of the training" were more affected the transfer of the training. Most of the drivers stated that the company's opinions about the gas saving changed and for that reason they tried to catch up company standards. Moreover, this factor was mostly mentioned one among the other factors affecting the transfer of the training. The managers pointed out that they wanted to drivers realize this change in company. They said that they started to arrange meetings to inform drivers about the change in company point of view about the fuel consumption amounts. Also, they stated that they started to broadcast the drivers who had least fuel consumption amounts in a list, monthly and gave a quarter gold the first three ones in the list. Although this factor had a positive effect on the transfer of the training, the drivers said that there are many factors affected the fuel consumption amounts, namely, weather conditions, loading amounts, working conditions, road types and traffic flows.

Shortly, the factors which may affect the validity of results of an instructional simulator were:

- age,
- expertise level,
- instructional method applied during the training,
- trainer's characteristic,
- company's point of view,
- real life conditions affecting the transfer of the training

Therefore, in the simulator validation model, the factors that may affect the validation process should be taken into account. Which factor affects which parts of the validation process should be determined before conducting the studies. Moreover, during the validation process, the validity of the instructional simulator should be defined according to this factor. For example, the simulator which is not valid for one context due to some factors can be valid in another context. As Foshay and Quinn (2005) stated the instructional and technological part of instructional media can not be separated. For that reason, the factors affecting the success of the media cannot be stemmed just because of the technological part but also because of the instructional part.

3. <u>Inform Participants about Their Performances</u>

As realized from the results of data collected under the scope of instructional validity, informing participants about their performances had an important role in the validation process. All the stakeholders pointed out that after the drivers' realizing the difference in fuel consumption amounts on the simulator between first and second driving experiences, they believed accuracy of information provided during the training. Moreover, after the driving experience on the simulator, the trainer controlled each parameter and discussed the result of the performance with the drivers. So, the drivers could repeat what they have learned and realized what they did or not during driving sessions. Moreover, the study results showed that the stakeholders prefer to take training on simulator instead of on real trucks because the simulator could provide statistical results for them. For that reason, the reports that were provided by instructional simulators about results of drivers' performances had contributed to the instruction. Moreover, according to the study results, immediate feedback provided about drivers errors were also beneficial since drivers could realize their driving errors on time.

So, it should be noted that feedback provided by the simulator enhanced the effectiveness of the instruction. The aim to use simulators was to contribute instruction for instructional simulator. For that reason, the properties of the simulators which services to instructional parts should be noted and they should be taken into account during the validation process.

5.2.2. Principles Related to Technical Issues

4. <u>Define the Fidelity Degree of Simulator</u>

In the literature, most of the studies equal the simulator validity with the similarity of measures to ones in real trucks (Blana, 1996a; Hoskins & El-Gindy, 2006). On the other hand, as limited literature advocated that the simulator validity criteria change for instructional simulators (Parkes, 2005; Martis, 2006; Estock et. al, 2008). Moreover, the instructional goals could be reached with a low fidelity simulator (Parkes, 2005; Martis, 2006; Estock et. al, 2008;). In the literature, validating the simulators according to their fidelity is named as "Physical Validity" or "Behavioral Validity". Chang and Ho (2001) state that "Physical Validity" is determined experimental studies without human during the simulator development stage. Blana (1996a) points out that "Behavioral Validity" of a simulator can be determined through experimental studies with human during the development and evaluation stage.

As seen from the current study, validity of instructional should not be determined only according to fidelity of the simulator but also its role in the instruction. Although the parts of the Truck Simulator did not represent ones of real models according to the data results of behavioral, face and instructional validity facets, the stakeholders described the simulator valid. The results showed that the simulator did not provide measures which exactly represent the real model ones. However, it enabled the drivers realize decrease in fuel consumption amounts when they drove the simulator by applying economic driving techniques. Moreover, the results showed that the simulator could provide a real life driving experience for the drivers. So, validation for instructional simulators should not be determined only according to the degree of the fidelity. It should be noted that what extend the capabilities of the simulators can enable instructors accomplish the instructional goals is the criteria for the validation of instructional simulators. Martis (2006) emphasized these issues under the title, namely, viewpoints on validation,

"These characteristics of validation" are listed accordingly below:

- A model should be judged for its usefulness rather than its absolute validity.
- A model cannot have absolute validity but it should be valid for the purpose for which it is constructed.
- There can be no one test with which the model validity can be judged.
- As a model passes the various tests, confidence in the model is enhanced.
- "Failing a test helps to reject a wrong hypothesis, but passing is no guarantee that the model is valid" (Sushil 1993).
- "Quantitative as well as qualitative validity criterion should be given more credence (Forrester 1961)".
- Most of the information from the real system is used to check the consistency of model behavior.
- Rejecting a model because it fails to reproduce an exact replica of past data is not acceptable.
- Rejecting a model because it fails to predict a specific future event is not acceptable because social systems operate in wide noise frequencies." (p.40).

5.2.3. Principles Related to Social/Organizational Issues

5. <u>Identify and Develop Participants' Awareness about the Benefits of the Training with Simulator</u>

At the beginning of the training, participants may not be aware of the benefits of training with the simulator. Moreover, they can resist taking training via the simulator since they think that the simulator will be used to evaluate them. Straus (1995) states that simulators can be used to evaluate participants' performances during training. Also, Aldrich (2005) points out that employee selection according to participants' simulator performances may be done by the companies. The study results also showed that the participants had negative attitude to the simulator since they think it was used to evaluate them. For that reason, in the validation studies they may be nervous at the beginning of the study. The participants' negative attitude affected the use of the knowledge offered during the training and it affected instructional validity of the simulator directly. Moreover, according to Blana (1996a), the results of the fidelity of the simulator experiments are affected from the participants' psychological situation and excitement. For that reason, the aim of the training and the role of the simulator in this instruction clearly explained to the participant.

In the current study, at the beginning of the training most of the drivers were suspicious about the use of the simulator in the training and they were excited. However, after the trainer explained the use aim of the simulator, they were more relaxed. Moreover, according to all data sources, the drivers were resistant to the training at the beginning of the study because they believed that they believed that they were experts and knew everything about the profession.

6. <u>Acknowledge Clearly Company's Point of View about the Training</u>

Policy of the company affects the participants' perceptions about the training and transfer of the training according to the results of instructional validity facets in the case. In the study, the stakeholders described the training as a indicator that showed change in the policy of the company about economic driving. The company changed the point of view about the fuel consumption and acknowledged this change to the drivers. However, according to them, without the necessary knowledge it was impossible to provide decrease in fuel consumption amount. In other words, training was one of the most important parts to provide change in the company system. However, the validation process showed that the point of view of the company made the drivers realize the importance of the training. Especially after the training, the point of view of the company emerged as an important factor that enables drivers to transfer information gained during the training.

Therefore, it should be noted that in the instructional simulator validation processes the company or organization policy should be identified. To success of the training also depends on the companies' policy. During the determination of overall validation instructional simulators, the results should be checked by taking into account the company policy.

5.2.4. Principles Related to Validation Process Issues

7. <u>Define the Scope of Validation Process</u>

The scope of the validation process is important especially to design a study for instructional simulators. According to the behavioral, face and instructional validity data results, all these facets should be merged during the instructional simulator validation process. Moreover, the scope of the validation process should be determined according to the applied validation facets.

Aforementioned before, the mostly mentioned validation approach in the literature is the behavioral validity (Blana, 1996a).Moreover, in that approach, the reality (fidelity) is the center of the studies (Blana, 1996a; Feinstein & Cannon, 2001; El-Gindy & Hoskins, 2006). On the other hand, as Foshay and Quinn (2005) states for the instructional technologies, there are two sides of the evaluation process, one of them is related to the technological part while other part is related to instructional part. Moreover, the scope of the instructional part is not identified clearly. In other words, some authors do not agree on extend of the instructional validity of the simulators. According to Blaauw (1982) transfer of the training is a part of validation of simulator which is designed for educational purposes (as cited in Blana 1996a). Wallace and Regan (1998), Cunto (2008) and Schmitz and Maag (2009) mention the transfer of the training offered via simulators. On the other hand, Blana (1996a) states that transferability should be investigated under the evaluation concept not validation concept. Parallel to the other authors, Feinstein and Cannon (2001) state that simulators can be used implementation or evaluation purposes during the instruction and transfer of the training was external validity of the simulator. As Blana (1996a) states the simulator are man-interacted systems and for that reason, as Uke (2006) points out the interaction issues, namely, usability should be taken in to account in the simulator studies.

Consistent with the literature, the results of the study showed that reality, usability and instructional benefits of the simulator was mentioned by all the stakeholders. For that reason, contrary to research simulators, while investigating the validity of instructional simulators, reality, usability as well as instructional benefits of the simulator should be taken into account. Moreover, the transferability of the training emerged as a part of the validation process in the current study case.

In the study, the participants pointed out that usability problems affected their performances at the beginning. However, they could easily get used to drive the truck simulator. Similarly, they stated that some reality problems in performance of the steering wheel, gas pedal or brake affected their performances, but, they could get used to them easily since they have been driving trucks for a long time. Moreover, according to the results, despite all the above statements, they found the truck simulator very beneficial for instructional purposes and the participants stated that transfer dimension of the training should be part of determination of the validity process.

Shorty, reality (fidelity), usability and contribution of simulators to training are dimensions in validity process for instructional simulators. Moreover, according to the results, contribution of simulators to training should have been evaluated by taking into account its contribution to transfer of knowledge.

8. Define Research Design and Methods of Validation Process

Aforementioned, the data collected under the scope behavioral, face and instructional validities showed that three facets should be applied during the instructional simulator validation process. Moreover, the research design and methods conducted under each validity facet should be determined at the beginning of the study and during the data collection. For example, face validity data showed that "transfer of the training" is a component of the instructional validity of the simulators.

In the early, the roles of the tools on learning are investigated experimental studies (Foshay and Quinn, 2005). However, the question on the instructional validity of the simulator is different than the question on the role of the simulator on learning because it is man interacted systems (Reeves, 2003). And the question asked about the instructional validation related to the learning experiences and/or assessment of learning. For that reason, Foshay & Quinn (2005) and Revees (2003) suggested multiple method use while investigating instructional facet of technologies used for instructional purposes. Moreover, Greene (2007) suggested using Mixed Methods Research Methods while conducting the complex evaluation studies.

Moreover, Blana (1996a) states that taking the stakeholders' opinions about the validity of the simulator was necessary to define any factors affecting the validation of the simulator. In the literature this approach is named as "Face Validity". Borenstein (1998) describes face validity as "consistency between the designer's view and the potential user's view of the problem in a timely and cost-effective way." (p.229). Face validation approach is based on taking users' opinions on whether the simulator represents the real vehicle (Feinstein and Cannon, 2001; Blana, 1996a, 1996b). Nilsson (1989) points out that the participants' subjective opinions and evaluations can be detected via questionnaires and interviews (as cited in Blana, 1996a). Similarly, Borenstein (1998) states that the potential users may be interviewed and they may fill questionnaires under the scope of some validation approaches. Moreover, he states that a number of observations and controlled data procedures should be conducted during the quantitative tests (Borenstein, 1998). Figure 5.4 illustrates the Face Validation and used Research Methods both in the literature and in the study.

The study results also showed that to reach an accurate picture about the validity of the instructional simulators, the best way to follow Mixed Methods Research methodology. Firstly, the validation process of the instructional simulators is complex (Reeves, 2003) and as Greene (2007) states complex issues best investigated by applying the MMR Methodology. Moreover, Foshay and

Quinn (2005), technological and instructional parts of the instructional technology require both experimental research designs and qualitative investigations.

Other important things in the MMR designs are to define weights and order of the methods (Greene, 2007; Tashakkori & Teddlie, 1998; Teddlie & Tashakkori, 2009). According to the simulator validation studies, the relationships between the different validation approaches are helpful to define weights and orders of the methods (Blana, 1996a). Blana (1996a) states that "Behavioral Validation" is an indicator for "Face Validation". In other words, if simulators are not valid in terms of "Behavioral Validation", it would probably not valid in terms of "Face Validation" (Blana, 1996a). Similarly, "Behavioral Validation" and "Face Validation" are indicators for "Instructional Validation" (Feinstein & Cannon, 2001). In other words, if simulators have necessary fidelity degree and participants' think they are contribute to training, simulators would probably valid in terms of instructionally (Feinstein & Cannon, 2001) . Similarly, current study results showed that "Behavioral Validity" and experience gained during "Behavioral Validation" caused the change in participants' negative perceptions about the simulators. Similarly, most of the participants state that experiences on the truck simulator provided their paying attention to the training and believed accuracy of knowledge. All the above statements referred to relationships between the approaches described according to literature. Figure 5.5 shows the relationships between the different validation approaches described in the literature.

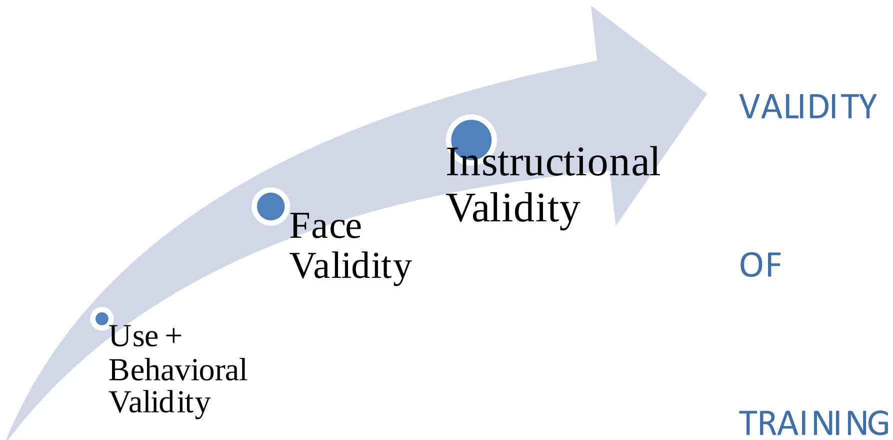

Figure 5.5 The Relationships of the Validity Approaches According to the Study Results

According to the **Error! Reference source not found.**5, the use and behavioral validities are related because usability of the system also means the reality of it. For that reason, their boundaries are difficult to define in the studies. For example the question such as "Did you have difficulty in driving the simulator?" refers to the both usability and reality of the simulator. Moreover, they affect the drivers' perception about the simulator and training. However, they are not center of the instructional simulator validation process. As seen from the **Error! Reference source not found.**6, Face validity is a complementary to the both use/behavioral and instructional validity parts. Since why and how questions are used to understand the reasons and factors affecting the study results, the face validity contains information about the overall validity of the instructional simulators. Moreover, the other function of the face validity is to learn drivers' opinions about the training and the contribution of the simulator to it. For that reason, it provides clues about the change in drivers' attitude about the training with simulator. The results of the study also showed that this change affected reaching the instructional goals since the drivers should have believed the accuracy of the knowledge to apply it. As said before, face validity is complementarity for both the behavioral and instructional validity of the simulators. All these results made the researcher place the face validity approaches between the use/behavioral and instructional validity approaches. The last approach placed in the figure is instructional validity. Although this approach is heavily mentioned one, the researcher placed it the last order in the simulator model name since all others approaches results affected the instructional validity. According to the results of the study, the instructional goals and learning experience that the simulator provided was the most important thing for all the data sources. For that reason in the model this approaches also placed the center of the model.

5.3. GISVM - The Goal-Based Instructional Simulator Validation Model

In this part, the researcher presents the Goal-based Instructional Simulator Validation Model (GISVM) developed according to the findings of the study. To do this, she merges the results and acknowledges the components of the model in detail.

5.3.1. Visual Representation of GISVM

Tarr (2006) describes a simulator as "representations of a piece of machinery or equipment (or a situation) in which the user is expected to react in a certain way" (p.1). Similarly, Aldrich (2005) and Reeves (2003) emphasized the importance of real life experience provided by the simulators. Moreover, Driscoll and Carliner (2005) state that the theoretical underpinnings of the simulations are based on Experiential Learning Theory. Kolb, Boyatzis and Mainemelis (2002) point out that in ELT, concern is to provide experience to the learner. For that reason according to them, ELT is different from other cognitive or behavioral learning theories in that it gives importance both affects and subjective experience (Kolb et al., 2002). When the simulations and simulators are thoughts, they are tools that are used to make abstract knowledge concrete by providing experience for learners. For that reason, as Blana (1996a) and Reeves (2003) state human affect on the validation studies should not be ignored. The model emerged from the findings of the study also took roots from human aspects and instructional goals of the validation process. Similarly, validation process principles emerged according to the current study results showed that there are three dimensions of instructional simulators validation process. One of them is fidelity degree of simulators and it should be defined according to instructional goals in addition to real vehicle data. Second one is "Human Perception" and participants' perception also complementary to fidelity and contribution of simulators to instruction. Third one is contribution of simulators to the effectiveness of training and transfer of training. It is important to be noted that GISV Model based on this three dimensions. Moreover, the study results showed that some factors stemmed from human characteristics, policies of organizations and context issues might affect the validation process. For that reason, in GISVM included all these factors. Figure 5.6 shows the visual representation of the Goal-Based Instructional Simulator Validation Model.

It is important to be pointed out that the GIVSM which is an instructional simulator validation model describes the validation process after the tool development. As stated before, the GISVM focuses on what a researcher should take into account during validation process of an instructional simulator. Since there are inconsistent comments on instructional simulator validation process in the literature, the main concern of the thesis is to develop a model which describes the validation process well. Although there are some explanations about how each component of the model can be applied, the main emphasis is on the components and factors that may affect the validation process.

Also, the GISV Model has implications for the developers on how they can determine the necessary fidelity of an instructional simulator during the analysis and development stage. It should be noted that this implications are more related to development stage, not evaluation one. However, as seen from the Figure 5.6, the model clearly defines the validation process in the evaluation phase although the results as well as the model have some implications that can be used by developers.

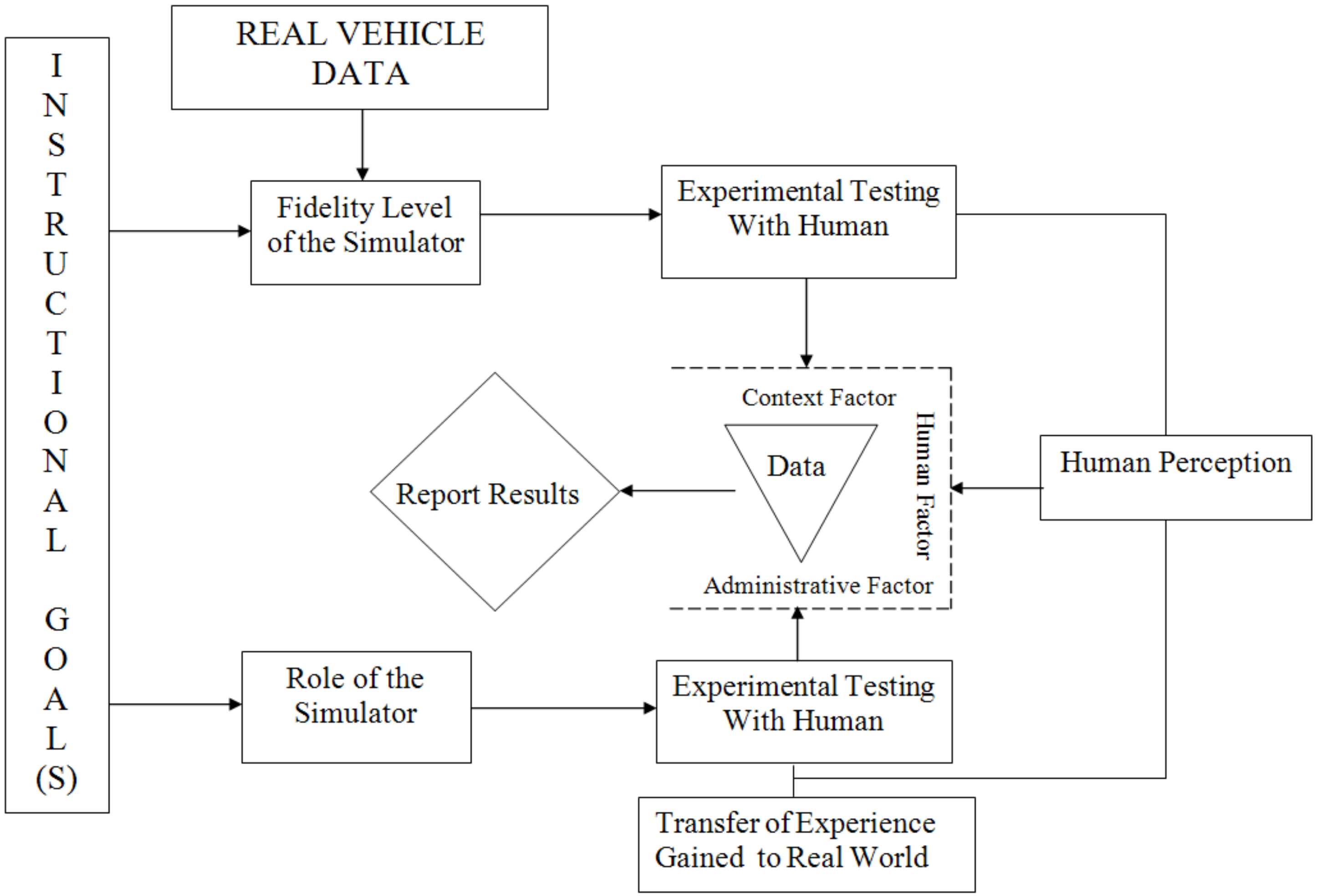

Figure 5.6 The Goal-Based Instructional Simulator Validation Model (GIVSM)

5.3.2. Overall Explanation on GISVM

The GISVM is a model which describes validation process for instructional simulators. In the model, main idea is that the base of instructional simulator validation process is “Instructional Goal(s)”. “Instructional Goal(s)” in the model refers to outcomes of learning. Researchers who want to validate any instructional simulator should start process by defining its instructional goals. According to “Instructional Goal (s)”, “The Role of the Simulator” and “Fidelity Level of the Simulator” should be defined.

“The Role of the Simulator” represents “Instructional Validity” approach in the validation process and is bounded to “Instructional Goal(s)” through validation studies. Simulators’ roles in an instruction can be, for example, providing drill and practice or showing mistake behavior results or making participants realize performance improvement after applying techniques offered during instruction. Moreover, as shown in the Figure 5.6, it can be determined through “Experimental Testing with Human”. A Researcher can design experiments with real users, then “Data” gathered through experiment designs should be analyzed by taking into account to what extend simulators do their role (s) accordance with “Instructional Goal(s)”

In the model, there is also, other part of “Instructional Validity” approach, “Transfer of Experience Gained to Real World”. This part refers to the transfer of the knowledge offered during instruction to real life. Although this aim is not pointed out in most of the instruction, it is very important for stakeholders (Frash, 2004). Also, validation process is affected from the transfer of training according to the GISVM since the results of the study shows that the participants want to evaluate simulator contribution to training after applying the knowledge gained during the training. For that reason, if possible for researchers, transfer of the training should be investigated during the validation process. “Data” on participants’ real life performances before and after the training have important clue for transfer of the training.

Parallel to this data gathering procedure, “Fidelity Level of the Simulator” should be investigated. This part represents “Behavioral Validity” approach. It should be noted that fidelity of the simulator is not unbounded from “Real Vehicle Data”. The important thing is to define “Fidelity Level” according to “Instructional Goal(s)”. “Data” on “Fidelity Level of the Simulator” can be collected through “Experimental Testing with Human”. Researchers can compare real vehicle data and simulator data to get information on similarity of measures provided both of them. Then, whether the defined “Fidelity Level” is enough or not should be checked in order to enable instructors reach instructional aim(s).

Aforementioned, experimental testing is not enough to gather accurate information about the overall validity determination. For that reason, “Human Perception” should be investigated. This part represents “Face Validity” approach. Under the scope of this part, “Data” on participants” opinions about reality, usability, instructional benefits of the simulators, as well as, experimental testing procedure and factors affecting validation process can be collected through interviews, questionnaires, observations and so on. For that reason, “Human Perception” part can be accepted a buffer between fidelity level and instructional benefits of the simulators in the simulator validation process.

As seen from the Figure 5.6, all “Data” collected under the scope of each approach should be interpreted conjunctively. Moreover, it is important to interpret “Data” by taking into account factors that may affect the validation process. Results of this study showed that these factors are “Context Factors”, “Human Factors” and “Administrative Factors”.

The last component of the model is “Report Results”. This part is the last step of the validation process. In that part, results of investigations should be presented as a report to all stakeholders. In the report, the results of “Fidelity Level”, contributions of instructional simulator to instruction which is based on “Role of the Simulator” and “Human Perception” should be written clearly. Then the data should be interpreted by taking into account “Instructional Goal(s)” and “Factors” affecting the validation process.

Shortly, the model reflects the idea that simulator validation process, especially, for instructional simulators should not be limited with fidelity level. According to the model, the important things are in a simulator validation process: 1) determining fidelity level, role of the simulator by taking into instructional goals; 2) taking participants’ opinion through the study; 3) interpreting all the data gathered under the scope of each part together; 4) taking into account the factors affecting validation process.

5.3.3. Components of the GISVM

In this title, the researcher presents the components of the GISVM. As seen from the Figure 5.6, there are 3 main components of the Goal-Based Instructional Simulator Validation Model. These main components are: “Fidelity Level of the Simulator” (Behavioral Validity), “Human Perception” (Face Validity) and “Role of the Simulator” (Instructional Validity). As realized from the Figure 5.6, the place and connection of the main components are defined according to the relationships between the approaches. “Human Perception” is in the middle and complementary to other methods.

Instructional Goal(s)

Instructional Goal (s) refers to instructors aim(s) and expected outcomes from instruction. Simulator validation process refers to "what extend a simulator does its design aims" (Blana, 1996a). For instructional simulators, design aims are connected to instructional goals. Moreover, "Fidelity Level" and "Role" of simulators are defined according to instructional goal(s).

As a summary, the first step is to define "instructional Goal(s)" in a simulator validation process. "Instructional Goal(s)" can be learned from instructors, development companies or project managers via interviews. For example, in this study, the researcher got information about instructional goal s) from the project managers of the petroleum company.

Real Vehicle Data

"Real Vehicle Data" refers to data gathered from experimental testing conducted with real users in real vehicle. The gathered data should be related to measures important in instruction. For example, in this study, truck drivers' fuel consumption amounts were important. For that reason, data was gathered with the participation of real truck drivers on a real truck. It should be noted that real vehicle data is collected before "Evaluation" phase and it is also necessary to interpret validity of simulators in terms of "Behavioral Validity". However, it does not mean that researchers cannot gather real vehicle data. In this study, the researcher interpreted the "Fidelity Level" data by taking into account expert opinion.

As a result, researchers can get information on "Real Vehicle Data" before conducting studies or parallel to studies. However, second option has disadvantages. The first disadvantage is that researchers loose times while collecting data from real vehicles. The second disadvantage is that real road and simulator environment cannot be the same. In other words, there is always a difference between two environments. For that reason, comparing these two environments data cannot guarantee the accuracy.

Fidelity Level of the Simulator

The "Fidelity of the Simulator" refers to what extent simulator measures represent real model measures. It s related to reality of the simulator and this component investigated through "Behavioral Validity". According to the GISVM, contrary to literature, "Fidelity Level of the Simulator" should be determined according to "Instructional Goal(s)". However, we cannot ignore "Real Vehicle Data" in the fidelity determination. In other words, both instructional goals and real vehicle data should be taken into account while defining the fidelity level of instructional simulators.

On the other hand, most of the studies limit the validation study by investigating the reality of the simulators to real models (Parkes, 2005). According to the results of this study, both instructional goal(s) and real model data have important role of the fidelity level of the simulator. In other words, the fidelity level may be low but if the simulator can enable instructor to accomplish instructional goals, the simulator is valid. For that reason, in the model, "Fidelity Level of the Simulator" components are not targeted the "Report Results" component directly.

Briefly, the critical issue according to GISVM is that the role of the instructional goal(s) while determining necessary fidelity level should not be ignored.

Experimental Testing with Human (Bounded to "Fidelity Level of the Simulator with an Arrow)

"Experimental Testing with Human" related to simulator fidelity level investigation refers to methods gathering data on "Behavioral Validity". In the scope of the fidelity level, experimental research designs are conducted. In the literature, fidelity (reality) level of the simulator is determined as a result of participants' performances comparison on the simulators and real models (Blana, 1996a; Feinstein & Cannon, 2001; Hoskins & El-Gindy 2006). As seen from Figure 5.6, "Experimental Testing with Human" is suggested method to gather information on fidelity level of simulators in the model. However, it should be kept in mind that the researcher should apply interviews for in depth information about the factors affecting the experimental study. Blana (1996a) advocates conducting interviews with different stakeholders during the experiments. According to him, it is a way to validate results of the experiments since the results can be affected many factors related to the context, human and so on (Blana, 1996a).

Shortly, researchers should design experiments with real users. These tests can be based on users' performances comparisons on real model and simulator. Also, these tests can be on similarity of the important parameters of simulator and real model. For example in this study, the researcher investigated important parameters relationships similarity of the simulator and real model.

Role of the Simulator

"Role of the Simulator" refers to which purposes simulators will be used in instruction and this part is related to "Instructional Validity". These roles may be providing drill and practice for participants, making the participants realize mistake behaviors' results, showing them real life situations and so on. As seen from the Figure 5.6, the important thing is to define the role of the simulator in instruction according to the instructional goals.

To sum, the instructional validity of simulators should be determined by focusing also role of simulators and what extend they do their roles parallel to instructional goals.

Experimental Testing with Human (Bounded to "Role of the Simulator" with an Arrow)

"Experimental Testing with Human" bounded to "Role of the Simulator" component in the model refers to methodology that researchers may apply to collect data on what extend simulator do their roles and what are their contributions to the training. The experimental research design may be applied to get information on the issue. For example, performance difference between participants who take training with simulators and one who take training without simulators may be compared. Another experimental design may be pre-post test designs in which participants' before training and after training performances are compared.

On the other hand, it should be noted that this methodology may not enough to get accurate picture on contribution of simulators to instruction. According to the study results, suggested research methods to investigate the role of the simulator in the instruction are applying Mixed Methods Research Methodology. The effects of the training on the participants' performances are suggested to be defined through experimental studies (Kihl & Wolf, 2007). On the other hand, stakeholders' opinions about to what extend the simulator can do the role in the instruction should be investigated through interviews with stakeholders.

As a summary, both quantitative and qualitative research methods should be applied to get whole picture on contribution of simulators to instruction.

Transfer of Experience Gained to Real World

"Transfer of Experience Gained to Real World" refers to transfer of the training to real life environment. This component is second part of "Instructional Validity". For that reason, transfer of the training is bounded "Role of the Simulator" component in the model. As seen from Figure 5.6 transfer of the training may be investigated through experimental research designs (P. J. Fadde, personal communication, November 5, 2009). However, it should be noted that there may be many factors affecting the transfer of the training. For that reason, the best way to get accurate picture on "Transfer of Experience Gained to Real World" part is also applying qualitative research methodology. For that reason, this component also bounded to "Human Perception" component which refers to take stakeholders opinions on simulator reality, usability and instructional validity in the model (Figure 5.6).

As a result, researchers should keep in mind that although instructional goals may not include transfer of training, all stakeholders' main concern is to transfer of what learned to real life environment. Especially, companies and learners are concerned with this issue. For that reason, transfer of training also investigated under "Instructional Validity" if possible. The researcher prefers to say “if possible” because investigation of transfer of the training is very difficult in some situations as Frash (2004) states.

Human Perception

“Human perception” refers to stakeholders’ opinions on simulator reality, usability and instructional validity. This validation approach is named in the literature as “Face Validity” (Feinstein & Cannon, 2001). The Figure 5.6 shows that humans’ perception may be used as a complementary to all type of methods which are applied to collect data on fidelity, role of simulators in instruction and their effects on transfer of training. Parallel to the literature, applying the methods in a complementary manner is one of the main aspects in the model. Aforementioned, this component data are gathered through interviews, observations, diaries and so on.

Shortly, it should be noted that “Human Perception” component is a buffer between “Fidelity Level of the Simulator” component and “Role of the Simulator” and “Transfer of Experience Gained to real World” components. Data gathered from this component is a complemetarity to all data gathered under the scope of other components.

Data

“Data” refers to information gathered through quantitative and qualitative methods. The Figure 5.6 shows that all the main components in the model bounded to only one “Data” component. This means that all data gathered through the study should be interpreted together. So, this figure also reflects the main idea of GISVM, all components are complementary each others.

Briefly, data gathered throughout simulator validation process should be interpreted together. Researchers may use joint analysis advised by Greene (2007) for this type of data interpretation process.

Context, Human and Administrative Factors

“Context Factors” refers to factors are related to design and environment of experimental testing and may affect results of the study. “Human Factors” refers to factors are related to participants’ age, gender, experience etc. and may affect results of the study. “Administrative Factors” refers to factors are related to managers’ attitude to training and companies’ policy and may affect results of the study.

Since some factors may affect the overall validation of simulators, it is important to note that these factors should be taken into account in two aspects. First, it is important to define factors. Second, it is important to define how these factors affect the validity of the instructional simulator. For example, administrative may affect the validity positively or negatively. Before interpreting the data, the directions of the factors in the validation process also should be defined since the factors also change the validity weights of the validity criteria. For example, in the case, participants were professional truck drivers and for that reason, they could easily get used to the steering wheel of the simulator. Although most of them complained about the sensitiveness of the steering wheel, they stated that they could get used to it in a short time. However, it could be a problem in a case in which the participants are novice. For that reason in the model, factors that may affect the validity determination are bounded by the methods. Moreover, since the factors also should be taken into account while interpreting the data, these factors are surrounding the "Data" component with dashed lines. Dashed lines are used in the model because these factors are lenses that may be used during the data interpretation. Moreover, as seen the Figure 5.6, there is no dashed lines on the side of "Report Results" component. The researcher wanted to show effects of these factors should also be used during reporting the results.

As a summary, the results of the each component should be defined and interpreted by taking into account factors that may affect study results.

Report Results

The last component in the model is "Repot Results" part. In this part, reports are prepared to present results of simulator validation studies. The important things in that part are: 1) used language in the report should be clear; 2) applied methods and research design should be pointed out; 3) results of data gathered under each component should be presented separately; 4) Then all results should be interpreted in a complementary manner; 5) suggestions on use of simulators in instruction and necessary improvement for simulators should be written clearly.

5.4. Guidelines for Practical Usage of the Model

Since the current study meet a need in the field and fill a gap in the literature, it has a potential to be used by many researchers and practitioners. The GISV Model includes beneficial information for the researchers who will conduct simulator validation studies and engineers who will develop simulators for instructional purposes.

For Researchers

The researchers who want to validate instructional simulators should take into account main components of the GIVSM. Moreover, the researcher should be aware of the factors that may affect the study and use strategies to take with them. The index about how a researcher can use the model is explained item by item:

- ***Instructional Goal (s):*** The instructional goals should be defined at the beginning of the study. Researchers can get information on "Instructional Goal(s)" from instructors, development companies or project managers via interviews. For example, in this study, the researcher got information about instructional goal s) from the project managers of the petroleum company.
- ***Real Vehicle Data:*** Researchers should keep in mind that validity of instructional simulators is not unbounded from fidelity level completely. Moreover, fidelity level is not determined only by "Instructional Goal (s). Instructional goals define only what extent fidelity is necessary to accomplish instructional goals. After necessary fidelity level determination, researchers should collect data from simulator systems and compare them with real vehicle data. For that reason, researcher should get information about real vehicle data by conducting researches themselves or by using previous research results.
- ***Fidelity Level of the Simulator:*** Researchers should define fidelity level of simulators according to instructional goals. Then they should compare real vehicle data and simulator data in order to get information whether simulators has necessary fidelity to accomplish instructional goals.
- ***Experimental Testing with Human (Bounded to "Fidelity Level of the Simulator with an Arrow):*** To define the fidelity level of the simulator, experimental research designs should be conducted. These experiments should be conducted with the participation of real users during training sessions. Moreover, researchers should take stakeholders opinions about the test environment and testing procedure since all these issues may affect the experiment results.
- ***The role of the Simulator:*** Researchers should determine the instructional validity of simulators by focusing also role of simulators and what extend they do their roles parallel to instructional goals. For that reason role of the simulator should be defined according to instructional goals.
- ***Experimental Testing with Human (Bounded to "Role of the Simulator" with an Arrow):*** The contribution of the simulator to the training should be determined through both quantitative and qualitative research methods since this part has two aspects: during the training (role of the simulator) and after the training (transfer of the training) contribution of the simulators.
- ***Transfer of Experience Gained to Real World:*** Transfer of the training is important for all stakeholders. For that reason, researchers should know that one part "Instructional Validity" is "Transfer of the Training Gained to Real World". To investigate transfer of training, researchers may compare real life performance of participants' before and after training.
- ***Human Perception:*** Researchers should take all stakeholders' opinions about both the simulator fidelity and contribution to the training. To collect data, researcher may conduct questionnaires, interviews, observations and so on.
- ***Data:*** Researchers should interpret all data collected though studies jointly. Aforementioned before the GISVM is based on the idea that all the methods should be applied in a

complementary manner to get whole picture about the simulator validation. For that reason, joint analysis during data interpretation is also critical for the study.

- ***Context, Human and Administrative Factors:*** Researchers should define the factors that may affect overall validity process. Moreover, they should point out whether these factors affect the study results positively or negatively.

- ***Report Results:*** Researchers, in the last step, should present study results as a report. In the reports, they should use a clear and fluent language that enables all stakeholders to understand results of studies. Moreover, the applied methods, procedures of studies, results and discussion of results should be placed in the report. Maybe, most important thing in reports is to give suggestions on how validated simulator can be improved or how they can be used in instruction. For that reason, researchers should give suggestion on use of simulators in instructions and necessary improvement.

For Simulator Developers

Maybe, the most important contribution of the GISVM to the instructional design field can be truth if the developers use it. As the literature advocated, we need the tools designed according to the instructional goals and aforementioned, the model has implications that can be used during the analysis and development stage by the developers. So, developers may develop appropriate tools for the instruction in a cost effective way. The following items include information on how developers could use GISVM:

- ***Instructional Goal (s):*** Developers, before the development phase, should arrange meetings with customers and learn about instructional goals of instructions that simulators will be used. It should keep in mind that fidelity level of the simulator should be defined according to instructional goals.
- ***Real Vehicle Data:*** Developers should collect data on real model measures or benefit previous study results on the issue. After the fidelity level determined, developers should determine which real vehicle data measures are critical in instruction and which parts of simulators fidelity should be high.
- ***Fidelity Level of the Simulator:*** Developers should determine fidelity degree of simulators by taking into account instructional goals. Moreover, expert opinions should be taken during this process. It is possible that customers can be stubborn to want high fidelity simulators. Under such situation, customer satisfaction should be provided by making cost and necessity chart.
- ***Experimental Testing with Human (Bounded to "Fidelity Level of the Simulator with an Arrow):*** During the development phase, experiments should be conducted with human. During

the experiments, participants' opinion should be taken about the simulator fidelity in the light of defined fidelity level as well.

Aforementioned, this validation model included the procedures could be applied in the evaluation step. However, simulator developers are interested in development stage. Although the GISVM also has practical benefits for developers, because broad of development sage is different than one of evaluation stage, some components of the model is not related to developers' working areas.

5.5. Conclusion

Under this title, the researcher presents summary of the results of the study by starting the necessity to design such study. Moreover, she acknowledges the validity determination of the Truck Simulator under this title.

There are many validation approaches and classifications for the simulators in the literature (Blana, 1996a; Hoskins & El-Gindy, 2006; Feinstein & Cannon 2001). Especially, fidelity degree of simulators in validation process is emphasized frequently. Moreover, most of the authors limit the validation process with fidelity investigation of simulators and named this approach as "Behavioral Validity" (Blana, 1996a). However, the use aims of simulators change the approaches which should be applied for validating simulators. Blana (1996b) classifies the simulators into "Training Simulators" and "Research Simulators" according to their use types. Also, Straus (2005) and Driscoll and Carliner (2005) mention "Evaluation Simulators". Parkes (2005) and Estock et. al (2008) state that instructional simulator validation process should be investigated differently than other types of the simulators. According to them, fidelity for an instructional simulator should be defined with respect to instructional goals (Parkes, 2005; Estock et. al.). On the other hand, fidelity should be high for "Research" or "Evaluation" simulators (Reed & Green, 1995; Blana, 1996a; Feinstein & Cannon, 2001; Chang & Ho, 2002). All these statements showed that there is a controversy on simulator validation process for instructional simulators. For that reason, in this study, the researcher focused development a simulator validation model for instructional simulators in addition to validating a truck simulator.

According to the results of the study, the validation process for the simulators had 3 approaches. The researcher explained these approaches according to mostly mentioned to least mentioned. First and heavily mentioned approach by all the data sources was the contribution of the simulator to training and transfer of the knowledge gained. Second approaches were similarity of the simulator to real truck in terms of measures and appearance. The third one was the perception of the participants' about the simulator and the simulator role to change the perception of the drivers' about the training. The fourth and the last one was the usability of the simulator.

All the data sources mentioned from the contribution of the simulator to the training by taking into account the instructional goals. It is important to state that they equal the success of the simulator what extend it do what is supposed to do. The trainer pointed out that the simulator use aims were to provide the practice for the drivers and make them to realize the difference in the fuel consumption amounts between before and after the training. Moreover, he stated that simulator use aim was reached in %70 percent. The data obtained from the drivers supported the trainer's statements in that the mostly mentioned contribution of the simulator to the training was its providing the practice for them. The drivers pointed out that they tried to drive the simulator according to the knowledge offered during the training. Also, they said that after realizing the difference in fuel consumption amounts provided by the simulator before after the training, they trusted the knowledge accuracy. The managers stated that practicing the knowledge was important for enhancing the effectiveness of the training as well as transferring it to the real work environment. One of the managers also pointed out that he talked to all the drivers after the training and the mostly mentioned things by the drivers was simulator's making them trusting the knowledge offered.

The observation results also showed that the drivers mostly discussed before and after training fuel consumption amounts with each others. While discussing the fuel consumption amounts, most of them stated that the techniques they learned during the training caused it. Also, they just showed each other the fuel consumption amounts not the other parameters' relationships which affected the gas saving.

All the above results are related to the instructional validity approaches advocated in the literature since they contained information about the learning experiences of the drivers and how much the simulator contributed to it.

The secondly emphasized issue by the expert trainer was the importance of similarity of the measures provided by the simulator to the fuel consumption theory. The trainer stated that the parameters that affected the fuel consumption amount should have reflected the theory claims. He also said that it is necessary to reach the instructional aims. On the other hand, the TS was reflected the reality in terms of measures in %30-35 percent according to him. Similarly, the drivers emphasized the importance to see the decrease in fuel consumption amounts after they applied the techniques learned during the theoretical part. Moreover, the drivers who were interviewed with after the training stated the same things and added that they applied the techniques offered during the training because they believed the accuracy of the knowledge after seeing gas saving in the simulator. The manager said that the drivers pointed out the simulator made them to believe accuracy of the knowledge.

It was important to point out a difference between trainer's and other data sources' comparisons of the simulator measures similarity to real truck ones. While the trainer evaluated the reality of the measures of the simulator by looking at parameters' relationships, the drivers and manager focused on the simulator's proving decrease when the techniques learned during the training was applied. Actually, the trainer pointed out that the simulator provided gas saving when it was driven according to theory but the parameter did not reflected the fuel consumption theory exactly. On the other hand, the drivers and managers did not mention the parameters' relationships. Observation results supported the interview results in that after the second driving the trainer showed the parameters changes between their first and second driving sessions. On the other hand the drivers did not pay attention to it and just looked and discussed their fuel consumption amounts with other drivers and the trainer.

Moreover, according to the interview and observation results, all the data sources pointed out the importance of the similarity of the simulator measures to the real truck measures. The trainer stated that if the simulator did not provide consistent results with the theory, the drivers would not believe the accuracy of the knowledge. Moreover the drivers and managers emphasized the same things during the interview. On the other hand, the most important result of the current study was that extend of the reality should be determined according to the instructional aims. In other words, the low fidelity (reality) simulators could also provide the instructor reach the instructional goals compare to its high version one. In the literature, most of the studies equal the simulator validity with the similarity of measures to ones in real trucks (Blana, 1996a; Hoskins and El-Gindy, 2006). On the other hand, as limited literature advocated the simulator validity criteria changed for instructional simulators and the instructional goals could be reached with a simulator which provides low real measures (Parkes, 2005; Martis, 2006; Estock et. al, 2008;). Parallel to the limited literature, the trainer also stated that the simulator reached its use aims in %70 percent while he stated that he provided similar measures to real trucks one in %30 percent. This meant that this simulator were valid although it was not reflected the reality exactly.

Parallel to these results, although the drivers complained from the performance differences of some simulator parts, they said that the simulator provided a practice opportunity for them. The trainer also stated that since the drivers were expert, they could get used to these performance differences in 5 minutes and this were not have an important effect on fuel consumption amounts. These results referred to the behavioral validity approach emphasized in the literature frequently.

The thirdly mentioned issue was the change in drivers' attitude towards the training. Although all the drivers mentioned the benefits of the training, some of them said that they were not want to attend the training because they thought they know everything about the profession. Moreover, most of these drivers pointed out that they changed their minds during the training. The factors affected this change about the training were trainer's manner, the simulator and content of the training. The drivers' interviewed with after the training emphasized the same factors' affects on the transfer of the training. Parallel to the drivers, the trainer said that at the beginning of the training, most of the drivers were not wanted to attend the training and they sometimes discussed with him for that reason. On the other hand, according to him, most of them completed the training with a satisfaction about what they learned. Observation results also supported these interview results in that, most of the drivers made negative comments about the training. They said that they were experts and did not need to learn to drive a truck. On the other hand, most of them thanked to the trainer for the knowledge gained at the end of the training. All these issues are labeled as face validity approach in the literature. On the other hand, the literature just mentioned the face validity and behavioral validity relationships. This study results also showed that for the instructional simulators face validity approaches also provided information about the factors affected the instructional validity side of the simulators. Moreover, according to the literature the more high fidelity means the high positive attitude to the simulator. However, the study results showed that although the fidelity of the simulator provided the positive attitude toward the training, the simulators did not have to have high fidelity to provide it since there were many factors affecting the transfer of the training, namely, instructional aims of using the simulator, trainer's manner, context and drivers' characteristics. Usability issues of the truck simulator are also emphasized by the drivers. According to the drivers, getting used to drive a truck took time and at the begging they had difficulty in driving it. On the other hand, they stated that it did not cause the problem because they were experts. According to the observation results, the trainer mentioned the usability of simulator by saying that getting used to the simulator took 4-5 minutes of the drivers and it had a minimum affect on fuel consumption amounts. According to these results, usability of the simulator had an effect on the fuel consumption amount but this affect was limited because the drivers' expertise.

Moreover, when the data was investigated it was realized that the usability had an effect on drivers' commenting on the simulator reality. The drivers who had difficulty in using the some parts of the simulators complained the reality of the simulator parts. The mostly mentioned parts were steering wheel and screen of the simulator. On the other hand, overall comments about the simulator were positive although it represented the reality very little.

It should be noted that there were some factors that might affect the study results. These factors affecting the validation process were "participants' resistance to the training", "participants' expertise", "participants' ages", "instructional method applied during the training", "trainer's characteristic", "company's point of view" and "real life conditions that may affect transfer of the training".

According to the results of the study, the drivers' expertise level could tolerance some inefficiency in the simulator. For example the usability problems or reality problems related to the simulator parts' not performing as the real truck's ones did not cause a problem due to the drivers' expertise. All the data sources pointed out that usability and simulators' parts' not reflecting the reality did not much affected the study results because the drivers could able to get use to the simulator due to their expertise.

Another issue was emphasized the data sources was drivers' ages. While the trainer and managers pointed out that the drivers' ages mean was about 40 and they have been doing the profession for a long time, they were resistant to the training. Moreover, the drivers stated that the training with simulator much more beneficial for the novice drivers because they do not know the profession. On the other hand, some young drivers stated that older drivers had difficulty in understanding the instruction and simulator made knowledge concrete for them.

It is important to point out that the instructional method the instructor use was the affected the whole process. According to the instructional goals, the method was determined and his design of the instruction was shaped with regard to the method. For that reason, the tools role in the instruction should have been determined by the method of the instruction according to the trainer. Moreover, the literature advocates that the role of the simulator should be defined according to method (e.g. Cagiltay, 2001).

The trainer's manner and communication style with the drivers was another factor affected the drivers' attitude toward the training. Some drivers also stated that they were pleased from the training due to the trainer's communication manner with them. The trainer pointed out that he preferred to introduce himself and informed about his background to the drivers since the drivers felt more comfortable themselves when they realized he also had same background. According to the observation results, the trainer listened what the drivers said, he also tried to involve them to the instruction with questions, and talked to them about different things other than training. In other words, most of the drivers started talking to the trainer as he was one of their friends in time.

The factors, namely, "company's point of view" and "real life conditions that may affect transfer of the training" were more affected the transfer of the training. Most of the drivers stated that the company's opinions about the gas saving changed and for that reason they tried to catch up company standards. Moreover, this factor was mostly mentioned one among the other factors affecting the transfer of the training. The managers pointed out that they wanted to drivers realize this change in company. They said that they started to arrange meetings to inform drivers about the change in company point of view about the fuel consumption amounts. Also, they stated that they started to broadcast the drivers who had least fuel consumption amounts in a list, monthly and gave a quarter gold the first three ones in the list. Although this factor had a positive effect on the transfer of the training, the drivers said that there are many factors affected the fuel consumption amounts, namely, weather conditions, loading amounts, working conditions, road types and traffic flows.

Lastly, all these factors could be labeled under a system label since some of them had common characteristics. For that reason the researcher, placed this factors under the specific groups. One of these groups was human related factors. The other one was instruction related factors while one of them was subject matter related factors.

When all the results were interpreted together, it could be said that the main components of the simulator validation process are simulator contribution to training, fidelity level of simulators and stakeholders' opinions on simulator systems validity. Moreover, the determination of the overall validity of the simulator should be decided according to the instructional aims. In other words, a simulator which is low fidelity level may be valid for instruction. Researcher also should keep in mind that factors affecting the results of studies should be taken into account during the data interpretation and validity determination.

This result also gives implications for developers in that if the same instructional benefit was accomplished with a low fidelity simulator, developers should choose to develop a low fidelity one because of the economic reason. Moreover, high fidelity does not guarantee that it would contribute to the instruction.

5.6. Implications for Further Research

In the IT field, the specific problem is thinking every new technology as a miracle that would solve all our educational problems (Reiser, 2001). And now, the simulators are seen as a miracle for the instruction especially, in the training sectors but they are not miracles (Estock et al, 2008). What makes a simulator miracle for instruction is to develop it according to the instructional goals and participants' needs (Parkes, 2005; Estock, et. al. 2008). This study provides the ways how a simulator can be a miracle for instruction since it gives precious information about the first step, validation process for researchers and developers. For that reason, the expectation of the researcher is that this study results will be taken into account by many researchers and developers.

It should be noted that the model developed during the current study is not the last version of the model. As Reigeluth and Frick (1999) pointed out the models and theories developed can be improved by applying them to another research studies. For that reason, the researcher intention is researchers use this model for other instructional simulator validation studies.

Moreover, there is a gap in the literature on how to validate other types of simulators. For that reason, for further, validity process for research and instructional simulators should be defined.

In this study, the many factors such as gender, age, company policy and so on were mentioned and it was stated that they could affected the validity study results. However, the selected group was homogeny in terms of (e.g) gender, age, company policy. For that reason, in the future, researchers can investigate these factors affects on the process by comparing different age, gender or company groups' performances by using the same simulator validation process

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APPENDIX A

LOJİSTİK ve NAKLİYAT ŞİRKETİNDEN TALEP EDİLEN BİLGİLER

1. 26 Ocak- 10 Şubat, 2009 ve 2 -11 Mart 2009 tarihleri arasında eğitim alacak şoförlerin listesi.

2. 26 Ocak- 10 Şubat, 2009 ve 2 -11 Mart 2009 tarihleri arasında eğitim alacak şoförlerin Ekim- Kasım- Aralık 2008 ve Ocak, 2009 tarihlerinde (Simülatör eğitimi almadan önceki 4 ayı kapsayan süreçte) hangi araçlarla, ne kadar yükle, nerelere yük taşıdıkları.

3. 26 Ocak- 10 Şubat, 2009 ve 2 -11 Mart 2009 tarihleri arasında eğitim alacak şoförlerin Ekim-Kasım- Aralık 2008 ve Ocak, 2009 tarihlerinde (Simülatör eğitimi almadan önceki 4 ayı kapsayan süreçte) aylık yakıt tüketim miktarları.

4. 26 Ocak- 10 Şubat, 2009 ve 2 -11 Mart 2009 tarihleri arasında eğitim alacak şoförlerin Ekim-Kasım- Aralık 2008 ve Ocak, 2009 tarihlerinde (Simülatör eğitimi almadan önceki 4 ayı kapsayan süreçte) sefer başına tüketmiş oldukları yakıt miktarı.

5. 26 Ocak- 10 Şubat, 2009 ve 2 -11 Mart 2009 tarihleri arasında eğitim alacak şoförlerin Şubat-Mart-Nisan-Mayıs 2009 tarihlerinde (Simülatör eğitimi aldıktan sonraki 4 ayı kapsayan süreçte) hangi araçlarla, ne kadar yükle, nerelere yük taşıdıkları.

6. 26 Ocak- 10 Şubat, 2009 ve 2 -11 Mart 2009 tarihleri arasında eğitim alacak şoförlerin Şubat-Mart-Nisan-Mayıs 2009 tarihlerinde (Simülatör eğitimi aldıktan sonraki 4 ayı kapsayan süreçte) aylık yakıt tüketim miktarları.

7. 26 Ocak- 10 Şubat, 2009 ve 2 -11 Mart 2009 tarihleri arasında eğitim alacak şoförlerin Şubat-Mart-Nisan-Mayıs 2009 tarihlerinde (Simülatör eğitimi aldıktan sonraki 4 ayı kapsayan süreçte) sefer başına tüketmiş oldukları yakıt miktarı.

8. 26 Ocak- 10 Şubat, 2009 ve 2 -11 Mart 2009 tarihleri arasında eğitim alacak şoförlerden eğitimi aldıktan sonraki 4 ay içerisinde işinden ayrılanların listesi.

APPENDIX B

BİLGİ DEĞİŞİMİ VE GİZLİLİK SÖZLEŞMESİ

Madde 1. Taraflar

Samandıra/İSTANBUL adresinde faaliyet gösteren Ekol Lojistik A.Ş. ve Çankaya/ANKARA adresinde bulunan ODTÜ Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümü doktora öğrencisi Hatice SANCAR arasında işbu Bilgi Değişimi ve Gizlilik Sözleşmesi aşağıda belirtilen tarihte imzalanmıştır.

Ekol Lojistik A.Ş. ve Hatice SANCAR her biri taraf ve beraber taraflar olarak anılacaktır.

Madde 2. Konu

Bu sözleşme Tarafların birlikte yapacağı tüm çalışmalarda birbirlerine açıklayacağı ve/veya aktaracağı gizlilik dereceli bilgilerin değişiminin düzenlenmesi ve aktarılan bilgilerin korunmasına yönelik hak ve yükümlülüklerin belirlenmesi amacıyla düzenlenmiştir.

Madde 3. Gizli Bilgi

Bu Sözleşme bağlamında, aşağıdaki bilgiler kesinlikle 'Gizli Bilgi' olarak addedilecektir.

A. Tarafların işle ilgili olarak diğer tarafın konu ile ilgili personeli ve halen veya daha önceden sözleşmeye dayalı ilişkiyle bağlanmış durumdakiler de dahil olmak üzere her türlü temsilcisinden bu Sözleşme'nin imzalanmasından önce veya sonra, yazılı veya sözlü olarak aldığı gizli olduğu açıkça ifade edilen veya edilmeyen her türlü bilgi, tasarım bilgileri, teknik bilgileri, ticari sırları, fikirleri ve buluşları içeren her türlü yazılı, sözlü ve görsel bilgi, örnekler veya modeller ile açıklanan ve gizlilik derecesi olan bilgiler.

B. Çalışmalar/görüşmeler sırasında tarafların eline geçen her tür veya nitelikteki belgeler, çizimler, tablolar, kayıtlar, proje önerileri, proje verileri ve diğer bütün yazışmalar.

C. Tarafların önerdiği fikirler, çalışma kapsamında ürünleri ile ilgili verdiği bilgiler ve bu bilgilere gönderme yapan bütün diğer belgeler

Aşağıdaki bilgiler gizli olarak addedilmeyecektir:

A. İfşa edilme tarihinde kamuya genel olarak duyurulmuş olan veya duyurulan ve bu duyurma işleminde Tarafların bu Sözleşme'nin herhangi bir ihlalinin söz konusu olmadığı bilgiler.

B. Taraflara, herhangi bir Anlaşma'ya veya gizlilik yükümlülüğü getiren bir göreve tabi olmayan bir kaynak tarafından gizliliğe tabi olmayan bir şekilde verilen bilgiler.

C. Yayınlanmaları veya kullanılmaları tarafların yazılı izni ile onaylanmış bilgiler.

D. Taraflara bu Sözleşme'nin feshedilmesinden veya sona ermesinden sonra gönderilmiş bilgiler.

Madde 4. Yükümlülükler

Taraflar, yazılı veya sözlü olarak aldığı Gizli Bilgi'lerle ilgili olarak aşağıdakileri kabul etmektedir. Ayrıca bünyesi altında faaliyet gösteren diğer tüm kuruluşlar ve personelin aşağıdaki yükümlülüklere uymasını sağlayacaktır:

A. Taraflar, birbirlerinden aldığı Gizli Bilgi'leri yalnızca ortak çalışmalar için kullanacaktır. Taraflar, Gizli Bilgi'leri başka herhangi bir amaçla, özellikle de diğer Taraf'a dolaylı veya doğrudan zarar verecek herhangi bir amaçla veya ticari bir avantaj ve dezavantaj sağlayacak şekilde kullanmayacaktır.

B. Taraflar, Gizli Bilgi'leri tamamen ve titizlikle gizli tutacak ve bu bilgilere ihtiyaç duyan Temsilcileri/personeli dışında herhangi bir şahsa kısmen veya tamamen ifşa etmeyeceklerdir. Temsilcilerine, Gizli Bilgi'lerin gizlilik niteliğini ve bu Sözleşme gereği bu bilgilerin gizli tutulmasından sorumlu olduğunu bildireceklerdir.

C. Taraflar, birbirlerinden teslim almış oldukları gizlilik dereceli bilgileri, yapılan çalışma sonuçlandırılmadığında, Gizli Bilgi'lerin bütün orijinalleri, talep üzerine ve de Sözleşme'nin hitamında derhal diğer Tarafa iade edecek, iade edilemeyen bütün kopyalar diğer Tarafca onaylanacak şekilde tahrip edilecektir.

Madde 5. Süre

A. Bu Sözleşme, imzalandığı tarihte yürürlüğe girecek ve süre sınırı olmaksızın geçerliliğini koruyacaktır. Yapılan ortak çalışmalar sonuçlanmışsa, çalışma sonucunda ortaya çıkan bilgiler, Tarafların görüşleri alınarak açıklanacaktır. Açıklanması uygun görülmeyen bilgiler gizli tutulacaktır.

B. Taraflar 3 (üç) ay önceden yazılı olarak ihbar etmek şartıyla iş bu sözleşmeyi sona erdirebilirler. Ancak, bu Sözleşme'nin sona ermesi; sona erme tarihinden önce alınmış bilgilerin korunmasıyla ilgili olarak, alan tarafa yüklenen yükümlülükleri ortadan kaldırmayacaktır. Sözleşmenin sona ermesi halinde 4.C. maddesi uygulanacaktır.

Madde 6. Genel Hükümler

A. Taraflar aldığı hassas ve gizlilik dereceli bilgilere en az kendisine ait olup, aynı derecede önemli hassas ve gizlilik dereceli bilgileri korumak için sarfettiği itinayı gösterecektir.

B. Bu Sözleşme kapsamındaki ve özellikle bu Sözleşme'ye göre edinilen hassas ve gizlilik dereceli bilgilerin açıklanmasına ilişkin yükümlülüklerinden herhangi birini kendi hatası veya ihmali nedeniyle ifa etmemesi durumunda Taraflar'ın yasal hakları saklıdır.

C. Taraflar, bu Sözleşme kapsamında aktarılan bilgileri kullanmaları sonucu, cihaz, araç gereçlerinde, personelinde ve/veya üçüncü şahıslarda meydana gelebilecek zarar ve hasar dolayısı ile diğer Tarafı sorumlu tutmayacaktır.

D. Bu Sözleşme; burada açıklanan hükümler haricinde, herhangi bir hak ve yükümlülük getirmez, ayrıca; Taraflar'ın ortak girişim, ortaklık, veya resmi mahiyette başka bir işin kurulmasını amaçladığı, birlikte çalışacakları veya gelecekte bir anlaşma yapılacağı şeklinde yorumlanamaz.

E. Bu Sözleşme aynı veya benzer konularda üçüncü şahıslarla benzer sözleşme yapılmasına engel teşkil etmez.

F. Taraflar, bu Sözleşme kapsamında gerçekleştirilecek çalışmalar için yapması gerekebilecek harcamaları diğer taraftan talep etmemeyi kabul eder.

G. Bu Sözleşme kapsamında elde ettiği Gizlilik Dereceli Bilgi ve Belgelere ilişkin yükümlülüklerinden herhangi birini yerine getirmeyen Taraf, diğer Tarafın bu nedenle görebileceği zararları karşılamakla yükümlü olacaktır.

H. Gizlilik dereceli Bilgilerin yanlışlıkla açıklanması durumunda açıklayan taraf diğer Tarafı derhal haberdar edecek ve Bilginin yanlışlıkla açıklandığının ispat edilmesi yükümlülüğü bilgiyi yanlışlıkla açıklayan taraftadır. Bilginin yanlışlıkla açıklanması bilgiyi veren Tarafın yasal haklarını kullanmasına engel teşkil etmeyecektir.

I. Sözleşmenin uygulanmasından doğacak anlaşmazlıklarının çözümlenmesinde İstanbul Mahkemeleri ve İcra Daireleri yetkili olacaktır.

Madde 7. Dağıtım ve Onay

İş bu sözleşme bu madde dahil yedi (7) maddeden ibaret olup, TARAFLAR'ca iki (2) nüsha olarak düzenlenip okunarak ... tarihinde imzalanmıştır. Sözleşmelerin bir nüshası Ekol Lojistik A.Ş. , bir nüshası da Hatice SANCAR tarafından saklanacaktır.

İmza 1	İmza 2	İmza 3	İmza 4
...	...	...	...

APPENDIX C

SİMÜLATÖR DEĞERLENDİRME ANKETİ

1. Lütfen öncelikli olarak aşağıda belirtilen ad-soyad, ehliyet no, filo ismi ve tarih kısımlarını doldurunuz.

2. Lütfen her ağır vasıta şoförünün sadece bir anket doldurduğuna dikkat ediniz.

3. Sorular ikinci sayfadan itibaren başlamaktadır.

4. Lütfen ikinci sayfada yer alan açıklama kısmını okuyunuz.

5. Lütfen anketi doldururken anketin her bir bölümünden önce yer alan açıklama kısmını okuyunuz.

Ad – Soyad :	
Ehliyet No :	
Filo İsmi :	
Tarih:	

Değerli Ağır Vasıta Soförü,

Sizin fikirleriniz ve bu ankete vereceğiniz yanıtlar "Ağır Vasıta Simülatörü"nün gerçek sürüş ortamını ne kadar temsil ettiği ile ilgili bilgi edinmek ve bu aracın kullanım zorluklarını ortaya çıkarmak için kullanılacaktır. Ayrıca bu ankete vereceğiniz bilgiler ışığında simülatörün daha etkili olacak şekilde geliştirilmesi amaçlanmaktadır. Sorulara verdiğiniz cevaplar, yalnızca ve kesinlikle araştırma amacıyla kullanılacaktır. Soruların cevaplanması 15-20 dakikanızı alacaktır. Lütfen bütün sorulara eksiksiz yanıt vermeye çalışın. Anketteki sorulara cevap verdiğiniz için şimdiden teşekkür ederiz.

Bölüm I

Kişisel Bilgiler

Açıklama: Anketin bu bölümdeki sorular sizlerle ilgili kişisel bilgi elde etmek amacıyla hazırlanmıştır. Lütfen size uygun bilgilerin ön kısmını işaretleyiniz.

1. **Yaşınız?**

   ____

2. **Cinsiyetiniz:**

   ☐ **Bay** ☐ **Bayan**

3. **Eğitim durumunuz:**

   ☐ **İlkokul mezunu**

   ☐ **Ortaokul mezunu**

   ☐ **Lise mezunu**

   ☐ **İki yıllık yüksekokul mezunu**

   ☐ **Üniversite mezunu**

   ☐ **Diğer (lütfen açıklayınız)..**

4. Ne kadar zamandır ağır vasıta soförlüğü yapıyorsunuz?

☐ **1 yıldan az**

☐ **1-2 yıl**

☐ **2-3 yıl**

☐ **3-4 yıl**

☐ **4-5 yıl**

☐ **yıldan fazla**

5. Kullandığınız ağır vasıta aracının türü nedir?

☐ **Kamyon**

☐ **Tır**

☐ **Diğer (Lütfen belirtiniz) ____**

6. Bilgisayar kullanıyor musunuz, kullanıyorsanız kaç yıldır kullanıyorsunuz?

☐ **Evet ____**

☐ **Hayır**

7. Eğer 6. soruya verdiğiniz yanıt "Evet" ise <u>haftada</u> kaç saat bilgisayar kullanıyor- sunuz?

____

8. Daha önce hiç simülatör kullandınız mı, kullandıysanız ne amaçlı bir simülatördü?

☐ **Evet ____**

☐ **Hayır**

Bölüm II

“Ağır Vasıta Simülatörü”nün Gerçeğe Yakınlık ve Kullanılabilirlik Açısından Değerlendirilmesi

Açıklama: Anketin bu bölümünün amacı “Ağır Vasıta Simülatörü”nü gerçeğe yakınlık ve kullanılabilirlik açısından değerlendirmektir. Lütfen aşağıdaki tanımlamaların her biri için size uygun seçeneği işaretleyiniz.

Kesinlikle katılmıyorum

Katılmıyorum

Kararsızım

Katılıyorum

Kesinlikle katılıyorum

Sürüş Deneyiminin Gerçekliği	1	2	3	4	5
1. Simülatörü kullanırken kendimi gerçek bir ağır vasıta aracı kullanıyor gibi hissettim.					
2. Simülatörde araç kullandığım yol bende gerçek bir yolda ağır vasıta aracı kullanıyormuşum hissi uyandırdı.					
3. Simülatörde ağır vasıta aracı kullanırken yanımdan başka bir vasıta geçtiğinde gerçekten yanımdan bir araç geçiyormuş gibi hissettim.					
4.Simülatörde bulunan araç aynaları gerçek ağır vasıta araçlarında kullandığım ayna hissini vermiştir.					
5.Simülatörde lamba kontrollerini yaparken bu kontrolleri gerçek ağır vasıta aracında yapıyormuşum gibi hissettim.					

Kesinlikle katılmıyorum

Katılmıyorum

Kararsızım

Katılıyorum

Kesinlikle katılıyorum

Simülatör ve Simülatör Ortanımın Görünüm Açısından Gerçekliği	1	2	3	4	5
6. Simülatörde sunulan "vites, fren,devir göstergesi, hız göstergesi,direksiyon, lambalar ve sinyaller vs" gibi araçlar gerçek ağır vasıtada bulunan araçların aynısıdır.					
7. Simülatörde duyulan motor sesi gerçek sürüş ortamında karşılaştıklarıma benzemektedir.					
8. Simülatörde kullanılmış olan trafik işaretleri gerçek yaşamda yollarda bulunan trafik işaretlerinin aynısıdır.					
9. Simülatörde sunulan ortamdaki "binalar, araçlar, insanlar vs" gerçek yaşam ortamında karşılaştıklarımın aynısıdır.					
Simülatördeki Parçaların Performans Gerçekliği					
10. Simülatörde bulunan vites gerçek ağır vasıta araçlarında bulunan vitesle aynı derecede geçiş performansına sahiptir.					
11. Simülatörde sunulan fren mekanizması gerçek ağır vasıta araçlarında bulunan fren mekanizması ile aynı derecede hassasiyete sahiptir.					
12. Simülatörde bulunan direksiyon mekanizması gerçek bir ağır vasıtada aracının direksiyonu hassasiyetine sahiptir.					

Kesinlikle katılmıyorum

Katılmıyorum

Kararsızım

Katılıyorum

Kesinlikle katılıyorum

	1	2	3	4	5
13. Simulatorde bulunan gaz pedalı gerçek ağır vasıta araçlarında bulunan gaz pedalı ile aynı derecede hassasiyete sahiptir.					
Simülatörün Kullanılabilirliği					
14. Simülatörün nasıl kullanılacağını anlamak benim için kolay oldu.					
15. Simülatörde sunulan "vites, fren,devir göstergesi, hız göstergesi,direksiyon, lambalar ve sinyaller vs" gibi araçlar gerçek ağır vasıta araçlarında bulunanlarla aynı şekilde kullanılmaktadır.					
16. Simülatörde sunulan "vites, fren,devir göstergesi, hız göstergesi,direksiyon, lambalar ve sinyaller vs" gibi araçları kullanırken zorluk çektim.					
17. Simülatörü kullanırken gerçek yaşamda yapmadığım hatalar yaptım.					
Simülatörün Öğretime Katkısı					
18. Simulatörü ekonomik bir şekilde sürdüğümü düşünüyorum.					
19. Simulatörün öğrenilen bilgileri pratikte uygulamak için uygun bir araç olduğunu düşünüyorum.					

Kesinlikle katılmıyorum

Katılmıyorum

Kararsızım

Katılıyorum

Kesinlikle katılıyorum

	1	2	3	4	5
20. Simülatörde yaptığım hatalara verilen uyarı mesajlarının faydalı olduğunu düşünüyorum.					
21. Simülatörü kullanmak kişinin ekonomik ve çevreye uyumlu sürüş alışkanlığı kazanmasını sağlayabilir.					
Simülatörlerle ilgili Memnuniyet					
22. Simülatörü kullanmak benim için zevkliydi.					
23. Simülatörün görünüşü ve konforu hoşuma gitti.					

24. Ağır Vasıta Simülatörünün iyileştirilmesi için vereceğiniz öneriler nelerdir?

a. ....

b. ....

Lütfen bütün soruları cevapladığınızdan emin olun.

Zaman ayırdığınız için teşekkürler.

APPENDIX D

GÖRÜŞME FORMU (EĞİTİM SIRASINDA SÜRÜCÜLERLE YAPILAN)

Ağır Vasıta Sürücüsü:________________ Tarih:___________________

Görüşme Süresi: 20-30 dakika
Araştırma Sorusu: Ağır Vasıta sürücülerinin, BP şirketinin sürücüleri ekonomik ve çevreye uyumlu araç kullanımı eğitimi için geliştirilmiş olan "Ağır Vasıta Simülatörü"nün gerçek sürüş ortamına ne kadar benzediği ve kullanım kolaylığı ile ilgili düşünceleri nelerdir?

Merhaba,

Herşeyden önce görüşmeyi kabul ettiğiniz için teşekkür ederim. Bu çalışmanın amacı ağır vasıta sürücülerinin, BP şirketinin sürücüleri ekonomik ve çevreye uyumlu araç kullanımı eğitimi için geliştirilmiş olan "Ağır Vasıta Simülatörü"nün gerçek sürüş ortamına ne kadar benzediği ve kullanım kolaylığı ile ilgili düşüncelerini almaktır. Bunun sonucunda elde edilecek verilerdoğrultusunda simülatörün tasarımında değişiklikler yapılabilecek ve kullanım kolaylığı arttırılabilecektir. Bu nedenle, bu konuda sizin bilgi ve tecrübelerinizden faydalanmak istiyorum.

Kişisel bilgileriniz ve cevaplarınız kesinlikle gizli tutulacak, sadece bu araştırma için kullanılacak ve araştırma sonunda toplu halde sunulacaktır. Araştırma sonuçlandığında dilerseniz size araştırmanın sonuçları hakkında bilgi verilebilecektir.

Sizin için vereceğiniz bilgilerin bilimsel bir araştırmada kullanılmasının bir sakıncası var mı? İzin verirseniz bu görüşmeyi kaydetmek istiyorum.

Yapılacak olan görüşme hakkında sormak istediğiniz herhangi bir soru yok ise görüşmeye başlayabiliriz. Görüşme yaklaşık olarak 20-30dk sürecektir, eğer kendiniz hazır hissediyorsanız ilk soru ile başlayalım.

Giriş Soruları

1. Kaç yıldır ağır vasıta şoförlüğü yapıyorsunuz?
2. Şimdiye kadar ne tür araçlar kullandınız? (Kamyon, tır, otobüs?)
3. Hangi şirketlerde çalıştınız?

Görüşme Soruları

1- Sizce simülatörde ağır vasıta aracı kullanmak gerçek ortamda ağır vasıta kullanmaya ne kadar benzerdi?

Sonda: Benzer yönlerinden sözedebilir misiniz?

Farklılıklarından söz edebilir misiniz?

2- Sizce simülatördeki aracı en ekonomik şekilde sürdünüz mü? Gerçek hayattaki sürüşünüz de böyle midir yoksa farklı mıdır?

3- Simülatörde sunulan "vites, fren,devir göstergesi, hız göstergesi,direksiyon, lambalar ve sinyaller vs" gibi araçlar gerçek ağır vasıtada bulunan araçlara ne kadar benzerdi? Bu araçlardan tanımakta zorlandıklarınız oldu mu? Açıklayabilir misiniz?

4- Bu araçlardan kullanmakta zorlandıklarınız oldu mu? Açıklayabilir misiniz?

5- Simülatörde kullandığınız ağır vasıta aracının görüş alanı ile ilgili düşünceleriniz nelerdir?

Sonda: Görüş alanınızı daralmış hissettiniz mi? Bu rahatsızlık yarattı mı?

6- Simülatörde araç kullanırken yanınızdan veya karşınızdan geçen araçlar sizde gerçek yaşamda yanınızdan bir araç geçiyormuş hissi uyandırabildi mi?

Sonda: Bu hissin uyanmasındaki faktörler nelerdir (Cevap evet ise)

Sonda: Bu hissin uyanmamasına neden olan etkenler nelerdir (Cevap hayır ise)

7- Simülatörde araç kulanırken yaptığınız hatalar gerçekte araç kullanırken yaptığınız hatalara ne kadar yakındı?

Sonda: Bunun nedenlerinden söz edebilir misniz? (Eğer farklı hatalar yaptığını söylediyse)

8- Simülatörün ekonomik ve çevreye uyumlu kullanımını arttırmak amacı ile sürücülere verilecek eğitimde ne kadar başarılı olacağını düşünüyorsunuz?

Sonda: Etkisi olmayacağını düşünmenizin sebepleri?

Etkili olacağını düşünmenizin sebepleri?

9- Simülatörün geliştirilmesi gereken yönlerinden söz edebilir misiniz?

10- Simülatörün hoşunuza giden yönlerinden söz edebilir misiniz?

APPENDIX E

GÖRÜŞME FORMU (EĞİTİM SONRASINDA SÜRÜCÜLERLE YAPILAN)

Ağır Vasıta Sürücüsü:________________ Tarih:____________________

Görüşme Süresi: 20-30 dakika

Araştırma Sorusu: Ağır Vasıta sürücülerinin, BP şirketinin sürücüleri ekonomik ve çevreye uyumlu araç kullanımı eğitimi için geliştirilmiş olan "Ağır Vasıta Simülatörü' nün eğitimin transferi üzerindeki etkisi nedir?

Eğitimin transferini olumlu ya da olumsuz yönde etkileyen faktörler nelerdir?

Merhaba,

Herşeyden önce görüşmeyi kabul ettiğiniz için teşekkür ederim. Bu çalışmanın amacı ağır vasıta sürücülerinin, BP şirketinin sürücülerin ekonomik ve çevreye uyumlu araç kullanımı eğitimi için geliştirtmiş oldukları "Ağır Vasıta Simülatörü" ile aldıkları eğitimi iş ortamlarına ne kadar yansıtabildikleri ile ilgili düşüncelerini almaktır. Ayrıca, sürücülerin eğitimi iş ortamında kullanmalarını olumlu ya da olumsuz yönde etkileyen diğer faktöler ile ilgili bilgi edinilmesi de amaçlanmaktadır. Bunun sonucunda elde edilecek verilerdoğrultusunda simülatörle verilen eğitimin gerçek ortamlarda kullanılabilmesi arttırılabilecektir. Bu nedenle, bu konuda sizin bilgi ve tecrübelerinizden faydalanmak istiyorum.

BP Projesi Görüşme Formu

Kişisel bilgileriniz ve cevaplarınız kesinlikle gizli tutulacak, sadece bu araştırma için kullanılacak ve araştırma sonunda toplu halde sunulacaktır. Araştırma sonuçlandığında dilerseniz size araştırmanın sonuçları hakkında bilgi verilebilecektir.

Sizin için vereceğiniz bilgilerin bilimsel bir araştırmada kullanılmasının bir sakıncası var mı? İzin verirseniz bu görüşmeyi kaydetmek istiyorum.

Yapılacak olan görüşme hakkında sormak istediğiniz herhangi bir soru yok ise görüşmeye başlayabiliriz. Görüşme yaklaşık olarak 20-30dk sürecektir, eğer kendiniz hazır hissediyorsanız ilk soru ile başlayalım.

Giriş Soruları

1. Kaç yıldır ağır vasıta şoförlüğü yapmaktasınız?
2. Şimdiye kadar ne tür araçlar kullandınız?
3. Kaç yıldır bu şirkette çalışmaktasınız?

Görüşme Soruları

1- Simülatörde aldığınız eğitimdeki bilgileri gerçek sürüş ortamlarında ne oranda kullanabildiniz?

2- Sizce simülatörün aldığınız eğitimi iş ortamında kullanabilmenizdeki etkisi nedir?
Sonda: Nedenleri nelerdir? (Yanıt: Herhangi bir etkisi olmadı ise)
Etkilerinden söz edebilir misiniz? (Yanıt:Etkisi var ise)

3- Simülatörle aldığınız eğitimdeki bilgileri sürüş ortamında kullanmanızı olumlu yönde etkileyen faktörlerden söz edebilir misiniz?

4- Simülatörle aldığınız eğitimdeki bilgileri sürüş ortamında kullanmanızı olumsuz yönde etkileyen faktörlerden söz edebilir misiniz?

5- Eğitimde verilen bilgilerin iş ortamında kullanılmasını arttırmak amacıyla eğitimde yapılabilecek değişiklik önerileriniz nelerdir?

APPENDIX F

GÖRÜŞME FORMU (EĞİTİMCİ İLE YAPILAN)

Eğitimci:________________ Tarih:___________________

Görüşme Süresi: 20-30 dakika

Araştırma Sorusu: Uzman eğitimciye göre, BP şirketinin sürücülerin ekonomik ve çevreye uyumlu araç kullanımı eğitimlerinde kullanmak üzere geliştirtmiş olduğu "Ağır Vasıta Simülatörü" ile verilen eğitimlerin amacına ulaşmasında simülatörün etkisi nedir?

Merhaba,

Herşeyden önce görüşmeyi kabul ettiğiniz için teşekkür ederim. Bu çalışmanın amacı uzman eğitimcinin, BP şirketinin sürücüleri ekonomik ve çevreye uyumlu araç kullanımı eğitimi için geliştirtmiş olduğu "Ağır Vasıta Simülatörü"nün gerçek sürüş ortamında verilen eğitimlere ne kadar benzer eğitim ortamı oluşturduğu ve gerçek modeline benzerliği, kullanım kolaylığı ile ilgili düşüncelerini almaktır. Bunun sonucunda elde edilecek veriler doğrultusunda simülatörün uygun eğitim ortamlarında kullanılması sağlanabilecektir. Bu nedenle, bu konuda sizin bilgi ve tecrübelerinizden faydalanmak istiyorum.

Kişisel bilgileriniz ve cevaplarınız kesinlikle gizli tutulacak, sadece bu araştırma için kullanılacak ve araştırma sonunda toplu halde sunulacaktır. Araştırma sonuçlandığında dilerseniz size araştırmanın sonuçları hakkında bilgi verilebilecektir.

Sizin için vereceğiniz bilgilerin bilimsel bir araştırmada kullanılmasının bir sakıncası var mı? İzin verirseniz bu görüşmeyi kaydetmek istiyorum.

Yapılacak olan görüşme hakkında sormak istediğiniz herhangi bir soru yok ise görüşmeye başlayabiliriz. Görüşme yaklaşık olarak 20-30dk sürecektir, eğer kendiniz hazır hissediyorsanız ilk soru ile başlayalım.

Giriş Soruları

1. Kaç yıldır ağır vasıta alanında eğitimcilik yapıyorsunuz?
2. Şimdiye kadar ne tür eğitimlerde bulundunuz?
3. Daha öncesinde simülatörle eğitim verdiniz mi?

Görüşme Soruları

1- Sizce simülatörde verilen eğitimler şu ana kadar ne kadar amacına ulaşmıştır?
Sonda: Ulaşmama nedenleri nelerdir? (Hayır ise)

2- Sizce simülatör gerçek ağır vasıta aracıyla verilebilecek bu tür bir eğitime ne kadar benzer bir eğitim ortamı yaratmaktadır?

3- Simülatörün geliştirilmesi gereken yönlerinden söz edebilir misiniz?

4- Simülatörde seçilen senaryonun güneşli havada yüklü olarak ve az araçlı bir yolda 16 kmlik alanda sürüşü kapsayacak şekilde belirlenmesinin nedenlerinden söz edebilir misiniz?

5- Ekonomik sürüşlerde dikkat edilmesi gereken şeyler nelerdir?

6- Simülatörün bize verdiği raporlarda ekonomik sürüşü etkileyen bölümler nelerdir?

APPENDIX G

GÖRÜŞME FORMU (NAKLİYAT ŞİRKETİ YÖNETİCİLERİ İLE YAPILAN)

Yönetici:________________ Tarih:___________________

Görüşme Süresi: 20-30 dakika

Araştırma Sorusu: Nakliyat Şirketi yöneticilerine göre, BP şirketinin sürücülerin ekonomik ve çevreye uyumlu araç kullanımı eğitimlerinde kullanmak üzere geliştirtmiş olduğu "Ağır Vasıta Simülatörü" ile verilen eğitimlerin amacına ulaşmasında simülatörün etkisi nedir?

Merhaba,

Herşeyden önce görüşmeyi kabul ettiğiniz için teşekkür ederim. Bu çalışmanın amacı nakliyat şirketi yöneticilerinin, BP şirketinin sürücüleri ekonomik ve çevreye uyumlu araç kullanımı eğitimi için geliştirtmiş olduğu "Ağır Vasıta Simülatörü"nün gerçek sürüş ortamında verilen eğitimlere ne kadar benzer eğitim ortamı oluşturduğu ve gerçek modeline benzerliği ve gerçek ortama alınan bilgilerin aktarılmasınındaki rolünün ne olduğu ile ilgili düşüncelerini almaktır. Bunun sonucunda elde edilecek veriler doğrultusunda simülatörün uygun eğitim ortamlarında kullanılması sağlanabilecektir. Bu nedenle, bu konuda sizin bilgi ve tecrübelerinizden faydalanmak istiyorum.

Kişisel bilgileriniz ve cevaplarınız kesinlikle gizli tutulacak, sadece bu araştırma için kullanılacak ve araştırma sonunda toplu halde sunulacaktır. Araştırma sonuçlandığında dilerseniz size araştırmanın sonuçları hakkında bilgi verilebilecektir.

Sizin için vereceğiniz bilgilerin bilimsel bir araştırmada kullanılmasının bir sakıncası var mı? İzin verirseniz bu görüşmeyi kaydetmek istiyorum.

Yapılacak olan görüşme hakkında sormak istediğiniz herhangi bir soru yok ise görüşmeye başlayabiliriz. Görüşme yaklaşık olarak 20-30dk sürecektir, eğer kendiniz hazır hissediyorsanız ilk soru ile başlayalım.

Giriş Soruları

1. Kısaca iş geçmişinizden söz edebilir misiniz?

Görüşme Soruları

1- Sizce sürücüler simülatörle aldıkları eğitimi iş ortamına ne oranda yansıtabilmişlerdir?

2- Sizce simulatörün sürücülerin aldıkları eğitimlerin iş ortamına yansıtmalarında ne kadar etkili olmuştur?

3- Sizce sürücülerin simülatörle aldıkları ekonomik ve çevreye uyumlu sürüş eğitimini iş ortamına yansıtmalarını olumlu yönde etkileyen faktörler nelerdir?

4- Sizce sürücülerin simülatörle aldıkları ekonomik ve çevreye uyumlu sürüş eğitimini iş ortamına yansıtmalarını olumsuz yönde etkileyen faktörler nelerdir?

5- Sürücülerin simülatörle aldkları ekonomik ve güvenl sürüş eğitimini iiş ortamına yansıtmalarında yükselme sağlayacak değişiklik önerileriniz nelerdir?

APPENDIX H

GÖZLEM FORMU

Amaç

Gerçek ortamlarda uygulanması zor ve çok pahalıya mal olacak durumlarda, özellikle de eğitim amaçlı olanlarda, simülasyon teknolojisi yaygın bir şekilde kullanılmaya başlanmıştır (Durdu ve Çağıltay,...). Sürüş simülatörleriyle sunulan sanal ortamlar ise gerçek yaşam ortamlarına kıyasla çok daha fazla avantaj sağlamaktadır (Kuhl, Evans,Papelis,Romano ve Watson,1996). Ancak bu avantajlar, simülatörlerin gerçek yaşam ortamlarını ne kadar yansıttığı ve kullanım kolaylıkları faktörlerinden oldukça fazla etkilenmektedir. Bu nedenle bu çalışmada "Ağır Vasıta Simülatörü"nün gerçek ortamı ne kadar yansıttığı incelenmiştir. Bunun yanısıra simülatörün kullanımı sırasında sürücülerin yaşadıkları zorlukların ortaya çıkarılması amaçlanmıştır.

Çalışmanın Soruları:

1-"Ağır Vasıta Simülatörü" gerçek ortamdaki ağır vasıta sürüş deneyimine benzer bir deneyimi ne kadar sağlamaktadır? (Gereçk ortamdakine ne kadar benzemektedir?)

2- Kullanıcılar, "Ağır Vasıta Simülatörü"nün kullanımı sırasında ne tür zorluklarla karşılaşmışlardır?

3-Kullanıcıların "Ağır Vasıta Simülatörü"nün kullanımına karşı tutumları nelerdir?

Önemi

Çalışma sonucunda eğitim amacıyla kullanımı oldukça yaygınlaşan simülatörlerin daha etkili tasarımlanabilmesi için yapılan çalışmalarda ne gibi yöntemler kullanılabileceği konusunda Alana yeni bir bakış açısı sağlanacaktır. Böylece tasarımlanmış simülatörlerin gerçek eğitimlerde kullanılmadan önce test edilmesi ve bu test sonuçlarına göre yeniden tasarımlanması konusunda tasarımcılara yeni fikirler verilecektir.

Veri Toplama

Çalışmanın gözlem metodu kullanılcak kısmında iki araştırmacı sürücünün simülatörü kullanımı sırasında tüm davranışlarını not etmekle birlikte aşağıda belirtilen davranışlarına odaklanacaktır.

a. Genel Uygunluk:

Simülatörde sunulan araçların gerçeğe yakınlığı gözlemlenmiştir.

- Sürücü aşağıda belirtilen mekanizmaları nasıl kullanmıştır?
- Bu mekanizmaların yerini bulmakta zorluk çekmiş midir?
- Bu mekanizmaları tanımakta zorluk çekmiş midir?
- Kullanımı sırasında herhangi bir zorlukla karşlaşmış mıdır?

- Vites, direksiyon ve fren mekanizmaları
- Gösterge panelleri
- Lambalar
- Sinyaller
- Aynalar

b. Hareket Uygunluğu:

Simülatörün kontrol hareketlerinin gerçeğe yakınlığı test edilmiştir.

- Kalkma, durma, hızlanma, yavaşlama, dönme, şerit değiştirme gibi hareketlerini sürücü ne kadar kolaylıkla yapabilmiştir?
- Hareket için kullandığı direksion, debriyaj, vites vs mekanizmaların yerini bulmakta zorluk çekmiş midir?

c. Görsel Uygunluk:

Araç görüntüsünün, ve ekrandaki dış çevrenin, görüş alanının ve görüş açısının gerçeğe yakınlığı aşağıdaki bakımlardan test edilmiştir.

- Çözünürlük
- Renk
- Aynalardaki görüntü
- Trafik kuralları
- Dışarıdaki diğer araçların görüntü ve davranışları

- Sürücü kendisine sunulan sanal yol ortamındaki işaretleri, yapıları tanımakta zorluk çekmiş midir?
- Sürücü yukarıda belirtilen faktörlerden dolayı sürüş zorluğu yaşamış mıdır?

d. Fonksiyonel Uygunluk:

Simülatördeki güvenli, ekonomik ve çevreye duyarlı sürüşle ilgili ölçütlerin varlığı aşağıdaki sorulara odaklanılarak gözlemlenmiştir.

- Sürücü simülatör ortamında sunulan uyarı mesajlarına ne kadar dikkat etmiştir?
- Sürücünün bu uyarı mesajlarına tepkisi ne şekilde olmuştur?

Davranışlar	**Bilişsel Süreç**	**Psikomotor süreç**	**Sürücünün yaptığı Davanışlar**	**Gözlemcinin notları**
Emniyet kemerini taktı				
Ayna kontrollerini yaptı				
Debriyaja bastı				
Vitese geçirdi				
Gaza bastı				
Trafik işaretlerine dikkat etti				
Simülatörde verilen hata uyarılarına dikkat etti.				

Araçlar	**Kullanımında zorluk çekti**	**Kullanımında zorluk çekti**	**Gözlemcinin notları**
Ayna kontrolleri			
Debriyaj			
Gaz Pedalı			
Fren			
Vites			
Direksiyon			
Sinyal mekanizması			
Devir Göztergesi			
Hız göstergesi			

APPENDIX I

GÖNÜLLÜ KATILIM FORMU

Bu çalışma, ODTÜ Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümünde Doç. Dr Kürşat ÇAĞILTAY danışmanlığında Araştırma Görevlisi Hatice SANCAR tarafından doktora tezi kapsamında Meteksan Sistem ve Bilgisayar Teknolojileri A.Ş. tarafından BP Petrolleri A.Ş. için geliştirmiş olduğu Ağır Vasıta Sürüş Simülatörünün (AVSS) geçerlemesinin yapılması amacıyla yürütülmektedir. Çalışmanın amacı, Hurmoğlu Eğitim Danışmanlık (HED) Ltd. Şirketinin BP Petrolleri A.Ş. adına vereceği ağır vasıta şoförlerinin ekonomik ve güvenli sürüş eğitimlerinde kullanılacak olan AVSS'nin etkiliğini ölçmek ve daha etkin kullanımını sağlamaktır. Çalışma süresince çalışmaya katılacak ağır vasıta şoförlerinden AVSS'nin ekonomik ve güvenli sürüş konusundaki düşünceleri anket ve görüşme yöntemi ile alınacaktır. Bunun yanısıra şoförlerin AVSS'yi kullanırken ne tür davranışlar gösterdiği de kameralar yardımıyla gözlemlenecektir. Yapılacak çalışma HED Ltd. A.Ş tarafından Ocak-Şubat-Mart aylarında verilecek eğitimleri kapsayıp 3 ay süresince devam edecektir. Cevaplarınız ve bilgileriniz tamamıyla gizli tutulacak ve sadece araştırmacılar tarafından değerlendirilecektir, elde edilen bilgiler doktora tezi kapsamında ve bilimsel yayımlarda kullanılacaktır.

Çalışmaya katılacak şoförlere, ekonomik ve güvenli sürüş eğitiminde AVSS'yi kullandıktan sonra verilecek olan olan Simülatör Anketinde 26 soru bulunmaktadır. Anket, katılımcıların AVSS'yi gerçek ağır vasıta aracına ne kadar yakın buldukları, kullanım kolaylığı ve eğitimde kullanılmasının ne kadar faydalı olduğu konularındaki düşüncelerini almaya yönelik sorulardan oluşmaktadır. Anket soruları baz alınarak hazırlanmış olan görüşme sorularında da anketteki soruların derinlemesine incelenmesi amaçlanmıştır. Ankette ve/veya görüşme sırasında sorulan sorulardan ya da herhangi başka bir nedenden ötürü kendinizi rahatsız hissederseniz cevaplama işini yarıda bırakıp çıkmakta serbestsiniz. Böyle bir durumda uygulamayı yürüten kişiye, uygulamayı ya da soruları tamamlamadığınızı söylemek yeterli olacaktır. Uygulama sonunda, bu çalışmayla ilgili sorularınız cevaplanacaktır. Bu çalışmaya katıldığınız için şimdiden teşekkür ederiz. Çalışma hakkında daha fazla bilgi almak için Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümü araştırma görevlisi Hatice SANCAR (Oda: Z17; Tel: 210 7525; E-posta: hsancar@metu.edu.tr) ile iletişim kurabilirsiniz.

Bu çalışmaya tamamen gönüllü olarak katılıyorum ve istediğim zaman yarıda kesip çıkabileceğimi biliyorum. Verdiğim bilgilerin bilimsel amaçlı yayımlarda kullanılmasını kabul ediyorum. (Formu doldurup imzaladıktan sonra uygulayıcıya geri veriniz).

İsim Soyad	Tarih	İmza	Alınan Eğitim
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APPENDIX J

KATILIM SONRASI BİLGİ FORMU

Bu çalışma, ODTÜ Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümünde Doç. Dr Kürşat ÇAĞILTAY danışmanlığında Araştırma Görevlisi Hatice SANCAR tarafından doktora tezi kapsamında "Sürüş Simülatörleri için bir geçerleme modeli geliştirmek ve geliştirilen bu modele göre bir simülatörün geçerlemesini yapmak" amacıyla yürütülmektedir. Çalışmanın amacı, bir çok alanda kullanılamaya başlayan sürüş simülatörlerinin geçerlemesi için bir model önermektir. Böylece bu araçların tasarımlanma amaçlarına uygun olarak etkili bir şekilde kullanılmaları sağlanabilecektir. Bu çalışma kapsamında sürüş simülatörleri için önerilen model kullanılarak bir sürüş simülatörünün geçerlemesi yapılacaktır ve katılımcılardan simülatörü kullandıktan sonra sürüş performansları, simülatörün gerçeğe yakınlığı, kullanım kolaylığı ve amacına hizmet edip etmediği konularında düşünceleri anket ve görüşme yöntemi ile alınacaktır. Yapılacak çalışma Hurmoğlu Eğitim Danışmanlık (HED) Ltd. Şirketinin Ekol Lojistik Ltd. A.Ş. şirketi ağır vasıta şoförlerine vereceği ekonomik ve güvenli sürüş eğitimi kapsamında 3 ay sürecek ve Ekol Lojistik Ltd. A.Ş. şirketinin Samandıra merkezinde Ağır Vasıta Sürüş Simülatörü aracında yapılacaktır. Cevaplarınız ve bilgileriniz tamamıyla gizli tutulacak ve sadece araştırmacılar tarafından değerlendirilecektir, elde edilen bilgiler doktora tezi kapsamında ve bilimsel yayımlarda kullanılacaktır.

Uygulama öncesi verilecek olan Simülatör Anketi, genel olarak katılımcıların sürüş performansları, simülatörün gerçeğe yakınlığı, kullanım kolaylığı ve amacına hizmet edip etmediği konularında düşüncelerini almak amaçlı hazırlanmış olan 26 sorudan oluşmaktadır. Anket uygulamasından sonra yapılacak görüşmelerde sorulacak sorular da anket soruları baz alınarak hazırlanmıştır. Uygulama sırasında sorulardan ya da herhangi başka bir nedenden ötürü kendinizi rahatsız hissederseniz cevaplama işini yarıda bırakıp çıkmakta serbestsiniz. Böyle bir durumda uygulamayı yürüten kişiye, uygulamayı ya da soruları tamamlamadığınızı söylemek yeterli olacaktır. Uygulama sonunda, bu çalışmayla ilgili sorularınız cevaplanacaktır.

Bu çalışmaya katıldığınız için şimdiden teşekkür ederiz. Bu çalışmadan alınacak ilk verilerin Ocak 2009 sonunda elde edilmesi amaçlanmaktadır. Elde edilen bilgiler sadece bilimsel araştırma ve yazılarda kullanılacaktır. Çalışmanın sonuçlarını öğrenmek ya da bu araştırma hakkında daha fazla bilgi almak için Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümü araştırma görevlisi Hatice SANCAR (Oda: Z17; Tel: 210 75 25; E-posta: hsancar@metu.edu.tr) ile iletişim kurabilirsiniz.

CURRICULUM VITAE

PERSONAL INFORMATION

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EDUCATION

Degree	**Institution**	**Year of Graduation**
Ph. D.	METU – Comp. Educ. & Inst. Tech.	2004 - 2010
BS	Çukurova University – Comp. Educ. & Inst. Tech.	1999 - 2003
High School	Cumhuriyet High School	1995 - 1999

WORK EXPERIENCE

Year	**Place**	**Enrollment**
2004 – Present	METU – Comp. Educ. & Inst.Tech.	Research Assistant
2003 – 2004	Yavuzlar Secondary School, Adana	Computer Teacher

FOREIGN LANGUAGES

English (advanced level)

PUBLICATIONS

Sancar, H., Cagiltay, K. and Isler, V. (2009). Design and Development of a Model to Validate Driving Simulators: A Truck Simulator Case. AECT 2009 Conference, Association for Educational Communications and Technology, October 27-31, Louisville, Kentucky, USA.

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Inal, Y., Cagiltay, K. & Sancar, H. (2005). Factors Effecting on Game Preferences of Children. TBD Bilişim Kurultayı, November 9-11, Ankara

Inal, Y., Cagiltay, K. & Sancar, H. (2005). Elektronik Oyunlardaki Dönüşümlü Oynama Özelliğinin Öğrenci Motivasyonuna Etkisi: The Incredible Machine Örneği. TBD Bilişim Kurultayı, November 9-11, Ankara.

Inal, Y., Cagiltay, K. & Sancar, H. (2005) Relationship between parents' attitudes toward the Computer Games and their Children's Computer Game Playing Habits. V. International Educational Technologies Conference, September 21-23, Sakarya

Sancar, H., Inal, Y. & Cagiltay, K. (2005). Why Educational Games Are Not Preferable among the Children: Children's Game Preferences. V. International Educational Technologies Conference, September 21-23, Sakarya

SPARE TIME ACTIVITIES

Swimming, cinema & theater, travelling.