



The role of driving simulators in driver education and training

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Abstract

The current study aims to reveal the role of driving simulators in driver education and training. The researcher gave a detailed presentation of simulation learning as an educational method, then provided a description of driving simulators and their importance in the field of driver education and training. The study concluded that Driving simulators have a positive role in teaching novice drivers and developing their safe driving skills.

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1. INTRODUCTION

Simulation learning is one of the latest technologies used in the field of driving education and training of novice drivers. It is usually used to bring learners closer to the real world, which is difficult or expensive to provide. It is an educational method in which the learner encounters virtual scenarios that simulate real reality, using a driving simulator that allows behaviors similar to driver behaviors in real driving, and allows teaching high-level procedural and cognitive skills. The use of simulators in the field of education and training has shown impressive results in the field of traffic security and safety Among novice drivers.

In this context, a study conducted in the Netherlands revealed that drivers who passed an educational program using a driving simulator (followed by training on the road) showed good results in terms of controlling the vehicle's steering and acceleration, with few violations and collisions as a result of their complete control of the vehicle and their awareness of the risks involved in driving (related to the driver, vehicle, road). This is what is widely trained using simulators in Australia, Europe, and the United States of America, with the aim of developing novice drivers' driving skills.

Based on what was mentioned above, the current study came to shed light on the role of simulators in developing safe

driving skills among novice drivers by answering the following question:

How can driving simulators contribute to the development of safe driving skills in novice drivers?

2. The simulation learning

2.1 The simulation learning Concept:

There are several definitions of simulation learning, perhaps the most prominent of which is the definition presented by Pierre and al (2006) that it is a useful educational process to help the learner extract information and acquire skills through experiential learning and practice on the simulator. It is a tool for learning skills (Rouge, 2016, p. 2).

Fuchs (1996) believes that imitation learning is allowing one or several people to carry out a set of sensory and cognitive activities in an artificial world, and it can be symbolic or simulate certain aspects of the real world (Faure, 2017, p. 18).

Anderson et al. (2006) defined it as a way of understanding systems, their variables, and their interrelationships, making it one of the most available and widely used strategies in systems analysis and operations research (Landriscina, 2013, p. 6).

According to Kamel (2010), simulation learning is defined as an educational method or method that the teacher usually uses to bring the learner closer to the real

world, which is difficult to provide due to material costs or human resources. It is one of experiential education forms where the learner is placed in educational scenarios that represent the truth or the real world, which contributes in developing the learner's critical thinking and evaluation ability. (Touil, 2023, p. 43).

As for Hamdi (2013), he went on to define simulation learning as an educational method that helps learning through imitation, which is an abstraction or simplification of some situations derived from real life, where the learner is placed in a system or environment similar to the environment which he is intended to deal with, and is given similar tools, to gain the required experience without risk or costs. (Touil, 2023, p. 43).

Simulation learning has been dealt with in the field of traffic safety and security as an educational method that was described by Michaut (1970) as a representation of the three elements that define the traffic system (driver, vehicle, surroundings). So it cannot be said that there is a simulation unless an element is represented or More than one of the three elements mentioned, it is defined as a useful way to teach and train novice drivers and enable them to develop a range of skills and practice them without any risk of collision or distraction (Filtness & al, 2013, p. 9).

From the above, we can say that simulation learning is an educational method based on a simulator, which is usually used to bring

the learner closer to real reality, which is difficult to provide due to its danger or high cost.

2.3 Historical development of simulation learning:

The emergence of driving simulators was linked to the field of aviation. Given the difficulty of controlling the first aircraft and the danger of experimental error (mostly fatal), experts came up with the idea of developing training devices capable of repeating the basic maneuvers to control the aircraft effectively and safely. Among the first innovative systems was the Antoinette barrel

Fig.1. Barrel Antoinette

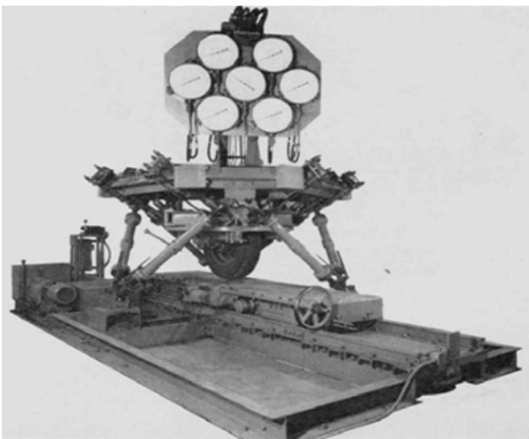


Source: Robache, 2017, p. 6

The Antoinette barrel consists of a frame with a seat and vehicle control system as shown in the picture above, where the assistants lift the entire frame and move it forward, backward and to the sides so that the trainee

pilot can adapt to its movements and control the turning process (Filtness & al, 2013, p. 9). In the early 1950s, engineer Stewart designed a platform that would carry tires and allow complex and intense loading conditions to be reproduced in the laboratory. This geometry remained unknown until Stewart described it in the mid-sixties in an article entitled "Stewart's Platform" (Robache, 2017, p. 7).

Fig.2. Stewart's Platform



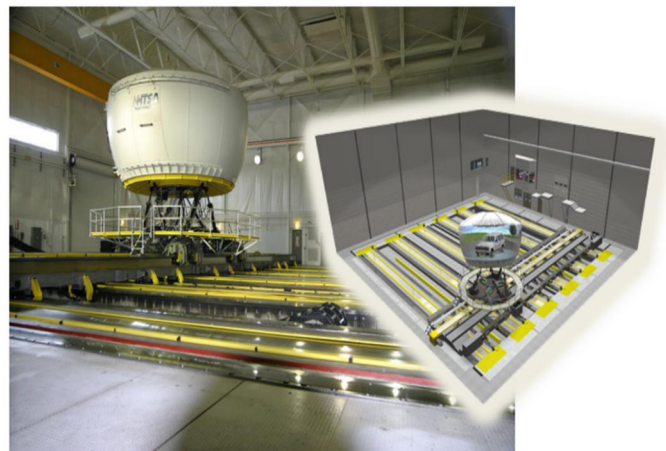
Source: Robache, 2017, p. 6

With the advent of computers and the development of information processing systems in the mid-1960s, experts were able to design the first car-driving simulator that worked using visual field generation techniques. By 1980, the first synthetic images created by cameras were used to develop visual realism thanks to the advent of 3D technology and tight image merging (Blana, 1996, p. 4).

Increasing interest in the field of simulation learning and the emergence of its importance in the field of teaching and training dangerous skills that are difficult to try in reality enabled Volkswagen in 1985 to design the first dynamic car simulator.

In addition, in the same year, Daimler-Benz presented a dynamic model with: 6 degrees of movement, Thanks to technological development, the Iowa Institute was able in 2003 to design the NADS simulator, which overcomes the problems of limited movement of the simulator's platform (Robache, 2017, pp. 6-7).

Fig.3. NADS-1 Driving Simulator



Source: MAS, 2012, p 54

2.4 The importance of simulation learning:

Previously, the process of drivers teaching and training targeted procedural skills related to collision risks only, but recent studies and research that have adopted simulation-based training have made it possible to train procedural skills and high-

level cognitive skills. In this context, the GDE matrix framework refers to the use of simulators, In teaching and training novice drivers how to perform a series of skills and procedures that become automatic with practice, and developing high-level cognitive skills by dealing with various difficult (dangerous) traffic situations that cannot be experienced in reality for security reasons. The simulation learning method allows drivers in general and novice drivers in particular to conduct a realistic assessment of their abilities and skills, which enables them to acquire the self-awareness skills of their limited abilities.

American philosopher David Kolb (1988) emphasized in his book “Experiential Learning” that learning is more effective and powerful when it relies on personal experience to gain experience, which is the advantage of simulation learning compared to other educational methods (Rouge, 2016, p. 2).

Jousse (2016) study revealed that the driving simulator remains an effective tool for teaching drivers the necessary driving skills gradually to the point of automated driving, and that the presence of simulators in driving school gives it a kind of modernity in drivers training.

The study conducted by Sætren and al (2018) in Norway revealed that adopting the simulation learning method has many advantages, perhaps the most notable of which are: effectiveness, cost reduction,

environmentally friendly training, and experimenting with various scenarios in a safe environment (accident scenarios, dangerous situations, traffic congestion, Darkness, difficult weather conditions, etc.), interaction with modern technology such as advanced driver assistance systems, etc.,

The Corneloup (2019) study also revealed the importance of virtual reality in teaching high-level driving skills and developing anticipatory skills (Touil, 2023, p. 163). Which makes it possible to detect visible dangers and anticipate hidden dangers, which allows the driver to make two types of proactive decisions:

The first is expressed at the tactical level and aims to reduce risks during the few seconds before arriving at the scene of danger, and the second is to initiate a rapid behavioral response at the operational level in case the expected danger actually arises.

The results of the study conducted by Wagner and al (2013) found the effectiveness of driving simulator in improving safe driving skills, risk perception, and understanding traffic rules among novice drivers. Abellsson (2017) noted that effective learning in simulation is transformed into actions as the trainee gains experience from managing different situations (Touil, 2023, p. 49).

The importance of simulation learning lies in independence and practice without time or space restrictions, thus moving forward

through trial and error cost-effectively and safely. This approach can also enhance the cognitive processes necessary for learning in terms of: selecting basic information, organizing this information into a cognitive structure, integrating this new information with previous knowledge, arriving at and creating appropriate comparisons (generating inferences, reorganizing cognitive structures), these steps can contribute to building new cognitive structures or modifying and replacing previous ones. (Landriscina, 2013, p. 7)

3. Driving simulator:

3.1 Definition of driving simulator:

There are several definitions of driving simulator, perhaps the most prominent of which is the definition proposed by Michael (1960) that it is a device whose function is identical and similar to the real system that has been copied and modeled (Michaut, 1970, p. 354).

It is a common term for a wide range of devices designed for experimental research on the relationships between driver, vehicle and driving environment (Harms, 1996, p. 19).

The driving simulator can be considered as a car equipped with a motor, dedicated to producing sensory stimuli (visual, auditory, and tactile) that create the virtual environment. This environment affects the driver in terms of cognitive and behavioral levels (Prévost, 2014, p. 40).

It is a device whose function is to reproduce as closely as possible the input and output behavior of a reference system. As the driver constantly analyzes information derived from his driving environment (visual scene, noise, etc.), this information is experienced as stimulation to the sensory organs. These organs transmit the stimulation to the brain, which decides the actions that take place on the control tools (pedals, wheel driving...etc). The reference system thus links the driver's actions on the pedals and steering wheel (inputs) with the cognitive perception of changes in the driving environment (outputs) .

From the above mentioned, we can say that a driving simulator is a vehicle that resembles a real vehicle and contains most of its equipment. It is usually used to teach and train drivers and provide them with the experiences that qualify them to drive in real reality effectively and safely. It allows the user to interact with a virtual environment in which he faces scenarios that enable him to deal with various traffic situations, under full control of driving conditions.

3.2 Installation (components) of driving simulator:

The device consists of the following elements:

3.2.1 Vehicle: it resembles a real vehicle and contains most of its equipment. Real vehicles are used in some third-generation simulators. By analyzing the simulator in

terms of its design, it can be said that it contains all the information that the user may need, which is mainly represented in the following:

- One or more screens to display the visual scene: their number varies from one device to another.
- Vehicle controls: mainly represented by the steering wheel, pedals, and transmission.
- Audio system to simulate vehicle noise and ambient noise.
- Effort compensation equipment in the pedals and steering wheel like a real car.

3.2.2 Environment: It includes all of the following:

- The auditory environment (auditory field): Despite the complexities of the auditory field, driving simulators are able to simulate real reality by emitting real car sounds such as the engine sound, sounds resulting from equipment and the external environment such as the air in parallel with the speed and the state of the windows (open or closed).
- The kinetic environment (the motor field): This is done by vibrating the driving center (the seat) according to each case, and it only exists in dynamic simulators, through which the vehicle is able to move and accelerate horizontally and vertically.

- Visual environment (visual field): The visual field is simulated in the driving simulator using multifaceted displays or cylindrical displays.

3.2.3 Software or Logiciels: The part related to software in driving simulators is somewhat complex, and includes many units, the most important of which are: (Mas, 2012, p. 48)

- Supervisor: This module allows the command center to start and stop the simulation and monitor its progress.
- Visual Rendering: This module manages the high-resolution three-dimensional (3D) rendering of scenes.
- Audio Rendering: This module manages the audio simulation of various elements of the environment, and includes a module for simulating engine noise.
- Traffic management: This module represents traffic vehicles, and includes a management module that allows these vehicles to be moved independently.
- Scenario management: This module allows scenarios to be created and executed, allowing various events to be triggered during the simulation.
- Recorder: This unit allows recording driving data such as vehicle speed, steering wheel angle, reactions...
- Acquisition: This unit manages the communication process between the

device's equipment by obtaining information from the controls and displaying it on the dashboard.

- Dynamic model: This module allows simulating vehicle responses based on driver actions, steering effort return , and some auxiliary systems.

- Control unit: This unit can control platform movements for dynamic simulators.

The process of managing these units is carried out by simulation programs such as: SCANeRc prepared by (Oktal) and the Sherpa program prepared by (PSA) and developed by ([GmbH] VIRES Simulation Technologie). These programs usually use the above-mentioned units. It can communicate with other modules and software .

3.2.4 Auxiliary tools and devices:

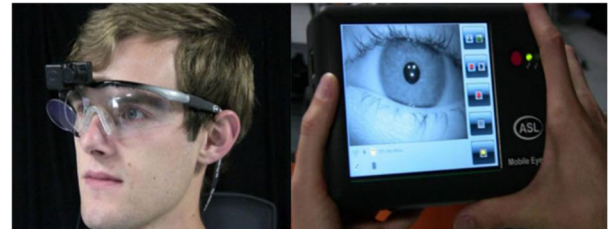
- Keyboard and mouse: Allows you to start and stop scenarios during exercises, adjust settings to suit each training, and move from one exercise to another.

- Eye movement tracker: The eye movement tracker is used to measure eye functions and movement, and allows data to be provided to the user simultaneously with the data of the driving simulator.

The eye movement makes it possible to determine eye movements and the driver's ability to accurately locate stimuli in the external environment. It is usually

observed that inexperienced drivers cover only a small area of the visual field, and direct their gaze to things that distract their focus from driving.

Fig.4. eye movement tracker



Source: Hurwitz, 2015, p. 1

4. Classification of driving simulators:

4.1 Classification of driving simulators according to their use:

Driving simulators are classified according to their use into three categories as follows:

4.1.1 Driving education:

It is considered among the most available and widely used simulators, which were used during World War II in the field of military training (operating aircraft, tanks, and ships), to be used later in teaching and training drivers to obtain a driver's license (Blana, 1996, p. 10). The main advantage of this type of device lies in conducting the training process faster, at a lower cost, and in a safer manner compared to using actual equipment, as well as developing the perceptual and cognitive driving skills of novice drivers and stimulating defensive driving methods.

Fig.5. Fraunhofer IAO driving simulator



Source: MAS, 2012, p 50

4.1.2 Scientific research:

The areas of application of scientific research simulators include studying the drivers performance and behavior , and vehicles and roads design, They have been used to study the effects of alcohol, drugs, lack of sleep and various symptoms that affect the driver's ability to drive, which are impossible to study in real life for security reasons. In this Context Michael stated that simply having an ideal research tool is considered an advance in the field of scientific research (Robache, 2017, p.9).

Fig.6. As-1200-6 driving simulator



Source: Niezgoda & al, 2011, p 311

4.1.3 Selection:

In this case, the simulator constitutes a test that was developed to evaluate the driver's abilities and competencies in a virtual environment similar to the real environment. Therefore, employing simulators to test drivers' ability can serve in selecting the required drivers without the need to use real vehicles and the risks they pose.

4.2 Classification of driving simulators according to their cost:

4.2.1 Low cost simulators:

Low-cost simulators are designed with limited graphics interface and control systems. It is characterized by being less expensive to maintain and develop compared to more advanced simulators.

The driver sits on a fixed chair or driving seat and the virtual environment is broadcast to one or more screens with a resolution often equivalent to that of mid-range televisions (Faure, 2017, p.22).

Fig.7. STISIM driving simulator of Dakota University



Source: STISIM Drive, 2023

Fig.8. low-cost driving simulators Leeds university



Source: Faure, 2017, p. 24

4.2.2 Medium cost simulators:

Medium-cost simulators have more advanced technical features compared to less expensive devices. They are equipped with high-quality displays with the ability to use 3D images and high-definition displays, a full-sized vehicle with all controls, a stable base and a simple feeling of movement through feedback. Such as seat or steering wheel vibrations. The scope of their use includes the same scope as that of low-cost simulators (Faure, 2017, p. 25).

Fig.9. Medium cost driving simulator LEPSIS (IFSTTAR)



Source: Faure, 2017, p. 26

4.2.3 High-cost simulators:

Very advanced devices designed to create a highly credible driving experience similar to reality, equipped with high-definition screens arranged to cover the entire visual field of the driver, providing an almost 360-degree field of view and a wide moving base. This type includes a movement system with six degrees of freedom,

These devices are distinguished by high-precision technical features compared to medium-cost devices. They are placed on platforms that allow movements according to several axes, whether withdrawal or rotation. The costs of operating, developing and maintaining this type of device are very high. These devices are often found in research and development centers in the automotive industry, and in a very small number of universities or public research centers (Faure, 2017, pp. 26-28).

Fig.10. high-cost driving simulator ULTIMATE



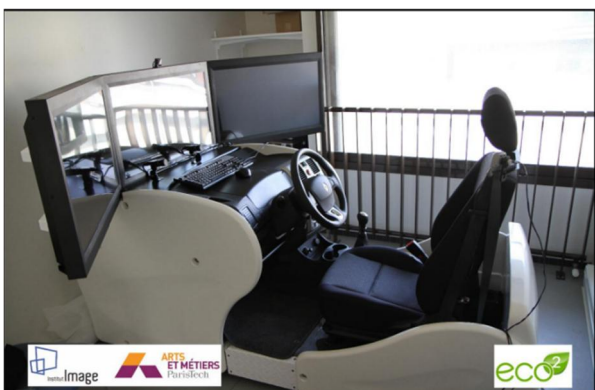
Source: MAS, 2012, p. 57

4.3 Classification of driving simulators according to their movement.

4.3.1 Static simulators:

They are fixed-base simulators that are inexpensive and easy to transport, including the Eco² simulator of the Central School of Nantes, shown in the following figure: (Mas, 2012, pp. 49-50).)

Fig.11. Eco² Oktal-Renault driving simulator



Source: MAS, 2012, p. 57

This device is inexpensive and easy to transport. The most advanced static simulators involve a fully equipped car in front of a large, curved or multi-faceted

screen. An example is the SIM² simulator from the French Institute for Science and Technology (IFSTTAR) consisting of a Citroën car. Xantia), the Fraunhofer IAO car simulator (Renault Scénic), and the 216Rover car simulator equipped with a curved screen.

Fig.12. DEVELTER driving simulator



Source: Dossier technique du simulateur de course, 2014, p.1

Fig.13. Fraunhofer IAO driving simulator



Source: MAS, 2012, p 50

4.3.2 Dynamic simulators:

Simulators with a moving platform in a limited working space, while producing a sufficient sense of motion as that

experienced in a real car (Nehaoua, Arioui, Mohelleb, & Espié, 2006)

This device are used in research centers and driving schools to better understand road hazards and mastering vehicle control and difficult traffic situations .

It constitutes an excellent educational tool with training programs adapted to all categories of drivers.

The device consists of driving seat, integrated driving panel, steering wheel with force feedback , handbrake, adjustable seat with seat belt, integrated center console, speaker, dynamic platform...etc.

Fig.14. Ultimate driving simulator



Source: MAS, 2012, p 58

Fig.15. Toyota driving simulator



Source: MAS, 2012, pp. 54

5. Using a driving simulator in the field of driver education and training:

The use of driving simulators aims to educate and train drivers and make them aware of the importance of applying safe driving principles and implementing safety measures in order to reduce the traffic accidents risks. The driving simulator includes comprehensive educational content for all topics related to safety and driving in various traffic situations that the driver may encounter, starting from the basic of vehicle control (such as the steering wheel) to high-level cognitive skills such as risk training, The most important exercises available on the device are the following

- Mastering maneuvers (vehicle control): The device allows practicing various maneuvers and performing them as in a real car without stress and without wasting time: getting to know the car, holding the steering wheel, starting and stopping, adjusting speed, steering the car...

- Free driving: This training allows to drive freely in the city, rural roads, highway, and in the middle of smart traffic, with other vehicles which move freely and randomly while respecting traffic rules, and their drivers can sometimes make some mistakes, as is the in the real life. .

- Emergency braking: emergency braking exercise on dry roads and on wet roads, with and without artificial intelligence systems.

- Stopping distance: The braking exercise integrates the driver's reaction time. Depending on the selected profile, small stop signs appear more or less randomly, so that the driver must stop as quickly as possible and at the shortest possible distance. With the possibility of comparing stopping distances.

- Emergency situation: This exercise makes it possible for vehicles to appear suddenly and randomly with or without an escape route. It is a form of the “stopping distance” exercise, but in this one, the driver faces an emergency.

- The speed effect: This exercise uses the same principle as the “emergency situation” exercise, where vehicles appear suddenly, but this time the distance from which the vehicles appear is determined. For example: The trainee's speed is 130 km/h, and 90 meters are specified as the distance for a vehicle to suddenly appear.

- Risky situations: It allows random simulation of risky situation scenarios inspired by reality. The user can also control events using the mouse or keyboard, such as a car crash, tire explosion, icy surfaces...etc. And driving errors such as sudden braking of the vehicle in front, increasing or decreasing the speed of other vehicles, pedestrians crossing through the parking area...etc.

- Slippery roads: This exercise allows you to practice driving on slippery roads (ice, snow, oil). The car's reactions depend on the stability of the road and the choice of tires. The simulator allows the user to modify the dynamic behavior of the car according to the type of choice.

-Driving safely: 100% AI behavior programming allows driving in a safe environment where vehicles respect traffic signals and road rules. Intelligence can also be set between 80% and 20%, which leads to non-respect of traffic signals and neglect of traffic rules by other road users, such as sudden braking, sudden lane change, operating vehicles in an emergency, crossing pedestrians behind parked vehicles, creating a traffic congestion. ...etc

-Economical driving: The information available thanks to the computer makes it possible to obtain a complete report that allows an analysis of the driver's driving style and the amount of fuel consumed during the trip. The entire track can also be re-watched using the video recorder

function. Full trip reviews can also be obtained.

6. Advantages of simulation learning:

There are many potential advantages of adopting simulation learning in the field of driver education and training in driving schools, the most important advantages of simulation learning can be summarized as follows:

- Teaching and training drivers and developing their safe driving skills: Simulators are usually used to teach and train novice drivers on procedural skills and it can also be used to develop high-level cognitive skills such as risk perception and road hazards awareness.
- Ensuring the driver safety and the safety of other road users: Simulators are used to train drivers to take risks by exposing them to dangerous situations, which represents an ethical challenge in real vehicles. This is something Flach revealed when he said that simulation provides an opportunity to learn from mistakes in a tolerant environment. (Berthelon & Perrin, 2017, p. 13).
- Cost reduction: Thanks to simulation learning, it has become possible to teach drivers with less effort and time, and at the lowest possible cost. (Faure, 2017, p. 14).
- Saving time and effort: The simulator allows reducing the number of hours spent in teaching driving on the road, as some researchers revealed that one hour of

education in a simulator may cover the learning content obtained in three hours of actual driving (Filtiness & al, 2013, p. 9).

- Measuring performance: The driving simulator can accurately and efficiently measure performance compared to real cars. For example, in one study that used a real car, it was impossible to determine the distance between the car and the stop line on the road, while this information is available in the simulator (Leeuwen, Winter & Happee, 2012, p. 47).

-Evaluating drivers' performance: The main advantage of driving simulators is their proficiency in evaluating drivers' performance through the scenarios available on the simulator according to the requirements of each experience, which allows the user to detect the level of deficiency in his performance and work to correct it .

Assessing drivers' performance: Simulators are good tools for accurately evaluating participants' reactions. They also allow standardization of assessment for all drivers compared to the real traffic environment, which is largely random. Mayhew's (2011) study demonstrated that driving simulators are sensitive enough to distinguish novice drivers. Based on procedural skills as well as detecting driving errors due to cognitive deficits (Prévost, 2014, p. 48).

- Environmental interaction management: The simulator allows the possibility of

creating different environmental effects and controlling many variables that occur while driving on the roads, including weather conditions, road conditions, driving conditions, types of vehicles, and unexpected behavior of other road users. This is impossible to provide and control in real reality (Filtess & al, 2013, p. 14).

- Recording the visual environment: The simulation makes it possible to record all available information such as speed, progress, reaction time..., which makes it possible to return to it later and discuss errors easily, which is difficult to obtain in real exercises (Rouge, 2016, p. 2).

- Data processing: Digital computer systems in driving simulators provide the ability to measure and process performance data accurately and efficiently compared to real cars and allow it to be formatted, arranged and stored (Leeuwen, Winter & Happee, 2012, p. 47).

- Reproduction and repetition of scenarios: Virtual environments allow scenarios of typical driving situations to be reproduced over and over again according to the requirements of each experience, especially for scenarios that rarely occur in reality .

- Providing psychological comfort for learners: Simulation learning avoids contact with inexperienced drivers and those violating the traffic system, all of which are external influences that negatively reflect the learner's psychology,

and the accompanying anxiety, tension, and pressure that may reflect negatively on his performance.

- Ensuring traffic flow and maintaining the cleanliness of the environment: Reducing the number of hours spent in learning using the simulator compared to a real car contributes to the flow of traffic and reduces gases that contribute to polluting the ocean and the environment.

- Using the device in the field of scientific and technological research: The simulator allows conducting laboratory research and studies that are impossible to do in real life for security reasons, and provides the possibility of testing new innovative devices in the car (Leeuwen, Winter & Happee, 2012, p. 47).

- Control of experimental conditions: Simulators enable control of experimental conditions across a wider range of field tests and can be changed from one case to another easily. This ability is important in terms of experimental design characteristics such as allowing successive comparisons of different experimental conditions.

- The possibility of using the device in the field of road and infrastructure design: Simulators provide different advantages for studying the impact of road infrastructure and design on driver behavior compared to field systems, especially when it comes to prior evaluation of a specific project.

7. Challenges of adopting simulation learning in driver education and training:

There are many potential advantages of adopting simulation learning such as cost reduction, environmentally friendly training, accessibility to different scenarios (accident scenarios, hazardous situations, darkness, difficult weather conditions, heavy traffic congestion of road traffic...etc.), possibility of making mistakes in a safe environment, and interacting with new technology such as advanced driver assistance systems...etc. However, adopting simulation training in the field of driver education and training requires discussing and solving many challenges and obstacles that can be summarized as follows:

- High cost of purchase and maintenance: Driving simulators are characterized by a high purchase cost. In addition, the costs of operation and maintenance are very high, so they are not available in driving schools and research laboratories, especially in light of the weak financial capacity of many organizations.
- The problem of validity: It is considered one of the main disadvantages of the simulation, because it is impossible to simulate the real world with all its complexities, as the real road environment is very complex and changing every time, compared to the virtual world. Moreover, the amount of total information processing required for the driver is less in

the simulation compared to reality, which may affect the users' behavior and performance.

- Simulation sickness: It can be defined as one of the main limitations of the simulator, simulator sickness can be described as a physical discomfort that occurs when driving the simulator and its symptoms can include dizziness, drowsiness, eye fatigue, headaches... (Prévost, 2014, p. 50)
- Overconfidence: Kappler (2010) revealed that the real danger in the consequences of risk-taking training using a simulator lies in the false sense of security, competence, and responsibility it leaves behind in the driver's psyche (Leeuwen, Winter & Happee, 2012, p. 48).
- Speed control problem: This means that the driving speed is higher in the driving simulator compared to the real road, which may negatively affect the driver's performance.
- Controlling training: according to the five levels included in the (GDE) matrix, considering the latter an important basis for driver education and training (2047) (Sætren & al, 2018, p. 2047).

8. Conclusion:

In order to develop safe driving practices among drivers especially novice drivers, as they are the most representative and exposed group to traffic accidents in the whole world. It is necessary to develop

their safe driving skills by improving the quality of education provided to driving learners.

Driving simulators are an effective educational tool in teaching and training drivers in general and novice drivers in particular, by training a set of procedural and cognitive skills that are impossible to implement in real life for security reasons. It can also be adopted as a research tool that allows researchers in the field of traffic safety and security to conduct various studies and research with the ability to fully control the experimental conditions and without any real danger, especially in light of the use of some additional tools such as eye movement tracking devices.

This study derives its importance from the current circumstances and the terrible increase of traffic accidents number in Algeria, and the material and human losses they cause. Its importance includes the following:

- Adding a new theoretical aspect that includes modern theoretical variables that can be adopted by researchers and specialists in the field of traffic security and safety to control the phenomenon of traffic accidents, especially since the theoretical aspect in Algeria has only a few studies that include these concepts.
- It is considered one of the rare scientific studies in Algeria that dealt with simulation learning technology in the field of

educating and training of young novice drivers, and developing their safe driving skills, as well as creating positive attitudes towards the driving task, which increases their awareness and reduces negative aspects that may appear later during the driving task, such as: poor vehicle control, poor control in difficult traffic situations, and adopting dangerous driving behaviors.

The study concluded that simulation learning has a positive role in enhancing safe driving practices among novice drivers in Algeria, if it is adopted as a tool in the driver education and training system, which has proven effective in many leading countries in the field of traffic Security and safety, and called for the necessity of using driving simulators in the Algerian driving education system, in order to obtain a driving license, or as a supplementary program within the requirements for obtaining a license.

To employ these devices in current and future driving education programs, the following must be taken into account:

- Understanding the basic strategies and rules in teaching driving using driving simulators compared to practical driving using a real car.
- Employing modern theories and models such as GDE model (Goals of Driver Education) in educational and training programs on driving simulators and determining their effectiveness in developing safe driving skills.

- Adopting the simulation learning strategy in driving schools and driver training centers.
- Adopting driving simulators in conducting studies and research related to traffic security and safety.

9. Bibliography List:

1. Berthelon, C., & Perrin, C. (2017). Introduction de scénarios d'accident dans les simulateurs de conduite - intérêt pour l'analyse du comportement des conducteurs. *Carnets d'accidentologie*, 2017, 13-21.
2. Blana, E. (1996). A Survey of Driving Research Simulators around the World (481). Leeds: Institute of Transport Studies.
3. Blana, E. (1996). Driving simulator validation studies: A literature review (480). Leeds: Institute of Transport Studies.
4. Faure, V. (2017). *Les simulateurs de conduite. Évaluation de la validité psychologique sous l'angle de la charge mentale* (Thèse doctorat, l'Université Paris-Saclay, France).
5. Filtness, A., Tones, M., Bates L., Watson B., Williamson A. (2013) How would changing driver training in the Queensland licensing system affect road safety? Deliverable 2: Simulators for skill acquisition training and assessment, and their impact on road safety (3). Queensland: The Centre for Accident Research & Road Safety.
6. Harms, L. (1996). Driving Performance on a Real Road and in a Driving Simulator: Results of a Validation Study. *VTL sartryck*, 267, 19-26.
7. Jousse, E. (2016). *Apprentissage sur simulateur de conduite automobile*, (thèse doctorat, l'université Angers, France).
8. Landriscina, F. (2013). Simulation and Learning A Model-Centered Approach. Trieste, Italy.
9. Leeuwen, P., Winter, J., & Happee, R. (2012, January). Advantages and Disadvantages of Driving Simulators: A Discussion. Paper presented at the Measuring Behavior Proceedings. Utrecht, Netherlands.
10. Mas, A. (2012). *Utilisation des simulateurs de conduite pour l'évaluation des systèmes d'aide à la conduite en situation d'urgence* (Thèse doctorat, l'École Nationale Supérieure d'Arts et Métiers, France).
11. Michaut, G. (1970). Les simulateurs de conduite automobile revue bibliographique critique. *Le travail humain*, 33(3-4), 353-378.

12. Niezgoda, M. Kaminski, T. Ucinska, M. & Kruszowski, M. (2011). Effective methods for drivers research with use of a driving simulator. *Journal of KONES Powertrain and Transport*, 18,(3) ,309-316.
13. Prévost, C. (2014). *Apport de la simulation dans l'évaluation des aptitudes à la conduite : l'exemple des personnes cérébrolésées* (Thèse doctorat, Université Rennes-2, France).
14. Robache, F. (2017). *Évaluation sur simulateur de conduite du comportement humain en situation de pré-crash: application à l'amélioration des airbags* (Thèse doctorat, Université de Valenciennes, France).
15. Rouge, J.A. (2016). Intérêt pédagogique de la simulation, *INTER BLOC*, 35(3), 174-177. Doi : 10.1016/j.bloc.2016.07.011
16. Sætren, G., Robertsen, R., Pedersen, P., Haukeberg, P., Rasmussen, M & Lindheim, C. (2018). Simulator training in driver education: potential gains and challenges. In S. Haugen , A. Barros, C. Gulijk, T. Kongsvik, & J. Vinnem (Eds.), *Safety and Reliability-safe societies in a changing world* (2045-2049). Trondheim, Norway : CRC Press.
17. Stim-drive. (2023). Retrieved 12/01/2024 from :<https://stisimdrive.com/solutions/>
18. Touil, A. (2023). "The effect of simulation learning on developing safe driving skills. An Experimental study on a sample of drivers using a "driving simulator" according to the GDE model". Doctoral Thesis, Batna 1 University, Algeria
19. Dossier technique du simulateur de course. (2014). Récupérée le 03 /01/ 2023 sur : http://cpge-grasshopper.fr/systemes/simulateur_de_course/dossier_technique/simulateur_de_course.pdf
20. Hurwitz, D. (2015). Eye Tracking. Retrieved 01/02/2023 from : <https://www.davidhurwitz.org/eye-tracking/>