

Opportunities and limitations in use of simulators in driver training in Norway. A qualitative study.

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Road transport is one of the leading causes of death worldwide (WHO, 2018) and considered one of the main sources of air pollution (EEA, 2008) which are both good reasons to make an attempt to move some of the driver training to driving simulators as they seem to make a safer training situation possible as well as offer good training possibilities, and are environmentally friendlier. Even though most high-risk industries use simulator training, this use is very limited in driver training in Norway. Further, most research on simulators concerns making instructor-free lessons, we would attempt to view the possibility of making the simulator a digital tool with the driver instructor present. Thus, our research question was: *Can use of simulators in driver training be beneficial or not from a safety perspective?* Method: five semi-structured interviews were conducted with driver instructors with experience of simulator use in driver training. Results: limitations were: (1) the learner driver would not use it, (2) difficult to use due partly to bad software, and (3) economy. The opportunities were: (1) less stressful environment for the learner driver, (2) possibility to spend more time on levels 3 and 4, (3) less hours on the road, and (4) safer work environment for the driver instructor. Our conclusion was that driver training in Norway could benefit from a well-planned use of simulators.

Keywords: driving simulator, driver training, learner driver, safety, driving class B, qualitative study.

1. Introduction

Simulators are widely used in many high-risk industries for training purposes. Examples such as aviation, nuclear power plant operators, maritime industries, medicine, and so forth, commonly use simulators (e.g. Salas and Cannon-Bowers, 2001; McGaghie et al. 2010; Bye et al. 2011). Even though driving also can be classified as a high-risk concept, simulators are not much used in Norway in driver training. There are several reasons for this; for instance, there are enough resources such as roads to practice on and driver instructors to teach, there are few economic factors as cars are not a very costly investment while a simulator historically has been a rather large investment. Additionally, the risk of having learner drivers in real traffic is not considered to be very high (Sætren et al., 2018).

However, road transport is one of the leading causes of death worldwide (WHO, 2018) and considered one of the main sources of air pollution (EEA, 2008; Gierè et al., 2018; Kole, Löhr, Belleghem, & Ragas, 2017). And, even though Europe and Norway are among the world's safest when it comes to road accidents (EC, 2018; ETSC, 2018), there are still too many deaths and thus there is a potential for better training. For these reasons, driver training in simulators could be beneficial.

Use of driving simulators in Norway today is very limited, and there is a need to explore why this is not more common, as well as how it could potentially optimize driver training. This is part of a larger four-year study of benefits and challenges regarding use of driver simulators in driver training in Norway.

International research on use of simulators today has focused on having a lesson in a

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simulator instead of a driver instructor. It is not viewed as a digital tool the driver instructor might use in order to have a safer way of training learner drivers and perhaps make them learn more in an alternative environment. This is the knowledge gap we would like to explore. Thus, our research question was: *Can use of simulators in driver training be beneficial or not from a safety perspective?*

1.1 Driver training in Norway

The Norwegian driver training is an extensive program with a comprehensive curriculum. It is recommended that you use two years to complete the training for the license and that you start when you are 16 years of age. The driver training consists of four levels.

Level 1 is a theoretical course (traffic basic course) and the learner driver is not allowed to drive a car in real traffic before this is completed. After this is completed, the learner driver might drive a car, for instance a lesson with a driver instructor or driver training with person who has had a license for minimum five years. During this level, which is level 2, the learner driver is to know how to maneuver the car, and braking, stopping, starting and so forth, are main goals for the driver training.

In level 3, the learner driver is to learn about more complex situations in driving such as hazard perception and maneuvering the vehicle in different contexts such as highways, rural areas, city driving and so forth. On level 4, the learner driver should master the maneuvering of the vehicle, understand and handle hazards in different environments, and so the focus on this level is to make strategic choices in traffic such as which route to choose or when to drive and so forth. Between each level there is an assessment conducted by the learner driver together with the driver instructor whether the learner driver is fit to access the next level or not (NPRA, 2017).

1.1.1 Driver training basic view of teaching in Norway

In order to be a driver, one must operate a machine in an environment with high tempo and precise coordination in a safe matter. To master this, instant feedback and much practice are two elements that theorists and practitioners seems to agree upon (e.g. Schank, Berman, and MacPherson, 1999; Aggarwal, Moorthy and Darzi, 2004; Reese, 2004). However, driver training is more than handling the vehicle. Operating a machine in different contexts with different hazards and in interaction with others, demands for understating complex systems that change and reflecting on different hazards and how to avoid hazardous actions. This is what is considered in the Goals for Driver Education

(GDE) matrix, which is the basis for most driver training in Europe. The GDE matrix consists of five levels. The first level is vehicle maneuvering, and the second level concerns mastering traffic situations. Thereafter, the third level is goals and context of driving, the fourth level concerns goals for life and skills for living (Keskinen 1996 in Hatakka Keskinen, Gregersen, Glad, and Hernetkoski, 2002), and the fifth level is social skills (Keskinen 2014). However, it does not state which training methods the teaching should be based on, and we do not have sufficient knowledge on how to train most efficiently apart from counting lessons and testing driver qualifications (Rismark and Sølvsberg, 2006). Even though in order to train for basic motoric tasks, an operant conditioning including practice and feedback is necessary, teaching driving in Norway is primarily based on the constructivist and social constructivist paradigm. The social and constructivist paradigm states that one's perception of the world is made from one's actions and interactions and how you interpret the world and construct the world in context with others (Solberg and Solberg, 2009). This is also why one of the most important parts of Norwegian driver instructor education, is to train for effective dialogue between the learner driver and the driver instructor, which seems to be efficient (Rismark and Sølvsberg, 2006). Due to the basic constructivist foundation, one of the main aspects from the curricula of driver training in Norway is the learner driver's reflections during the driver training (NPRA, 2017). Thus, one of the main tasks for a driver instructor in Norway is to foster dialogue and reflections. These reflections should be based on the experiences the learner driver encounters during the driver training process.

1.2 Safety aspects of simulator use in driver training

Even though driver training in Norway is comprehensive and extensive, there are training elements which a driving simulator might help optimize. For instance, by using a driver simulator the learner driver has the possibility to practice any maneuver, even dangerous ones, in a forgiving environment, as the learner driver can repeat training scenarios. Further, different views of the driving, including overhead view, helps the driver learner to see situations from different angles and thus gain a broader understanding. Difficult contexts such as weather conditions can be trained, as well as driving in the dark (de Winter, van Leeuwen, and Happee, 2012; Hirsch and Bellavance, 2016; Sætren et al., 2018).

Thus, it seems driver training in simulators has many benefits when it comes to safety, and there is rather little research conducted that illustrates that skills learned in a simulator (normally

consisting of a car seat, three screens and dash board, steering wheel and pedals like a car) are transferable to real life traffic. However, a review of those conducted show positive results in transfer of training of driving skills learned on a driving simulator to on-road driving (Hirsch and Bellavance, 2016).

2. Method

For this study, a qualitative approach was used to collect the data with semi structured interviews (Kvale, 1997) conducted with driver instructors having experience of using simulators in driver training in Norway. This is a part of a larger project concerning the use of driver simulators in Norway, with this as a first initiative of exploring the potential use of driving simulators in driver training with a driver instructor present. The method was chosen in order to explore a theme that is not widespread, and due to the fact that very few driving schools are experienced with the use of driving simulators, few interviews were possible to conduct.

2.1 Participants

Five semi structured qualitative interviews (Kvale, 1997) were conducted with driver instructors familiar with the use of driving simulators in driver training. Two of them were using it now for their teaching and the rest did not use the simulator any more. Even though the number of participants is quite few, the use of simulators in driver training in Norway is very limited (Sætren et al, 2018) as less than ten schools have or have used simulator for training purposes. The number of informants would therefore represent those experienced with the training method in recent years.

2.2 Interviews

The interviews (Kvale, 1997) were conducted at the workplace of the driver instructors face to face. They were situated in different parts of Norway. Further, the interviews lasted for approximately one hour and were recorded and transcribed.

The interview guide was divided in 6 main themes: (1) The first theme was about the driving school/workplace, and examples of questions here were "Could you describe a day where the simulator is/was used" or "How does a normal day look like to you". (2) The second theme was context description. Here questions were for instance concerning what simulator they had and for how long, and so forth. (3) The third theme was how the simulator was used. Questions here concerned how it was used according to the curricula, how much, for what parts did it function

best, not function, and so forth. (4) As a fourth aspect, how the use was carried out, was chosen. Here questions such as "How does/did the learner drivers choose what to use" What do they base their decision on". "Is it the driver instructor or the learner driver who choose to use a car or a simulator?" If the instructor is present, what role does/did the instructor have?" (5) The fifth theme concerned experience. Questions in this regard was for instance "Does some groups of learner drivers like it better than others? Why?" "Do you experience the simulator as useful? Why/Why not?" (6) As a sixth theme, the future was chosen including questions regarding their prospect of the future use of simulators in driver training.

2.3 Analysis

Thematic analysis was used to analyze the data. This is considered a theoretical and flexible approach to analyze the different themes found in interviews (Braun & Clarke, 2006; Aronson, 1994). Further, the software program Nvivo 12 was used to organize the transcribed material and analysis of this. Themes related to pros and cons regarding simulator training were prioritized in the coding process. Additionally, the development of themes process was guided by the interview material and not theory-driven.

3. Results

The findings from the qualitative semi-structured interviews were categorized into limitations and opportunities (see table 1).

Table 1. Findings of limitations and opportunities of the usage of driving simulator in driver training in Norway.

Limitations	
1)	the learner driver would not use it
2)	difficult to use due partly to bad software
3)	economy
Opportunities	
1)	less stressful environment for the learner driver
2)	possibility to spend more time on levels 3 and 4
3)	less hours on the road
4)	safer work environment for the driver instructor

3.1 Limitations

1 The learner driver would not use it. Regarding this category, the driving schools who acquired a simulator but did not use it any longer, all said that the main reason for this was that the learner driver would not use the simulator. It was explained that the learner drivers did not seem willing to pay for a lesson in a simulator without an instructor when they could have a lesson in a car with an instructor. Further, it was said that it was very hard to make the learner drivers book the simulator when they booked a lesson at the school, even though the payment for the simulator lesson was less than a lesson in a car with an instructor. An illustrative quote was: *“the learner driver seemed more interested in trying it out in real life traffic”*.

2 Difficult to use due partly to bad software. The second thing the schools who no longer used the simulator pointed out, was that the software was not good enough for their use, for instance that the scenarios were not good enough. All the schools had had simulators a few years ago; the latest got rid of its simulator three years ago, so the software might not be equivalent to what is existing today. The issues were for instance that hill-starts were not authentic enough or give good enough situations for level 3 and recognizing risk situations. A quote that illustrates this was: *“We must be able to choose risk situations more according to our needs and the traffic was not good enough”* and *“the software was not good enough for the traffical training”*.

3 Economy. Because learner drivers did not book simulator lessons, the driving schools did not see how the simulator could be paid for. Most driving schools had an agreement with the leasing company that they only paid for the lessons in which the simulator was actually used, so at the time they did not lose any money from it, but if it was to be bought, it would have been a significant investment which would require more usage as this quote shows: *“To have simulators that are good enough we must significantly up in cost and we know that it will cost more than investing in a car which we know for certain is applicable.”*

3.2 Opportunities

1 Less stressful learning environment for the learner driver. Those who used a simulator today in driver training, pointed out the aspect of making the initial learning as little stressful as possible. For learner drivers who had never sat in a car, or who were nervous about the experience for different reasons, driving in a simulator prior to a real car in real traffic was experienced as less overwhelming. For instance, if a learner driver is nervous in real traffic, elements such as involuntarily shutting the engine off in a road

section could cause more stress and irritated road users in the vicinity. By being familiar with the vehicle prior to this, it was said that the start with a car on the road was more relaxed and a better overall experience. An example of quotes in this regard was: *“Learner drivers who are nervous would feel safer by trying it in a simulator first, before entering real life traffic”* and *“the systematic and automatic skills you are supposed to learn are difficult when you are tense and anxious”*.

2 Can choose to spend more time on levels 3 and 4 in a car. It was emphasized that the training on levels 3 and 4 were the most important in order to send safe drivers out on the road after completed training. With a driving simulator it was experienced that there was better time to use on these levels. Here the instructor could help the learner driver to reflect and make good choices in a car out in traffic rather than spending more time on more basic levels. Another benefit with this, was that as an instructor, it was mentioned, it was more inspiring to guide the learner drivers on levels 3 and 4 than level 2. Thus, their workday became more interesting. *“The fact that I can use the simulator more on level 2 means I do not spend time to sit in the car with learner drivers to do that, which makes my workday more pleasant [...]when I get to teach more level 3 and 4, I enjoy my work much more than teaching basic starting and stopping a vehicle”*

3 Less hours on the road. To spend less hours on the road, was viewed as positive aspect from those who used a simulator in training today. For the learner drivers, it was said that they would spend less money as it was less expensive to use the simulator, and for the driver instructor, they could spend more time with the student on the higher levels of the training, rather than level 2, for instance. They experienced further that, if for instance learner drivers who needed more training to master a vehicle had some training in a simulator first, the experience was that they did not need as many hours in a car later to learn the necessary skills, as this quote illustrates: *“Yet also as a supplement to save money for the learner drivers is an important part of it. If they spend 10 hours in a simulator, they might save 3-4 hours in a car”*. Additionally, this quote explains the category; *“We use it most for learner drivers who are having technical difficulties and cannot drive at home. They use some hours on the simulator on starting, stopping and gearing, and maybe we use 6 instead of 10 hours in a car afterwards”*.

4 Safer work environment for the driver instructor. It was pointed out that the instructors had a perception of a safer workday with the use of a simulator. This was explained as they for instance did not have to get out in traffic to search for situations that are not too unsafe but unsafe

enough for the learner driver to encounter risk situations to reflect upon. Their first meeting with these situations could be in a simulator with an instructor prior to being out on the road. The instructor then knew a bit more about the learner driver's reaction to such situations and could be more at ease when out in traffic. These quotes illustrate this: *"It would have been a more comfortable workday for me if the learner driver knew some course stability for instance beforehand from a simulator. Just had practiced on keeping the car in a straight line on the road. It would make both me and the learner driver more relaxed"* and *"If the learner driver for instance knew a little about duty to yield right-of-way in the simulator, it would be better when we were to conduct it in a car, because the learner driver might have better control on who to stop for"*.

4. Discussion

In this paper we wanted to explore limitations and opportunities of using driving simulators in driver training in Norway. Thus, our research question was: *Can use of simulators in driver training be beneficial or not from a safety perspective?*

The results from the empirical data collection showed that limitations were (1) the learner driver would not use it, (2) difficult to use due partly to bad software, and (3) economy. The opportunities were: (1) less stressful environment for the learner driver, (2) possibility to spend more time on levels 3 and 4, (3) less hours on the road, and (4) safer work environment for the driver instructor.

4.1 Driving simulators in training and safety

From a safety perspective, it seems the use of simulators in driver training could be beneficial and in order to have as safe drivers as possible on the road, the quality of the training seems essential. For the driver instructor, a workday consists of many hours on the road. Road traffic is considered a high-risk context, and less hours here is a less risky work situation. Further, in this high-risk context, the driver instructor must be alert while having a learner driver in the car. If the driver instructor could have less to focus on in a less dangerous environment, the instructor, as stated in the interviews, can shift focus solely to follow up on the learner driver. Thus, it was stated, that the training situation could improve. In order to for instance see where the learner driver is looking and uses gaze, and makes decisions, and controls the road environment, the instructor does not need to pay as close attention to the traffic environment to be aware of all possible dangers in addition to watching the actions of the learner driver. Gazing correctly for instance, is one of the most important parts of

driver training, and this is one aspect that would be easier for the instructor to pay closer attention to in a simulator, so the learner driver can train this aspect prior to entering on road traffic. The simulators in this study did not have eye tracking. However, eye tracking is possible to install, and if this is included, this could further benefit this part of the training.

Additionally, learning is a complex process, and a stressful learning context could hinder optimal learning strategies (Boekaerts, 1993). As it was stated in the interviews, for learner drivers who were nervous about learning how to drive, the use of a simulator made the learning situation less stressful. A car on the road in real traffic could be perceived as overwhelming to handle the first time. Experiencing driving a car in a simulator first seemed to make the driving process in a real car more familiar. This could make the learner driver and the instructor capable of reflecting on other parts rather than just maneuvering the car on the road, which is in accordance to the Norwegian curricula for driver license class B (NPRA, 2017).

The Norwegian curriculum for driver's license class B is based on a constructivist foundation, and safety is a strong aspect (Solberg & Solberg, 2009; NPRA, 2017). The constructivist basis as well as the safety focus is for instance shown through the emphasis of reflection and making safe decisions more than being able to maneuver the vehicle excellently. It is seen as important to be able to handle the vehicle too, but the main focus is that a driver should be aware of one's own strengths and weaknesses and make choices based on this. Thus, to make a choice based on the acknowledgement of to which degree one handles the car and the effects of this, is important for the driver to reflect upon. This way, the attitudes taught to the learner driver are viewed as important. Dialogue and reflections are a basis of the learning paradigm of driver training in Norway and a safe driver is considered a driver who makes safe decisions based on one's own skill level, and not necessarily the person handling the vehicle best.

The limitations and opportunities seem to be viewed rather differently from the two categories of schools, those who use a simulator and those who no longer use a simulator. The basic understanding of how to use the simulator differs greatly. It seems that those who no longer use it expected the learner driver to book and use the simulator without a driver instructor present, which is more in line with a behaviorist view of operant conditioning. This could be viewed as a two-part pedagogical model including the learner driver and the simulator. The simulator was meant to substitute for a driver instructor. This is also an explanation for why the software was perceived

as not good enough, because it lacked a program where the learner driver could operate and choose a program without an instructor present. If the simulator was meant to do one thing and the users perceived or thought it was meant to do something else, this mismatch could explain why it was seen as a limitation. The other group, however, who still use a simulator, base their view rather differently. Here the instructors used the simulator while being present. It became a three-part pedagogical model including the learner driver, the driver instructor, and the simulator. In this case, the simulator was used instead of a car for specific elements, or more exactly, in addition to a car. This view of using it as a learning tool is more in line with constructivist thinking. Such a basic understanding of how to use the simulator in driver training seems essential if it is used and if it is seen as useful equipment in teaching driver skills.

It seems that use of simulators on less complex operations is a rather easy task. This includes training for level 2 in driver training, and these tasks do not require a driver instructor present. However, most learner drivers train these skills at home, in addition to it being a tendency of more learner drivers wanting a driver license for automatic gearing. Seen from an environmental perspective, learning these tasks in a simulator might be appropriate too, as wear and tear on tyres and brakes significantly contributes to micro plastics in the environment (Kole et al, 2017), and in a training situation on braking and gearing, more wear and tear are expected than for fully trained drivers.

Regarding the use of simulators for training for level 3 and 4, this is training in more complex contexts. For these operations, a three-part pedagogical model including a driver instructor present, seems to be a more optimal solution. Based on the findings, this is interpreted as the main aspect of the differences between limitations and opportunities found. It was viewed as a limitation that simulators did not provide sufficient software for training level 3 and 4 without an instructor present. However, these levels should perhaps be including a driver instructor, and it would still be beneficial for training outcomes as well as safety and environmental reasons.

4.2 Implications

It seems simulators have the potential to optimize driver training. However, implications from this study could be to initiate the idea that simulators are used instead of a car rather than instead of an instructor. This could make a learning context safer, less stressful in addition to beneficial against environmental pollution.

4.3 Further research

From this preliminary study which is a part of a larger research project on the use of driving simulators in driver training, we recommend more empirical studies on how to use the simulator during driver training. However, we recommend not only to focus on how the simulator can replace a driver instructor, but rather how the simulator can help the driver instructor teach the same and probably exceed training possibilities with a simulator compared to with a car. Additionally, future studies could work on identifying further requirements the simulator will need to fit objectives from the learner driver curricula, especially regarding level 3 and 4.

5. Conclusion

The simulator in driver training seems to have a potential to be of more use than it is today in Norway. Based on elements such as safety for the driver instructor, less stress during learning for the learner driver, and possibility to train more on safety aspects difficult to encounter in on the road training, we recommend well-planned use of driver simulators as a digital tool for driver instructors in addition to a car. We further recommend an instructor present during the simulator training, however, this should be considered based on what it is that is to be learned.

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