Feasibility study for the use of VR technology for driver training

Forprosjekt om bruk av VR-teknologi i føreropplæringen

Final Report / Sluttrapport

3rd March 2020

Giuseppe Marinelli (ed.)
Kåre Robertsen
Özlem Simsekoglu
Robin Isfold Munkvold
Rolf Robertsen
Trond Olav Skevik

www.nord.no

NORD universitet

NORD UNIVERSITY

Global challenges demand new insight, innovative solutions and local legitimacy. Nord University is a young university with strong regional ties and a global perspective.
We are committed to delivering relevant educational programmes and research, with a focus on blue and green growth, innovation and entrepreneurship, and welfare, health and education.
Nord University has 11,000 students and 1,300 employees at nine study locations in Norway.

NORD UNIVERSITY

Utfordringene verden står overfor krever ny innsikt, innovative løsninger og lokal forankring. Nord universitet er et ungt universitet med sterk regional tilknytning og et globalt perspektiv. Vi leverer fremtidsrettede studietilbud og relevant forskning med fokus på blå og grønn vekst, innovasjon og entreprenørskap, velferd, helse og oppvekst.
Nord universitet har 11 000 studenter og 1 300 ansatte fordelt på ni studiesteder i Norge.

NORD universitet

Preface

The people involved in this study, either in the planning, execution, analysis and reporting phase, are associate professor Giuseppe Marinelli, assistant professor Kåre Robertsen, associate professor Özlem Simsekoglu and associate teaching professor Rolf Robertsen from the Department of Traffic Studies at Nord University, faculty of Business School, campus Stjørdal. Furthermore, associate professor Robin Isfold Munkvold and assistant professor Trond Olav Skevik from the faculty of Social Sciences, campus Steinkjer, were parts of the team.

Giuseppe Marinelli's main interest is Mobility & Technology. He holds a master's degree in civil engineering (Infrastructures & Transport) and a PhD in Land and Environment Engineering. He has been appointed as project coordinator for this research report.

Ozlem Simsekoglu has her main background in traffic psychology and has provided significant input towards the analysis of the literature review regarding the psychological aspects of the use of VR, in addition to the development of the survey and the analysis of the main outcomes from the respondents.

Kåre Robertsen is responsible for the education of trucks & busses drivers' instructors and has greatly contributed in the development of the proposal and in the use of VR in the driving context.

Rolf Robertsen holds a honours degree in pedagogy and has a long experience in the field of education of Driving Instructors for driving license category B. He has been in charge of the analysis of the learning outcomes when it comes to the use of VR technologies, in addition to the analysis of some specific sections of the survey, dedicated to the feedback received from current driving instructors on the use of VR.

Robin Isfold Munkvold teaches "Game Design" and has a wide experience with the development of VR based applications, especially regarding the game industry, that represents today one of the biggest areas where VR are used. Together with Trond Olav Skevik, their contribution has been regarding the technological aspects of VR and their economic impact, in addition to providing reflections for the development of the possible VR scenarios that can be developed inside the driving education curricula and proposed in this report.

We express our gratitude to the Norwegian Public Roads Administration (NPRA) for considering Nord University as the best provider for this research work and having supported us throughout the entire project development. In particular, a deep thanks goes to Christina Eriksen and to Karstein Nikolaisen for helping the project to take off, having the time to meet us in Stjørdal and agreeing with us on the working plan.

Thanks also to Rikke Mo Veie and Ståle Lødemel, respectively leader of the Campus Stjørdal and Head of Department of the Traffic group, which agreed on investing money and time in this research activity, and also considering further investments in equipment for following up with further research activities. Thanks also to Marianne Frantzen Fostad for supporting into the project coordination and its financial management.

Thanks to ATL (Autoriserte trafikkskolers Landsforbund) and TF (Trafikkforum) for having supported us into spreading out the online survey to their members.

Last, but not least, thanks to Hege Holltrø, the XR.Tech.Conf 2019 staff and the Trafikklærerdagen 2019 staff for allowing us to advertise our survey and get very interesting contributions and answers during both the events.

List of Contents

Figures list

Tables list

Summary

This report represents the final outcome of a project funded by the Norwegian Public Roads Administration (from now on, NPRA) regarding the investigation about the use of Virtual Reality technologies in driving education.
The purpose of this feasibility study is to understand if the new educational and pedagogical possibilities given available by these innovative technologies, such as VR/AR glasses, could address some of the learning outcomes included in the actual Curriculum for Driving Licence regarding category B vehicles.
Nord University, after being selected as the most qualified research institution suitable for this work, have planned, initiated, conducted and analyzed research activities in order to address those questions.
In details, a literature review has been performed, regarding four main different points of view: education, psychology, driving education and technological development. In addition to that, a survey has been specifically designed to answer the identified research questions, with a special attention to two target groups: driving instructors and driving instructors' students.
Coupling together the outcomes from both the two mentioned methodologies, some possible scenarios have been identified as suitable for the specific purpose.

Sammendrag

Denne rapporten representerer det endelige resultatet av et prosjekt finansiert av Statens vegvesen om undersøkelsen av bruk av Virtual Reality-teknologier i føreropplæringen.
Formålet med dette forprosjektet er å forstå om de nye utdannings- og pedagogiske mulighetene som gjøres tilgjengelig av disse innovative teknologiene, for eksempel VR-/AR-briller, kan brukes for å oppnå noen av læringsresultatene som inngår i selve læreplanen for førerkortklasse B.
Nord universitet, etter å ha blitt valgt som den mest kvalifiserte forskningsinstitusjonen for dette arbeidet, har planlagt, initiert, utført og analysert forskningsaktiviteter for å ta opp disse spørsmålene.
Det har blitt utført en grundig litteraturgjennomgang med flere synsvinkler: utdanning, psykologi, føreropplæring og teknologisk utvikling. I tillegg til dette har det blitt utformet en egen spørreundersøkelse som skal svare på de identifiserte forskningsspørsmålene, spesielt rettet mot to målgrupper: trafikklærere og trafikklærestudenter.
Ved å knytte sammen resultatene fra begge de to nevnte metodene, har det blitt identifisert noen mulige scenarier som skal være egnet for det spesifikke formålet.

Content of this Feasibility Study

This final report represents the unique outcome of the project.
It has the following structure:

1. Introduction
2. Background and Literature Review
3. Data collection & measurement
4. Results from the data collection
5. Discussion
6. Conclusions & Future Developments

In chapter 1 it is firstly described our interpretation of the requests from NPRA, the way those requests have been translated into research questions and the methodologies that the research team has decided to apply in order to address those questions.

In chapter 2 there is an overview of the literature review and the background which is relevant for this topic, with a special focus on user acceptance, learning and VR, technology development.

Chapter 3 is dedicated to present how the different surveys adopted in this study have been developed, designed and presented to respondent.

Chapter 4 presents the results obtained from the data collection.

Chapter 5 discusses the results with the view towards the research questions, in addition to presenting the main outcomes obtained from the internal specialist discussion and towards the implementation of VR in driving education.

Chapter 6 summarizes this work and presents what are the possible future developments of this feasibility study.

1. Introduction

1.1. *Problem description*

The purpose of this study is to evaluate the possibility for the use of VR glasses to practice traffic situations in connection with the training of car drivers. Assessments must be made based on the maturity of the technology, the possibility to use it as a replacement for part of the training and / or as a supplement to increase quality and the cost estimate for the whole system.

The reference point for the work, as described in the “Requirement Specification” provided by NPRA, is today's category B Driver Education Curriculum, highlighting the current status of the VR technology in relevant field and the expected development in the future (with reference to all the three points listed above). The purpose for this study, according again to NPRA in the same document, is to “apply new technology in its areas of responsibility where this can be a benefit, both for users as well as for those who perform the services and the administration in general. The gains can be simplifications and better quality associated with the task execution, as well as lower costs overall.”

Regarding the current research work, NPRA has required some specific evaluations when it comes to both step 1 and the not compulsory parts of both step 2 and 3 of the current Official Curriculum for Driving License in Norway, as described in the Handbook V851E (Norwegian Public Road Administrations, 2018). The questions that are in need for an answer cover a wide variety of topics, such as the user acceptance, cost estimates, need for development or standardization of the equipment, need for staff training to adopt the technology and so on.

All these questions are supposed to have a direct impact on, e.g., the level of motivation from students, providing driving instructors a better tool to visualize possible scenarios, set the trend to a more effective learning, etc.

In addition to those general objectives, NPRA has also identified some more specific objectives regarding the driving education, e.g., to increase the understanding of the traffic as a system, to provide better solutions for students having language issues, to reduce the time to get the students ready to tackle safe private driving practice, to experience risky situations in a safe environment, to simulate situations that are difficult to be experienced in real driving, etc.

1.2. *Research questions*

In order to properly identify and address the needs highlighted from NPRA, the authors have decided to arrange those needs inside a logical scheme based on main pillars and detailed research questions.

Three research pillars have been identified:

P1. ***Technology Readiness***

This pillar refers to how much the VR technology is ready to be implemented inside an everyday work environment such as a driving school. This evaluation can include the technology development level, its ease of use, the willingness to be used by the stakeholders, etc…

P2. ***Ability to replace or supplement current training***

This pillar refers to the potential of this technology when adopted in educational environments, especially regarding how easy is to reach the learning outcomes, the potential to supplement certain current training activities, offer new trainings now impossible in reality, let the students see what are the consequences of wrong decision without risks and keeping a good and positive attitude.

P3. ***Economical sustainability***

This pillar refers to the economical aspect related to the implementation of VR technology in driving education. This implies the necessity to acquire and install the equipment, maintain it, update and, eventually, renovate it. In addition to those direct costs, operators will need to develop or acquire training scenarios and learn how to use the equipment, which might lead to additional costs.

In order to better analyze and assess the elements contained inside those pillars, 11 research questions have been developed, each one referring to a specific pillar. In the following list, each and every research question is listed, and a brief text is present to explain what is the meaning of each question and why it is relevant.

P1 – Technology Readiness

Is VR Technology ready for this specific purpose? (RQ1)

Almost all new technologies are not necessarily developed with a specific use in mind, and therefore there is always a period of “accommodation” in which, based on their specific features, they find some optimal applications. Most of the times these transitions need for a further development/specialization of the product towards the need of that field. Therefore, is there such a need for using VR in driving education environment, or it is “ready to use”?

What is the time frame for this implementation? (RQ2)

Each technology needs time to be successfully implemented in any everyday routine, and the same is valid for adopting VR into driving education. Therefore, it is interesting to try to understand how much time it might be needed to have it up & running at an operative level in a significative number of driving schools in Norway.

Is there a need for setting up some standards? (RQ3)

In order to scale up with the use of a technology at a wider scale it is generally necessary to set up some standards. Are these standards still to be established when it comes to VR equipment? Is there the need for working in defining those standards, or the technology is already sufficiently standardized to be almost ready to be adopted?

What are the user acceptance and possible limitations towards this technology? (RQ4)

Are users (mostly, driver instructors and driving school students) ready to embrace VR in their educational plan? Is there any possible limitation that might arise when using such technology?

What is the needed competence in NPRA and among driving instructors to be able to use VR? (RQ5)

In order to use VR effectively and without problems, similarly to other technologies, also VR might need a training period in which both driving instructors and, maybe, NPRA get instructed on how using the technology in the best way. Is this the case? What kind of competence it is needed? Does this competence change based on the model used to implement and adopt VR?

Are we able to simulate risky situations and/or maneuvers with enough adhesion to reality? (RQ6)

One of the most intuitive and immediate applications of VR in driver training is to allow the students experience situations not possible to be tested in real training, because unusual or too dangerous. Is VR close enough to reality to let the students make those experience with sufficient realism, and not such as they are playing a bad game or watching a bad movie?

P2 – Ability to replace or supplement current training

With regard to the Category B driver training Curriculum, what are the possible topics that that might be covered by using VR? (RQ7)

The Curriculum for Driver Education build the base for the driving education programs in current driving school in Norway, therefore it is interesting to understand which part of this curriculum are suitable to be dispensed or supplemented through the use of VR technologies.

Can VR facilitate the learning process for students who might have problems related with language? (RQ8)

In the context of driving education, specific issues raise when it comes to educate people that do not have a Nordic language as their mother tongue. Therefore, it might be that using innovative technologies, such as VR, that are less based on text and written material but more on direct experience and immersive environments, could help to fill the language gap for those specific situations.

Can VR increase motivation and effective learning, or provide to teachers better tools for visualization? (RQ9)

Is VR technology a support for the teacher in order to better visualize specific situations, or increase the motivation of students, generating a deeper and life-lasting learning?

P3 – Economical Sustainability

How much does it cost to acquire, develop and implement VR in training? (RQ10)

In order to adopt VR in driver education, driving schools will need to acquire the needed equipment and scenarios and use it in daily teaching. What will be the economic impact of this implementation?

What are the needs and costs in terms of operation, maintenance and updates? (RQ11)

As always when it comes to implementing new technologies, there is the need for the operators to be trained in order to use it, maintain it in good operating conditions and eventually update it when there is the need for it or when it needs to be replaces with a new one. This aspect represents a cost that needs to be evaluated.

1.3. ***Methodologies and tools***

In order to address the research questions, the team has decided to adopt 3 different methodologies:

- *Literature review on all the different disciplines involved*
- *Data collection through the development of a survey oriented to a specific target group*
- *Critical analysis on learning outcomes, learning processes and possible scenarios*

The three methodologies have been selected based on an evaluation of the research questions and the needs for addressing those questions. In particular, it has been decided that a literature review was necessary in order to investigate previous approaches to the use of VR in education and, therefore, being able to transfer this experience into the driving education scenario.

Regarding the personal perspectives towards using VR, such as ease of use, perceived usefulness, readiness to implementation and user acceptance, it has been decided that a data collection, through a dedicated online survey, would have been the best way to provide data for discussing those aspects, with a specific focus on the Norwegian environment and the Norwegian stakeholders. The survey has been developed and designed entirely to fulfill this research project and has been spread out mainly towards driving instructors and driving instructors students in Norway.

Since among the requests there is also the need to discuss about possible scenarios in using VR into driving education, it has been necessary an internal specialist discussion between all the professionals involved in driving education at Nord University, Stjørdal. Therefore, a detailed evaluation of the learning processes, the learning outcomes and their integration with VR has been one of the methodologies adopted, that has been practically performed through internal meetings and workshops all along the project development.

2. Background and literature overview

2.1. *User acceptance related to VR*

Virtual reality (VR) is a technology that is widely applied for education and training purposes. It facilitates learning new tasks by allowing the users to interact with a computer-generated simulation of three-dimensional images or environments (Ott & Freina, 2015). Although VR technology has been used in various educational areas, such as medical education (Huang, Liaw, & Lai, 2016) and high school education (Kaufmann, Schmalstieg, & Wagner, 2000), its use in driver training is limited. However, it has a great potential to facilitate the training process of the learner drivers by allowing the students to interact with various computer-generated traffic situations. It might be useful especially for creating risky traffic situations which the students do not experience on real roads frequently. This gives a chance to the students for getting familiar with the potential risky situations in traffic and learning how to manage these risks in a safe environment. Thus, use of VR technology in driver training can be increased since it has a good potential to be a supplemental digital tool that can facilitate training for the learner drivers.

Whether a technology innovation will be widely and successfully applied depends heavily on the user acceptance, which is determined by several factors. Some of these factors are related with the attributes of the innovations (e.g. benefits and simplicity) whereas some other factors are more psychological, such as user attitudes, perceptions and social norms (Dillon & Morris, 1996). According to the Technology Acceptance Model (TAM), whether a new technology will be used firstly depends on the user's attitudes, which are determined by perceived usefulness (i.e. the degree to which the individual believes that using a particular technology will enhance his/her performance/learning) and perceived ease-of-use (i.e. the degree to which an individual believes that using a particular technology will be free of physical and mental effort) (Davis, 1993). There is also some external stimulus, system design features, which influence the users' perceptions about the usefulness and ease-of-use of the new technology. Hence, in order to increase use of VR technology in driver training, it is important to understand potential users' perceptions and attitudes related to VR. In addition, it is also important to focus on the intentions of the users related to VR use as the intention is an important predictor of the behavior. According to the Theory of Reasoned Action (Fishbein & Ajzen, 1975), which is closely related with the TAM model, behavioral intention (i.e. readiness to perform a certain behavior) is an immediate predictor of the behavior.

Although there are some previous studies focusing on the user acceptance for VR technology use in education (Huang et al., 2016; Huang, Rauch, & Liaw, 2010), there is a lack of research focusing on the possibilities of VR technology use in driver training. In this study, we aimed to examine the role of some demographic and psychological variables (attitudes, perceived attributes and intentions) for explaining the use of VR glasses in driver training.

2.2. *Understanding learning with use of VR*

2.2.1. Introduction

Wu, Hsiao, Wu, Lin and Huang (2012) suggested that for the most part, educators and teachers know little about games, game development and the learning potential associated with this, and maybe developers of video games know little about training, education and the

design of training programmes. This may be an assertion that is relevant to consider when assessing the possibilities that VR technology can provide in driver training.
Firstly, based on the assertion of Wu et al. (2012) in the above paragraph, this chapter will present a general description of various learning theories. The different ways of understanding the learning process of the learner will influence how one discusses educational issues and will greatly influence how one can add to a training programme, or develop a digital or Virtual Reality Based Learning Environment (VRBLE). Furthermore, this will be placed into a context regarding the use of VR in learning so that it is gains a more concrete and common starting point in relation to educational thinking. This will in turn affect the development of VR scenarios. Chapter 2.4 will establish a possible common educational foundation for how a VR-based learning environment can be developed in driver training.

2.2.2. The different perspectives of learning theory

Behaviourism was among the first learning theories developed. Behaviourism bases its understanding on stimulation and reinforcement. It measures learning as a change in behaviour, and the principles of the relationship between stimuli and response are key to explaining the learning process (Grippin & Peters, 1984; Wu et al., 2012). The principle of punishment and reward is often used to describe this tradition.

Cognitivism describes that learning consists not only of stimulation and reinforcement, but also involves thinking. Cognitivism points out that the memory system is an active, organised processor of information and that prior knowledge plays an important role in learning. Within the field of ‘adult learning’, it is described that all new knowledge to be acquired or changed is greatly influenced by previous knowledge (Lindeman, 1984).

Humanism focuses on the freedom, value, worth, dignity and integrity of persons (Combs, 1981). Affective and cognitive needs are considered key aspects of learning. According to humanists, learning should be student-centred and adapted, and the teacher should act as a facilitator. The goal is to develop individuals in a cooperative and supportive environment. Humanism involves the principle of experimental learning (Kolb, 1984). Experimental learning, or experiential learning, requires no teacher and relates solely to the meaning-making process of the individual's direct experience.

Constructivism views learning as an active process. It describes that individuals actively construct or create their own subjective representations of an objective reality. And the construction of new knowledge is always related to prior knowledge. The Learning Paradigm views learning as an individual process, but that it is also influenced by others through social interaction (Vygotsky, Cole, John-Steiner, Scribner, & Souberman, 1978).

An educator, or teacher who facilitates learning, often prefers one of these mindsets. However, for many, the learning objectives classified through *measurable verbs (Bloom, 1956)* will determine educational thinking. For example, if only simple motor skills are required such as *executing* a change of lanes, a behavioural mindset may be enough. In its simplest form, let the learner change lanes and then either praise or criticise them for correct or incorrect execution. If the learner also must *understand* the risk associated with changing lanes, a more cognitive approach is required. More knowledge and cognitive activity are then required. If the learning objective is that the learner must *influence* the flow of traffic that is associated with changing lanes, another type of educational thinking is required that includes social interaction and empathy, and putting the mobility and welfare of others ahead of their own.

An analysis has been carried out on the extent to which a learning theory foundation can be found in surveys related to learning in digital learning environments (Wu et al., 2012). Figure 1 shows that of the 658 studies that were conducted, the learning theory foundations of 12 studies could be classified as being based on behaviourism, 17 based on cognitivism, 25 based on humanism and 48 based on constructivism, and 567 could be classified as not using a learning theory foundation (Wu et al., 2012). This survey deals with computer-based learning environments in general and is therefore not directly representative of virtual reality-based learning environments, but it confirms the trend that the educator has not been the prominent party in their development.

Within the main paradigms described in the above paragraph, new theories or explanations are often investigated that describe how learning takes place, or that influence individual or group learning. As an example, Case-Based Learning (CBL) can be mentioned, which is grounded in constructivism. CBL is rooted in the tried and tested learning method of learning by doing. It is based on the fact that the learner or learners work on a specific issue that is relevant to the learning objective, and learning takes place as a process of finding solutions to the given issue (case).

Experience-based learning theory points to the importance of learning through direct experience, as opposed to learning through 'instruction' that is more of a prominent strategy in the behavioural learning tradition. It has been stated that direct experience results in the most powerful learning - by acting and seeing the consequences of that action. Confluent education is rooted in gestalt psychology and builds on the principle that to learn is to discover, and with its help, either consciously or unconsciously, promotes cognitive, motoric and affective reflections.

Attribution theory is not in itself a learning theory but is relevant in that it shares the way in which people attribute causality. External attribution assigns causality to an external factor such as luck or the actions of others, while internal attribution assigns causality to factors within the person, such as their own level of intelligence or other variables that make the person responsible for what occurs (Hogg & Vaughan, 2011). Unintentional learning is when there is no desire to learn, or when the situation itself is not a learning situation. In some contexts, when this form of learning has a negative effect related to the learning objective, it is called 'the hidden curriculum' (Norwegian Public Roads Administration, 2018).

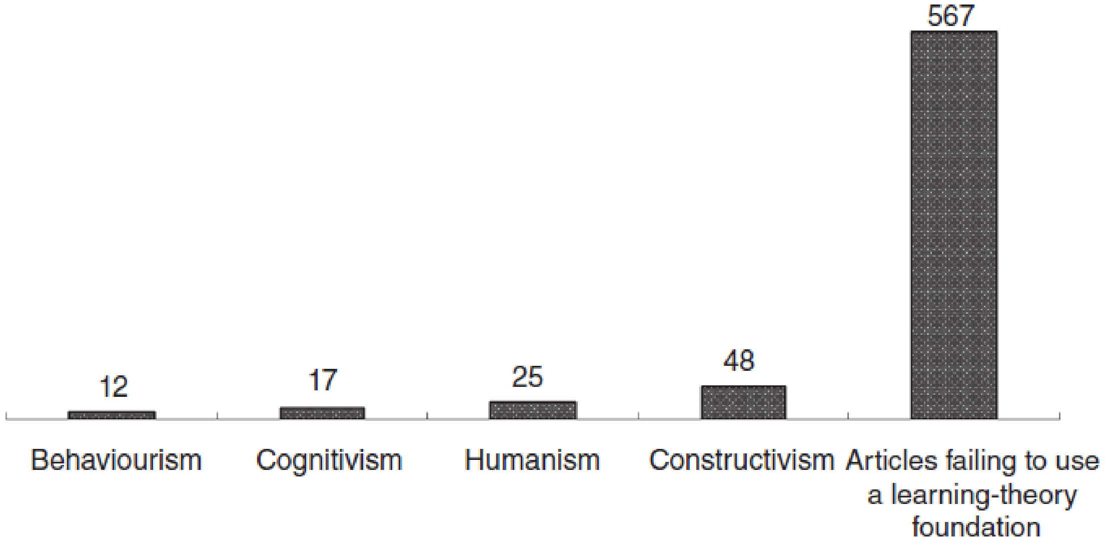

Figure 1 - Types of learning theories (Wu et al., 2012)

It can be argued that this type of unintentional learning takes place all the time. However, it is the previous knowledge, experiences and attitudes of the learner that are of importance, in the sense that if what is learned is consistent with their image of reality, then what is unintentionally learned will be reinforced and vice versa.

Game-based learning (intentional or unintentional learning through digital games) is described as the learner acquiring knowledge, values and attitudes through the challenges the game provides. Often, the situational aspect of the game isn't highlighted as a learning outcome. The situational aspect could include building a house, a city, landing a plane or winning a war. Learning outcomes occur in experiencing whether the strategy you chose when learning how to build the city was suitable for use. It is also highlighted that games provide learning outcomes such as developing spatial abilities and the ability to collaborate with others. Developing social skills is also highlighted as a learning outcome in games when one participant depends on others in order to succeed.

Over the last 15 to 20 years, **neuroscience** has developed internationally as an academic discipline. Here, knowledge from psychology, pedagogy and science are united in the understanding of educational methodologies and learning processes. Currently, the term that is used to refer to this development is Mind, Brain and Education (MBE), where the three disciplines complement each other (Moe, 2019). In relation to learning, it has led to a completely different focus regarding the underlying neural processes. MBE has led to a more biological understanding of what controls our behaviour, and this research has, to a greater degree, established how the affective part of the brain controls our brain. Our emotive power and desire are a driving force behind all our behaviour. However, as human beings, we have the advantage, to a large extent, of being able to control our emotions through a conscious process.

2.2.3. Approach to using VR technology

VRBLE is predicted to be an important and prominent change within the field of training and education (Chen, Toh, & Fauzy, 2004). Virtual Reality (VR) allows you to visualise a three-dimensional representation of a problem or to concretise abstract concepts. VR also allows you to create discussions related to the understanding of a phenomenon, and to visualise dynamic conditions in a system. One can, by being in and interacting with situations, facilitate an infinite number of views about them. In addition, one can concretise phenomena that are unavailable or impossible due to distance, time, cost or safety factors. The power of virtual reality as a tool that can be used to experience pre-built worlds as representations of reality, suggests that the technology will be very applicable to education. Furthermore, with the current development of virtual reality on the World Wide Web (WWW or Web), other relevant information from the Internet can also be linked to the virtual representation of the problem. The integration of the Internet and VR makes it possible to manipulate the benefits offered by both technologies.

Learning using VR technology can be understood through different approaches and it may be appropriate to discuss some of the perspectives individually. One approach is to see VR technology as a tool that makes learning more independent of the teacher. This means that pupils themselves, without the teacher being present, will carry out the learning activities on their own. In other words, technology can replace the work that is traditionally carried out by a teacher. For example, the learner has to complete a training programme that is programmed in advance. Or, he or she has to discover something through the visualisation or modelling of a reality or phenomenon. Being active and interactive in the virtual world on the selected digital platform will lead to a learning outcome. When this is described as streamlining the learning process, it means that it is more time-efficient or cost-effective. Another approach is to see VR technology as a tool for the teacher. The purpose of this approach is for the learner to improve achievement or gain a better learning outcome by the teacher facilitating this using VR. The goal of the training is either provided by framework plans or detailed curricula. The reason for this division lies in the fact that the two different ways of thinking regarding the use of VR will greatly affect how one creates the scenarios to be used in learning activities.

There is a discussion whether violence-based games contribute to increasing the acceptance of, or the exercise of violence, or whether the individual is able to separate games and reality, and even gain a more conscious relationship with the exercise of violence and violence in general. The same problem is associated with the category of driving games. The aim of driving games is often to reach a place faster than others, and often at the expense of others. In this context, it is rather ambiguous whether the behaviour exercised as a player affects driving behaviour on the road.

In relation to cognitivism and constructivism, the influence of such games will likely depend on the individual's prior knowledge, experiences, motivation and attitudes. The fact that research points out that accident-prone youth are drivers who play more car games than average can be explained in two ways. One is that they are predisposed to driving fast and use car games as a means of acting out this desire. The other is that car games cause them to drive fast on the road. It is the individual's prerequisites such as knowledge, skills, motivation and attitudes that will determine what is learned at a more general level (Figure 2).

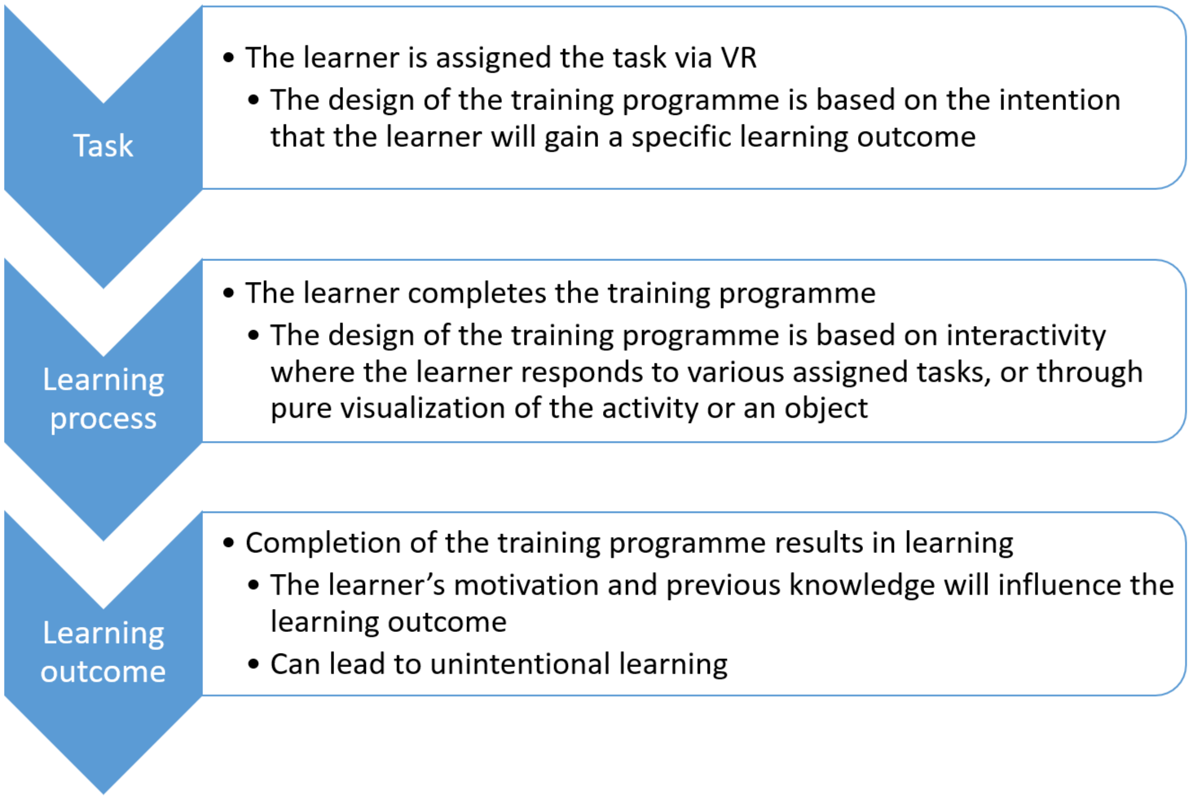

Figure 2 - Learning model where the game itself manages the learning process

Pedagogy is claimed to be one of the most important components of successful game-based learning. However, within this tradition, there won't necessarily be anyone present who affects the learning process. The learner will learn through completing the training programme. Then, there is the question of what or who should be the corrective actor. Without a corrective actor, such as a teacher, the risk of unintentional learning is present to a large degree.

The other approach to using VR technology in learning is that it is used as a tool that the teacher can take advantage of in order to achieve a better learning outcome. Designs in simulation technology and game-based learning, and constructivist views on learning, have a very similar view when it comes to learning. Both are based on learning from gained knowledge or experience. The theory describes that the highest achievement is attained by first gaining an experience that you can associate the acquisition of knowledge with. If the constructivist paradigm is used as a basis, and experiential learning is acknowledged an effective form of learning, the model (Figure 3) will be appropriate to use as a structure when developing scenarios. In this case, VR will serve as an aid in creating knowledge or experience. The facilitator, or teacher who knows which learning outcome the learner should be left with, can then use this further in the learning process and allow the learner to reflect on the issues produced by the phenomenon.

By using this approach, benefits will be gained both from the advantages VR brings to the learning process, and the strength of having a corrective actor, so that the learner receives the intended learning outcome.

In recent decades, several attempts have been made to describe virtual learning environments (Chen et al., 2004; Lainema & Kriz, 2009; Martín-Gutiérrez, Mora, Añorbe-Díaz, & González-Marrero, 2017). Most are described from a technological perspective. Fowler (2015) has used a pedagogical perspective as a basis, and this shows some of the complexity when applying digital, or VR-based learning environments. Below is a description of the content of this model.

A framework is required to fully describe the learning experience, one that is not only derived from technological advice, but also includes pedagogical requirements. These requirements should also describe the design of the learning process.

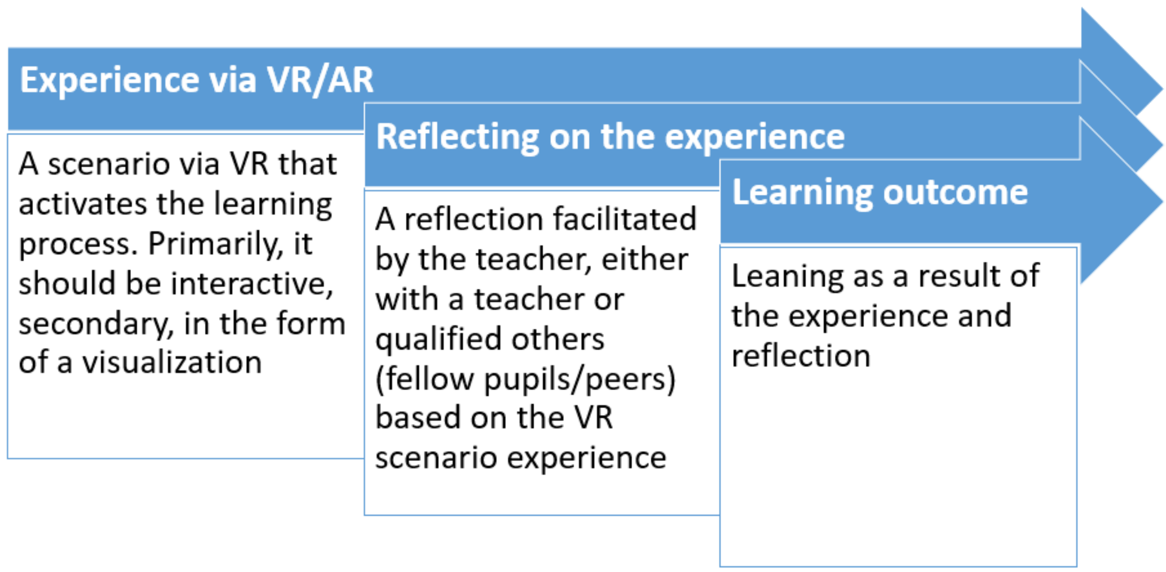

Figure 3 - The learning process in which a corrective actor is present

A principle that is highlighted as being key when applying virtual learning environments is the ability to 'engage'. Being involved is an activator that provides motivation to immerse oneself in the subject matter and may be what builds a bridge between the technological, psychological and educational experiences of learning in a 3D virtual world.

The model is a composite model in which the pedagogical framework is described by Mayes and Fowler (1999), which is represented on the left-hand side of the model, and Dalgarno and Lee (2010) showing the technological approach (right-hand side) (Figure 4). A learning process that is one in a series of three steps is characterized on the educational side. Firstly, the pupil will meet a type of explanation or description of what they have to learn. In the model, this is called conceptualisation. If the learning of skills is involved, this stage will somehow demonstrate what to learn or be a type of presentation for the pupil. This will correspond to traditional forms of instruction, such as lectures or textbooks, but will include multimedia presentations that are highly representational. The next step for the pupil will be to deepen their understanding, begin to explore, manipulate or ask questions, and this means they have to perform some actions on, or with, the new learning element in a way that provides feedback. The pupil's actions will now control the flow of information. The involvement, and thus the motivation to immerse oneself, is now part of the task, rather than being part of the representation of the learning element.

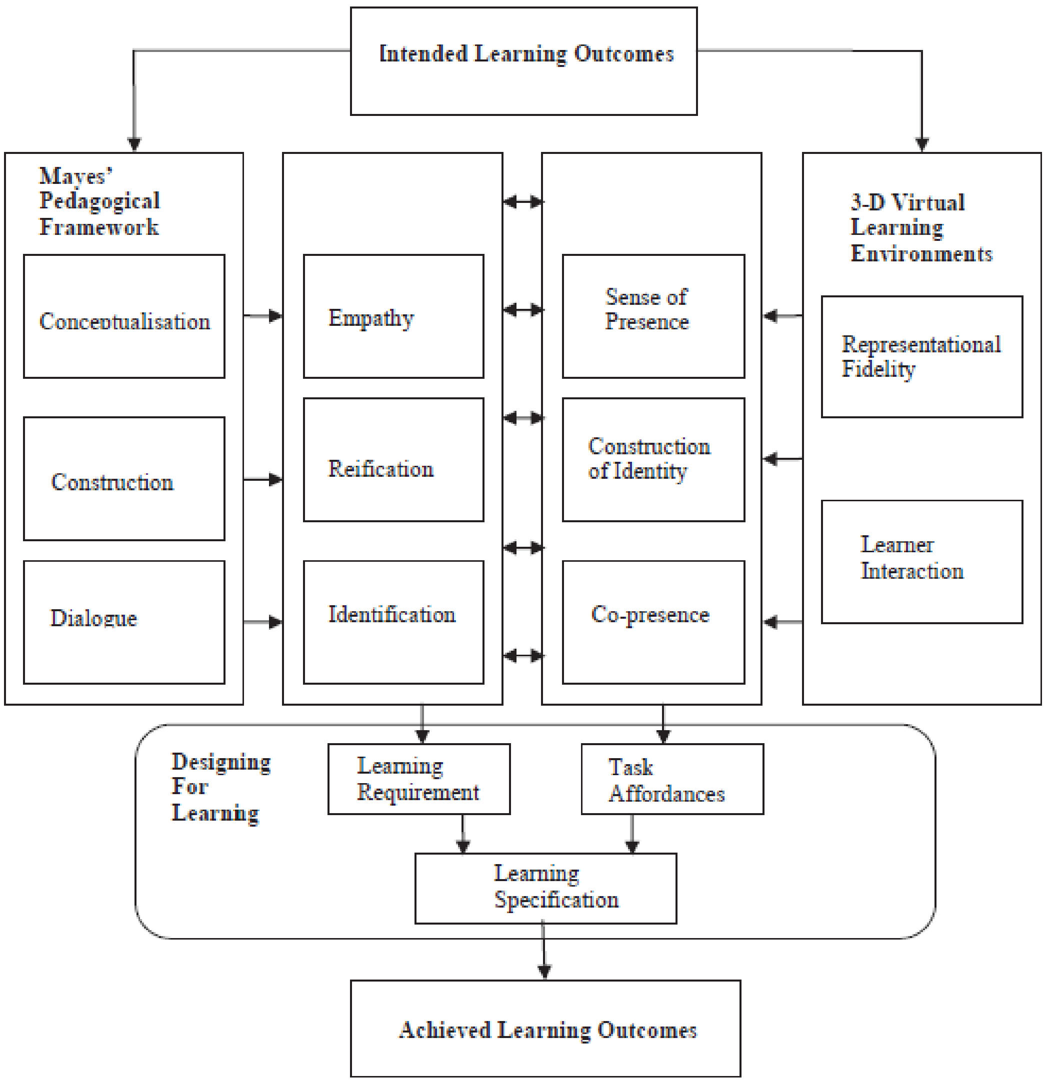

Figure 4 – Composite model of Mayes & Fowler (1999) and Dalgarno & Lee (2010)

The third step in this model is called *dialogue*, where the pupil must acknowledge that all learning elements somehow exist in a larger social context. The pupil should now be able to test their emerging understanding through some type of interaction or discussion with others. In a computer-based virtual learning environment, we see that avatars can play a very facilitative role in the dialogue stage. For example, in the form of a role-play or other adapted dialogue. The person wearing VR glasses is able to be the actor. Whether the learner participates by using interactive VR glasses technology, or whether an avatar is present, it will allow a self-governed exploration of the different representations and provide a high learning effect.

Further into the model we meet terms such as empathy, reflection and identification, which are also key concepts in constructivist views on learning.

On the other side of the model we find the technological prerequisites that form a basis, such as the degree of representational fidelity and interaction opportunities with the subject matter, which in turn must lead to a sense of presence, construction of identity and interaction with others. The framework described above is one of the few conceptual tools specifically made with the intention of supporting the design of digital and virtual-based learning systems. The development should be driven by educational considerations rather than technological ones. Both sides of the model are united by a common need to create or expose the pupil to an experience that meets the intended learning outcome. Therefore, a key prerequisite is to ensure that learning objectives or learning outcomes are defined. Learning outcomes are what pupils are expected to know, understand and be able to do towards the end of the learning process. Once the objectives are clear and the learning process is defined, the correct, specific learning activities can be created. The *construction* stage requires an interactivity that in traditional constructivist traditional could be used as material in books, web searches, field and laboratory studies, interviews, or even in essay writing.

2.3. *VR Technology*

Virtual Reality is "*an artificial environment which is experienced through sensory stimuli (such as sights and sounds) provided by a computer and in which one's actions partially determine what happens in the environment*" (*Virtual Reality*, 2020).

VR gives us the possibility of representing virtual realities in diverse ways, giving us a sense of presence in a real world. The technology is mostly used for entertainment technology, but we do see more and more development of VR solutions made for serious purposes, especially within the area of simulation of safety.

VR can be separated between Immersive and Non-immersive, where non-immersive VR is defined to be a type of virtual reality technology that provides users with a computer-generated environment without a feeling of being immersed in the virtual world (Tsyktor, 2019). Typically, this is technology where one uses traditional monitors and input devices and where the user is taken into a pretended reality, but where the user at the same time has full awareness of the surrounding environment (sounds, visuals, haptics).

With Immersive VR technology, the user is taken into a world that is perceived as very realistic and where the technology enables to user to interact with a 3D environment through the use of haptic devices (Tsyktor, 2019).

The main focus in this report is the use of immersive VR technology, focusing on the use of VR headsets and related input devices. Today this technology is typically the Oculus Rift / Quest / Go and HTC Vive systems (Figure 5).

Figure 5 – Different VR sets: the Oculus VR and the HTC Vive Pro

The Oculus VR (currently owned by Facebook Inc) delivers different types of headsets with controllers. The Oculus Quest and Go are standalone all-in-one headsets made for entertainment, without the need of connecting it to a powerful computer. The Ocules Quest is similar, but more powerful and the Oculus Rift S (latest version) needs to be connected to a computer, for high performance experiences ("Oculus Official Website," 2020)
The HTC Vive system is developed by HTC and Valve. The headset uses “room scale” tracking technology which allows the user to physically move within the realm of the physical environment, but at the same time move and interact within the virtual world using the handheld controllers. Vive delivers headsets Vive Cosmos, Vive Pro, Vive and Vive Focus. The Vive focus is a all-in-one, wireless solution without the need for a computer, base stations or additional sensors. The system offers positional tracking both indoors and outdoors. The Vive is a room scale VR system, including 360-degree controllers (with the use of base stations), headset tracking, directional audio and haptic feedback. This system needs to be connected to a computer.
The Vive Pro gives the same opportunities as the Vive, but is more powerful and is said to give better experiences (through millimeter tracking, multiuser possibilities, etc.), whilst the Vive cosmos is a simpler version, not demanding the same amount of additional equipment ("Vive Official Website," 2020).
In addition to the minimum solution of a head mounted display width or without audio capabilities, modern VR solutions also allows for other types of technology to be used for enhancing the VR experience;

- Haptic feedback via gloves, vests and full body suits
    - Giving the user the experience of touching objects in the VR-simulation with fingers, hands or other parts of their body
- Haptic feedback from other equipment like chairs, steering wheels and gear sticks
    - Giving feedback when accelerating a vehicle, turning on a slick surface or trying to reverse a car while moving fast forward
- Motion Capture sensory equipment for registering the user’s movements in the virtual environment
    - Data can be used for displaying the users’ movements in the virtual environment. This can be used as feedback to instructors and/or other users

2.3.1. The maturity of VR technology

A mature technology is a technology that has gone through its innovative phases and is now considered to be in a productive phase, where it is in use, and will be used for practical

applications. Start-up and design problems have been removed or reduced through the development of the technology.
There are various assessments of VR as technology in general, and of the maturity of VR / AR technology in particular. Each year, the Gartner Group publishes a report on various technologies and their opportunity to reach the term "mature technology". In 2018, the conclusions of this report were that VR technology would not reach the level Gartner defines as "mature" until about 5-10 years (Costello & Van der Meulen, 2018). In the 2019 version (Rimol & Goasduff, 2019) of the same report, VR technology is generally defined as a mature technology. This rapid change seems to come from the widespread use of practical applications of this technology for very different purposes in entertainment, visualization, training and analysis (Panetta, 2018).
From a user perspective, VR technology has matured and become more widely available. This happens as a result of the technology being increasingly used for entertainment and in other contexts, but also because different suppliers offer functional equipment with ever-better experiences within an increasingly affordable cost framework. Sony was early on offering VR to its Playstation users, and as standalone solutions, both Oculus Rift and HTC Vive have paved the way for VR headsets to be no longer an unknown concept. In 2019, wireless VR sets have also become available within the same cost category. In addition, the various technological solutions have also become increasingly easier, and thus more applicable in terms of technology. which user groups can use them - from young children and healthy adults, to bedridden and nursing patients in hospitals etc (Hamilton, 2018).

2.3.2. Standardization and operation / maintenance of VR technology

IEEE works on standardization solutions within both development, testing and evaluation of AR and VR technologies within a number of projects. The standardization process is at an early stage and IEEE's efforts are running in parallel with an Open Source initiative called Open XR. Open XR 0.90 is per. March 2019 an available standard to "simplify AR / VR software development, to allow applications to reach a wider range of hardware platforms without having to port or reprogram". Both an open standard and an IEEE-based industry standard will be appropriate for future development, operation and maintenance of VR-based solutions. Any standardization outlined in the IEEE and Open XR initiatives will also potentially contribute to a significantly longer lifespan for both equipment and applications, which can help reduce operating and maintenance budgets for the solutions ("OpenXR Official Website," 2020).

2.3.3. Costs

When discussing costs, there are several elements to consider. One is the hardware itself. Then comes costs for software and possible licenses, plus the cost for maintaining and running it all.

Hardware

The HTV Vive Pro is delivered as a bundle kit from komplett.no, at the price of 18.999 NOK. In addition, one needs a computer with a good graphics card that is suitable for “normal” gaming. This could typically be a computer to a cost of about 10 000 NOK (and upwards). Prices are dropping by the day and one could get hold of high-quality VR-hardware solutions

to the cost of around 20 000 NOK (per December 2019). There do also exist cheaper versions of the HTV Vive Pro.
The Oculus Quest and the Oculus Rift S are currently at a price range of 5.000 – 7.000 NOK. This demand the same type of computer as for the HTC Vive Pro, giving a total cost of about 15.000 NOK.
In addition to the VR headsets and the computers, there are other types of hardware that can be added, to make the experience more realistic. In this project we used a car steering wheel, a gear shifter and pedals. This was bought at the local Elkjøp store to the price of about 5.000 NOK.

Software

The costs for software of course depend on what type of software is needed. Typically, prices range from about 100 NOK to 300 NOK for the most interesting VR games on the marked (Oculus ready software, from Beat Games, Beat Saber costs about 300 NOK). These are games that are made for commercial use with thousands of users, reducing the price accordingly. For software specifically developed for a given serious usage (training) the price is normally much higher. Pale Blue is a provider of VR simulators for diverse serious purposes ("Pale Blue Official Website," 2020), but we are unsure about the costs as it does not show on their website (or anywhere else).

For comparison

WAY AS ("Way Official Website," 2020) in Trondheim, Norway, provide training for driver education and they combine this with using a big driving simulator. This simulator is a very realistic simulator, including a physical car and huge monitors surrounding the car (hence it does not make use of a VR headset). This simulator has proven very efficient when it comes to learning outcomes, adapting the learning activities to the knowledge and skills of the student, and gives the students the possibility of practicing unusual and dangerous situations. This is not a system that is easily moved, but it is very much a system to use as a basis for the development of VR solutions for driver education and for comparing learning outcomes, effectiveness, etc.

2.4. ***VR in driver education***

Driving simulators of diverse levels of complexity in both hardware and software solutions have been around for several years. The use of simulators for both education and entertainment include both the very simple gaming setup with a PC and a Joystick or Steering Wheel connected to it, and the immensely more complex solution of Way AS with an actual vehicle fitted with sensors and actuators allowing the system to provide both the student and the evaluators/teachers with a very realistic driving experience and learning situation where it's possible for a student to experience a dangerous situation or repeatedly practice a specific maneuver in a short time.

While these solutions simulate a virtual driving experience transitioning to using VR technology also allows for a much greater degree of mobility. Modern VR-kits can operate without being connected to a computer, allowing the user to bring them into a classroom or indeed in a car to use – while the car's stationary – for studying topics related to the lessons being addressed by the teacher.

A few VR solutions are in use as an aid for driving school students, and more are being developed. These solutions address different issues related to learning to operate a vehicle safely. One of the most important issues when learning to drive is getting enough training behind the wheel. Another is the ability to get practice in driving in conditions and situations that are not currently available due to the season and other conditions. In VR, seasons, time of day, traffic density or accidents are situations that can be tuned and used individually for each student to achieve specific learning goals.

As an example of solutions currently being deployed: The Oregon-based company VR Motion ("VR Motion Corp Official Website," 2020) are currently deploying a system which comes in two different versions; Portable Desktop and Premium Enterprise. The Portable Desktop solution consists of affordable commercially available hardware:

- Consumer-quality controls
    - Universal steering wheel
    - Universal pedals
- Virtual Reality headset
- VR-certified laptop

This setup resembles the setup described in chapter 3.3. The Premium Enterprise version includes a customizable heavy-duty multi-axis motion base complete with steering wheel and seat that can be specified to a specific vehicle class or model. VR Motion’s software supports a variety of customizable scenarios ranging from vehicle type to driving conditions, hazards and common situations for educators and students to choose from.

However, it is uncertain whether existing systems are adapted to driver training in Norway. In 2020, only one driving school has focused on simulator-based driver training. Their concept includes driving simulators that are screen-based and do not use VR glasses. However, within a broad definition of VR technology, the driving school has a major focus on developing virtual reality-based learning environments. Nord University also has ongoing research in the field, and it is claimed from many quarters that technology-based training (‘XR Tech. Conference’, 2019) will be a significant area of focus in the years ahead. Below is a description of the driver training as it is described. On the basis of this, an attempt will be made to implement this into a Virtual Reality Based Learning Environment that safeguards the distinctive characteristics of driver training.

Driver training in Norway is described as being within the constructivist learning paradigm, even though pedagogically designed training programmes are rarely based on one pedagogical direction alone. This is done on the basis that modern research within the field of traffic psychology shows that it is not just what the driver can or must do that determines safe driving behaviour. Factors such as motivation and attitudes are also important, i.e. what the driver is willing to do, or wants to do. In other words, driver training must have training programmes that influence the individual’s willingness to behave responsibly in traffic, and not just ability. Driver training is based on the fact that learning is an active and ongoing process in which the pupil builds upon and expands their foundation of knowledge and skills. This process is based on and is led by the knowledge, motivation and attitudes the pupil already has. This corresponds to the central assumptions found in cognitive psychology, as discussed above. In constructive learning, the pupil is at the centre of the learning process, and the focus is on the learning process itself and not just on fact-based knowledge (Peräaho, Keskinen, Hatakka, & University of Turku, 2004). The learning process includes collaborative learning, not to mention reflection on one's own insight. Self-awareness and action tendencies are two main themes that are consistent throughout the whole training process. Emphasis is placed on the pupil's internal processes and the importance and power these internal processes have in relation to behaviour and behavioural change. Knowledge and willingness are not transferred unchanged from teacher to pupil. Pupils will form their own interpretation of what is taught on the basis of what already exists regarding knowledge, experience, motivation, attitude and other prerequisites.

The driving process is a driver training tool and is a model that assists in analysing driver behaviour. It describes driver behaviour as a process through four sections, to sense-perceive-decide-act. Driving errors can be described as failure that takes place in one or more of these sections. One example is that if a person is unable to detect that he or she is approaching an obscured road junction, neither will they make the right decision with regard to speed. If there is a failure in the perception section, such as a misconception of the obligation to give way, he or she will not receive the correct action. The driving process can be divided into two parallel processes, one cognitive and one emotional, where the emotional is perhaps the most crucial regarding behaviour.

Current driver training emphasises reflection on one's own action tendencies and awareness of one's own motives, emotions and knowledge. If one uses behavioural tradition as a basis, a computer could reward pupils by providing points or something similar. This would then reinforce correct behaviour. When it comes to factual knowledge and simple motor skills, this might have a function. But theories of emotions, desire and culture, as well as the discipline of neurobiology, describe that developing the correct knowledge and ability is not sufficient in order to achieve safe driving behaviour. Emotions, desire and culture are human characteristics that, to a greater extent, influence the choices we make compared to factual knowledge and simple motor skills.

Chen et al. (2004) have described a theoretical model in a VR-based learning environment based on a driver training supplement in Malaysia; it refers to a model (Figure 6) that designs constructivist learning environments (CLE) as proposed by Jonassen (1999). This model can be a good starting point to find out which qualities a Virtual Reality Based Learning Environment (hereafter VRBLE) should also have. Seeing as driver training is generally based on constructivist views on learning, VRBLE should also be based on the same qualities. The model can be seen in context with the composite model in chapter **Two**, and can supplement it. What it suggests is the importance of realising that learning demands that the problem presentation facilitates solving the problem with the help of a number of cognitive and social systems within the learner. These are described as Related Cases and Information resources, Cognitive Tools, Conversation and Collaboration tools, and Social or Contextual Support. As an example, this presentation uses an objective taken from the Norwegian Curriculum for Driving Licence Category B BE. 'The pupil must account for roads, road markings, signs and other traffic regulation'. This is relatively similar to the objective referred to in the article used as a starting point in this presentation.

An instructional designer needs to know the various skills and knowledge related to the objective, and design a representation that includes the various elements that are implicit in the objective. It must be possible to identify the various elements, and those that the learner is able to interpret.

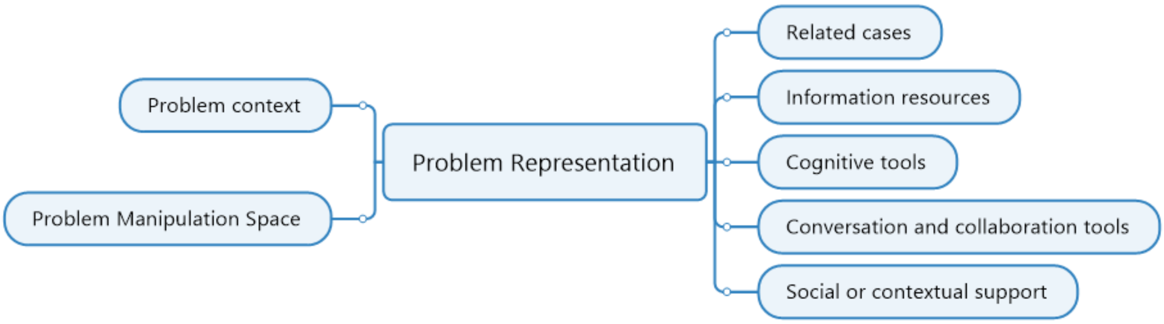

Figure 6 – Model for the development of constructivist learning environments

The basic rules for a road scenario that includes ordinary roads, road junctions and different traffic signs. VRBLE must also possess a social, cultural or intellectual element that challenges the learner. VRBLE must, through its capacity, engage the pupil in learning activities.

The problem presentation must provide an interesting, appealing and engaging issue that is able to engage the pupil and must be placed in a certain context. A virtual narrative can be used that is presented in a virtual environment in order to help the pupil build a mental representation of the problem. Both problem context and the issue describe a set of events that led up to the problem that needs to be solved. The objectives must describe expected behaviour related to the representation of the problem.

Space for trial and error. (Problem manipulation space) The learner must have the opportunity to try something and receive feedback. In this learning environment, the virtual road scenarios serve as a place where the pupil can test their solutions by moving virtually in a virtual car through the virtual road scenarios. This is achieved by using input devices such as VR glasses and possibly VR gloves, or other input devices that record the pupil's navigation. Navigation must be limited to movements that are possible in the real world, such as moving forward or backward, and turning left or right.

The principle of representativeness. (Related cases) An important principle of the constructivist perspective is that the learning environment provides access to a set of related experiences or knowledge that pupils can associate their experiences with. One of the main advantages of a virtual environment is its ability to provide three-dimensional graphic representation that imitates the real world. As previously pointed out, knowledge and skills that are learned in a specific context are easy to repeat. In VRLE, the virtual road scenarios should implicitly provide authentic representations that the pupil can easily relate to as if they were in the real world. As an example, the inclusion of a suitable traffic sign into a simulated road scenario will present a similar cognitive challenge that the learner encounters during real driving conditions. Through the process of visiting or exploring the simulated environment, pupils can understand the real use of these signs as opposed to learning them through printed text alone.

Information resources. (Information resources) Rich sources of information are also essential in the constructivist learning environment. These allows pupils to construct their own mental models and formulate hypotheses that drive an exploration of the problem area. In VRBLE, a hyperlink, for example, to different resources that include a description of relevant basic rules for ordinary roads and road junctions, traffic signs and road markings could be such a resource. The pupil must have free access to these resources while trying to solve the problem.

Cognitive Tools VRBLA must contain a few cognitive support tools. The virtual road scenarios act as a world where pupils can visualise a dynamic three-dimensional representation of the problem area. This is then much more authentic compared to static two-dimensional representations. This representation, which imitates the real world, helps reduce the pupil's cognitive load when constructing mental images and performing visualising activities. I this sense, the virtual environment works as a cognitive tool that is able to make imperceptible things perceptible. It can be designed to make something that is abstract look more concrete and visible by providing symbols that are not available in the real world. For example, VRBLE can provide guidance by displaying arrows in appropriate locations in the virtual road scenarios in order to prevent the pupil from getting lost in the virtual environment, or to point out key elements. VRBLE should also be able to show different elements in perspective. By virtually allowing the learner to switch position in the situation, it will be a powerful cognitive tool that strengthens understanding. Primarily, the virtual road scenarios are designed to be less complex than those that are in the real world. This allows the pupil to focus on the prominent aspects of the representation.
(Conversation and Collaboration tools are relevant in this example where roadworks are the theme of the learning objective, in the sense that most roadworks involve having to interact with others. Seeing as large programming resources are required to develop realistic communication partners in a social environment such as driving in traffic, one could imagine the teacher participating in the virtual environment and acting as a party in the traffic situation, or as a corrective actor in dialogue with the learner.
Social or Contextual Support could possibly be a group of like-minded people who work towards the same learning objectives, and could serve as conversation and discussion partners on the way to gaining even deeper understanding of the problem area.
As in this description, a virtual learning arena should provide greater demands as opposed to simply providing a visualisation of a problem area. If VRBLE is to have any function beyond simply showing something, it requires the system to allow for interactivity. And the objective doesn't necessarily have to involve the learner having to practice a correct way of performing a driving action, but rather the learner can explore the different possibilities.

3. Data Collection & Measurements

3.1. *The pre-study survey*

The pre-study survey was done with pupils ages 14-16 years old, attending seminars held on behalf of the Forskningsdagene in Levanger (September 19, 2019) and Steinkjer (September 24, 2019). All respondents played the VR car game before they answered the survey (paper based). There were two research assistants present while the pupils were playing the game and filling out the survey.
Pupils' comments on the pre-survey showed that it was easy to understand the contents of the survey an to answer it. In total, 27pupils answered the pre-survey. From these 42 responses, 3 indicated that the survey had a few questions that were hard to answer, but this was mostly based on the fact that the survey was presented to them in English. None of them gave good indications on what parts of the survey was hard to answer.
24 of 27 pupils had tried VR 1 year or less. Three pupils had tried VR for 1-3 years. 23 of these had tried VR for gaming purposes, one for health and six for other purposes. Most of them (25) indicate that they use VR less than once a week.
On their opinions of using VR for educational purposes, ease of use and on future usage, they have been asked to answer to what degree they disagree or agree - on a scale for 1-7.

3.2. *The electronic survey*

The data was collected using an electronic survey (see attachments).
The scales in the survey were developed to answer especially this specific Research Question 4 (RQ4).
Technology Acceptance Model (TAM) is a commonly used theoretical framework to measure different aspects of user acceptance towards new technology (Davis, 1993; Dillon & Morris, 1996). According to the TAM, user acceptance for a new technology depends on the user's attitudes, which are determined by perceived usefulness and perceived ease-of-use (Davis, 1993).

In line with some previous studies (Huang et al., 2016) the present study also used the TAM framework to measure the user acceptance towards the use of VR technology. The perceived usefulness was measured by 9 items related to usefulness of VR glasses especially for educational purposes (e.g. "Use of VR glasses makes it easy to earn new things for me") and perceived ease-of-use was measured by 10 items covering how easy/difficult is to use VR glasses (e.g. "It is easy to use VR glasses"). Both scales were rated using a 5-point Likert type scale (1=completely disagree, 5=completely agree). Attitudes towards use of VR glasses were measured using a 6-items semantic differential scale (e.g. Using VR glasses in driving training is/would be 1=Not useful 5= Useful; 1=Complicated, 5=Easy etc.).

In addition, intentions and familiarity with VR were measured for those with no experience of VR use since behavioral intention is an immediate predictor of the behavior according to the Theory of Reasoned Action (Fishbein & Ajzen, 1975). There was one item asking about how familiar respondents are with use of VR glasses (1=not at all, 5=very much) and two items asking about the intentions/willingness to use VR glasses in future (e.g. "I am willing to use VR glasses in future"). This section was answered only by those who did not use a VR glasses before.

The final section included questions specifically about possible use of VR glasses in driving training and it was only answered by the driving teachers. This section included both scales asking about the frequency of use of different digital tools (e.g. computers, driving simulators) in driving education and some open-ended questions that asked about which type of competences driving teachers need to use VR technology in their classes, how much impact VR technology can have on students learning outcomes, and in which levels in driving training use of VR technology would be most beneficial. In addition, in order to identify the demographic profile of the participants and use characteristics for the VR glasses, the questionnaire also included some questions related to age, gender, occupation/status of the respondents, and the use experience (yes/no), frequency and purpose of VR glasses.

3.3. *User testing of a VR car game*

The VR car game Project Cars 2 has been made available during the conferences and people were asked to play the game and then answer an electronic survey adapted to the purpose and closely connected to the larger survey.

The first part of the questionnaire included some questions related to demographic profile (age, gender, occupation/status) of the respondents. The second part included some questions asking about the use experience (yes/no) and use frequency and purpose of VR glasses, plus the experience playing the specific car game. The next section included some scales measuring perceived usefulness, perceived ease-of-use and attitudes related to us of VR glasses. The perceived usefulness was measured by 9 items related to usefulness of VR glasses especially for educational purposes (e.g. “Use of VR glasses makes it easy to earn new things for me”) and perceived ease-of-use was measured by 10 items covering how easy/difficult is to use VR glasses (e.g. “It is easy to use VR glasses”). Both scales were rated using a 5-point Likert type scale (1=completely disagree, 5=completely agree). Attitudes towards use of VR glasses were measured using a 6-items semantic differential scale (e.g. Using VR glasses in driving training is/would be 1=Not useful 5= Useful; 1=Complicated, 5=Easy etc.) Section four included one item asking about how familiar respondents are with use of VR glasses (1=not at all, 5=very much) and two items asking about the intentions/willingness to use VR glasses in future (e.g. “I am willing to use VR glasses in future”). This section was answered only by those who did not use VR glasses before. The final section included questions specifically about possible use of VR glasses in driving training and it was only answered by the driving teachers. This section included both scales asking about the frequency of use of different digital tools (e.g. computers, driving simulators) in driving education and some open-ended questions that asked about which type of competences driving teachers need to use VR technology in their classes, how much impact VR technology can have on students learning outcomes, and in which levels in driving training use of VR technology would be most beneficial.

4. Results from the data collection

4.1. *Results from the pre-study*

In the following tables (Table 1, Table 2, Table 3) the results obtained in the pre-study are shown.
High score indicates that the respondent agrees. A low score indicates that the respondent disagrees. 1 = Strongly disagrees whilst 7 = Strongly agree. Mean values are calculates based on the answers of the respondents.

4.2. *Results from the electronic survey*

4.2.1. Sample Characteristics

A total of 155 respondents participated to the survey. Most of them were either driving teachers working at different traffic schools (56.8%) or driving teacher students (29.7%). Majority of them were males (65.2 %) and were between 26 and 50 years old (51%). In addition, most of them (62.6%) reported that they used VR glasses before. Sample characteristics both for VR users and non-users are shown in Table 4. Comparison of the two groups in terms of demographic profile shows that females, people between 51-65 years old and driving teachers are represented considerably more among respondents who have not used VR before compared to those who have used VR glasses before.

Table 1 – Perceived usefulness

Statement	**Average**
Using VR technology makes it easier for me to learn new tasks	4,9
I find the use of VR technology in education useful	5,0
VR technology is a good tool that supports my learning process	4,9
Using VR technology makes me learn things more quickly	5,1
I think VR technology use creates a realistic learning environment	5,6
VR technology enables me to learn the new tasks more effectively by providing visualization	5,3

Table 2 – Ease of use

Statement on VR and ease of use	**Average**
I think it is easy to use VR glasses	4,6
Learning how to use the VR glasses requires a lot of effort	3,7
It is not practical to use VR glasses because they are too heavy	2,3
The tasks that I can do using a VR technology are easy for me to understand	4,6

Table 3 – Future usage

Statement	**Average**
I am willing to use VR technology in future	5,8
I find the use of VR technology in education useful	5,0

Table 4 – Sample characteristics

	VR users (n= 97)	**Non-users (n= 58)**
	[%]	*[%]*
Gender		
Male	70.1	56.9
Female	29.9	43.1
Age		
10-18	7.2	0.0
19-25	20.6	20.7
26-35	22.7	22.4
36-50	29.9	25.9
51-65	17.5	29.3
Above 65	2.1	1.7
Occupation/status		
Driving teacher	53.6	62.1
Driving teacher student	28.9	31.0
Learner driver	4.1	0.0
Other	13.4	6.9
VR glasses use frequency		
1 time	16.5	*n.a.*
2-5 times	51.5	*n.a.*
6 to 10 times	12.4	*n.a.*
11 to 20 times	4.1	*n.a.*
More than 20 times	15.5	*n.a.*
Purpose of use for VR glasses		
Games	83.5	*n.a.*
Education	13.4	*n.a.*
Health	1.0	*n.a.*
Work	9.3	*n.a.*
Research	3.1	*n.a.*
Other	17.5	*n.a.*

n.a. = not applicable

4.2.2. VR use experience & Purpose of use

Most of the respondents (51.5%) who used VR glasses used it 2-5 times before, which indicates that there is rather limited use experience with VR glasses among the respondents of the study. In addition, the most frequently reported reasons for use of VR glasses were games (83.5%) followed by education (13.4%) and work (9.3%) (see Table 4).

4.2.3. Factors related to user acceptance for VR glasses

Perceived usefulness, ease-of-use and attitudes towards use of VR glasses were measured to examine the user acceptance for VR glasses. Mean and Standard Deviation (SD) scores for the items of the perceived usefulness, ease-of-use and attitudes scales for the VR users are shown in Table 5. In perceived usefulness scale, the most positively rated item was item number 9 followed by 8, 2 and 6. These items are reflecting different benefits of using VR glasses in education, thus it appears that overall the respondents are positive about the usefulness and benefits of VR glasses in education.

Table 5 – Descriptive information for the perceived usefulness, ease-of-use and attitudes items among the VR users

Items	Average	SD
Perceived usefulness		
1. Using VR glasses will make it easier for me to learn something new	3.7	1.1
2. I think the use of VR glasses in education and training will be very useful	3.9	1.1
3. VR glasses are not a good aid that will support my learning*	3.5	1.1
4. VR glasses will help to learn things faster	3.7	1.1
5. I don't think VR glasses will provide a realistic picture of the physical environment and the task to be learned*	3.1	1.5
6. Visualisation of the learning task using VR glasses will increase learning efficiency	3.8	1.1
7. I don't think VR glasses simulate realistic situations*	3.4	1.4
8. I think VR glasses support learning processes for pupils who have language difficulties	4.0	1.1
9. I think the use of VR glasses will motivate people to learn	4.1	1.0
Ease-of-use		
1. I thought it was very easy to use the VR glasses	4.2	1.1
2. Trying to find out how to use the glasses was demanding*	4.0	1.1
3. VR glasses make it easier to understand the task I have to solve	3.4	1.2
4. Using the VR glasses made me feel unwell*	3.2	1.4
5. I didn't feel any discomfort when using VR glasses	3.3	1.5
6. I found it quite uncomfortable using VR glasses*	3.8	1.3
7. I became nauseous and almost vomited when I used the VR glasses*	4.2	1.3
8. Using the VR glasses was impractical because they were too heavy*	4.0	1.1
9. VR glasses are expensive to buy*	2.3	1.2
10. Learning something new was quite time consuming when using VR glasses*	3.8	1.0
Attitudes		
1. Useless-Useful	3.7	1.2
2. Bad-Good	3.7	1.3
3. Complicated-Simple	3.6	1.2
4. Boring-Fun	4.3	1.1
5. Expensive-Affordable	3.0	1.2
6. Unimportant-Important	3.4	1.2

All the items were rated on a 5-point scale, higher scores indicating a more positive evaluation about the use of VR glasses

*These negative items have been recoded during the data analysis

On the other hand, ratings especially for items 5 and 7 were less positive. These items were related with to what extend situations created by VR technology can reflect reality, thus relatively lower scores here indicate that the respondents have some concerns about the similarity of the situations simulated by the VR glasses to the real situations.

In terms of the attitudes scale, overall ratings given to the items were quite high indicating that generally there is a positive attitude towards the use of VR glasses. The highest rating was given to the item number 4, which was about how boring/enjoyable it was to use VR glasses, showing that the respondents overall find using VR glasses very enjoyable. In addition, ratings for the items measuring usefulness and goodness of VR glasses were high, indicating that the respondents find it useful and good to use VR glasses. Mean scores for the ease-of-use scale items show that overall the respondents find quite it easy to use VR glasses. The lowest rating was given to item number 9, which was about the expense for buying VR glasses, indicating that they find it quite expensive to buy VR glasses.

Also, ratings for items number 4 and 5, which were about feeling bad and uncomfortable when using VR glasses, were relatively low. Thus, it seems that the respondents feel moderately uncomfortable and disturbed when using VR glasses.

4.2.4. Demographics on perceived usefulness, ease-of-use and attitudes

Independent samples t-tests were run to see if there is a significant gender difference in the sum scores for the variables of the study. Results show that there was no significant difference between male and female respondents in terms of perceived usefulness, ease-of-use and attitudes scores related to use of VR glasses.
In addition, One-Way ANOVA tests were run to examine if there are significant differences between different age and occupation/status groups in sum scores for the measured variables. Results show that there is no significant difference between the different age and occupation groups in the perceived usefulness, ease-of-use and attitudes scores.

4.2.5. Familiarity, intentions and attitudes related to VR among non-users

Descriptive information for the familiarity, intentions and attitudes items among the VR non-users can be seen in Table 6. Mean score for the familiarity item was quite low indicating that familiarity level with the VR glasses among those who have not used VR glasses before is quite low. In terms of the intentions to use VR glasses in future, the respondents have relatively high score for the willingness to use VR glasses in future; whereas they have a lower score for having plans to use VR glasses in near future. This finding indicates that although they are quite willing to use VR glasses in future, they do not specifically plan this for near future.
Scores for the attitude items among the non-users are quite similar to those reported by the VR-users. Both groups have the highest score for the item number 4 indicating that they find/would find using VR glasses quite enjoyable. An independent sample t-test was conducted to examine if sum score for attitude items show a significant difference between VR users and non-users show that there's no significant difference between the two groups.

Table 6 – Descriptive information for the familiarity, intention and attitude items among the VR non-users

Items	Mean	SD
Familiarity with VR glasses	2.1	1.1
Intention to use VR glasses		
1. I am willing to use VR glasses in the future	4.0	1.1
2. I plan to use VR glasses in the near future	2.4	1.2
Attitudes		
1. Useless-Useful	3.6	1.2
2. Bad-Good	3.6	1.1
3. Complicated-Simple	3.6	1.2
4. Boring-Fun	4.0	1.1
5. Expensive-Affordable	3.2	1.2
6. Unimportant-Important	3.4	1.2

4.2.6. Use of digital technology in teaching

Some of the questions in the survey were about the use frequency of different digitals tools in driving education and the impact of VR technology use on learning outcomes of the students. Means scores to these items are given in Table 7 . It seems that Office programs followed by tablets and computers are the most frequently used digital tools by the driving teachers in education. On the other hand, VR glasses, eye-trackers and driving simulators were reported as least frequently used in education among the driving teachers. Thus, it appears that although some of the digital tools appear as commonly used, more advanced and expensive digital tools, such as driving simulator or VR glasses, are almost never used in driving education. Driving teachers also reported that on average digital tools are used at a moderate level in driving education process in Norway. Finally, the mean score (3.3) for the question asking about the impact of the use of VR glasses for the learning outcomes of the students indicate that driving teachers think use of VR glasses could have a moderate impact on the learning outcomes of the students.

Table 7 – Use of digital technology in teaching

	Mean	**SD**
How often do you use any type of digital tool when teaching in a car or classroom?*		
PC / Laptop	3.8	1.2
Smartphone	3.5	1.3
Tablet	3.8	1.2
Software like Word, Powerpoint, Excel, etc...	3.9	1.1
Projector	3.8	1.2
Smart board	2.5	1.4
Driving simulator	1.2	0.7
VR glasses	1.1	0.5
Eye trackers	1.1	0.3
Other	2.1	1.3
How often do you think digital tools are used in driver training in Norway today?*	3.4	1.0
How much do you think using VR technology will impact pupils' learning outcomes?**	3.3	1.2

*Questions were answered on 5-point Likert type scale (1=never, 5=very often)

**This question was answered on 5-point Likert type scale (1=very little, 5=very big)

4.2.7. Results from the questions in part 5 of the survey

Del 5 inneholder i alt 9 spørsmål, hvorav 6 av dem er åpne spørsmål. Svarene på disse presenteres fortløpende. Spørsmålsnumrene her referer til spørsmålene I spørreskjemaet. The responses identified are categorized in accordance to the topics listed in the Curriculum for Driver Education Category B and the categories "*do not know/not sure/not suited for*" and *"other".*

Question 3: What skills do you think the driving instructor needs in order to apply VR technology to his/her teaching? (Short description)

Seven different types of response categories were obtained for question 3, with the percentages showed in Figure 7.

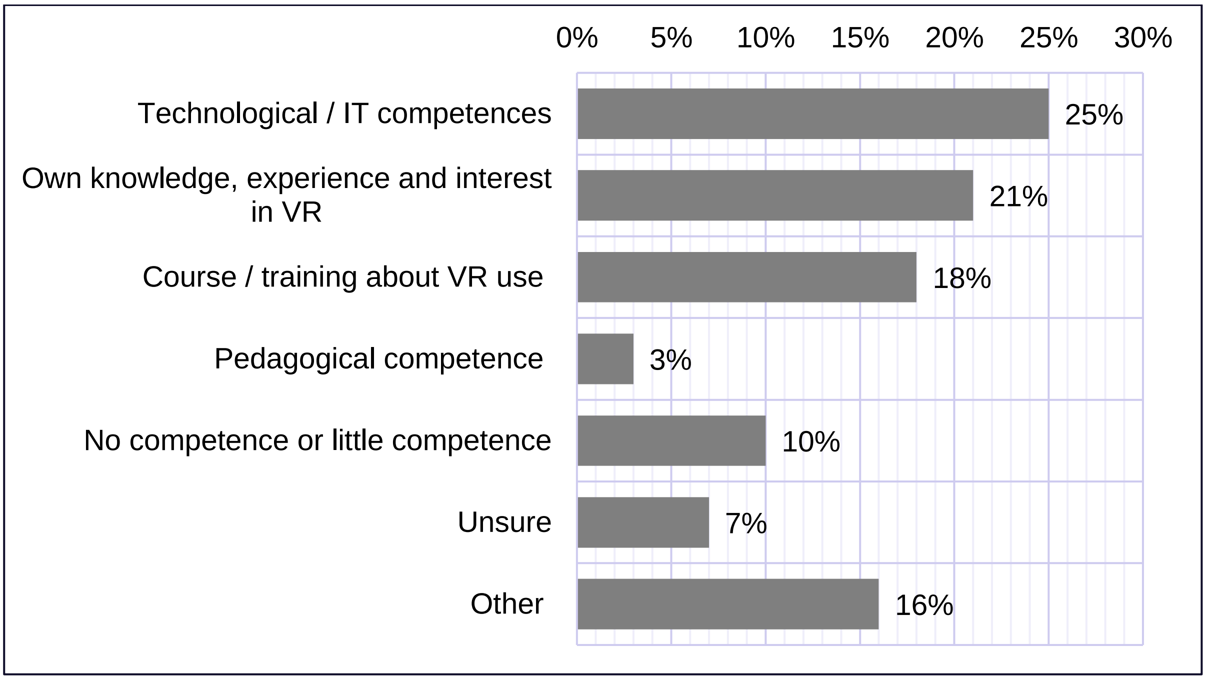

Figure 7 - Competence needed in VR usage

where:

- **Technological / IT competence**
  Responses in that category indicate mainly the need for technology/IT and data use competencies. *E.g.: "Må ha tekniske ferdigheter, slik at det ikke oppstår problemer. If the instructor knows the technical side of things, it's easier to continue learning so it becomes more structured"*

- **Own knowledge, experience and interest in VR**
  Responses in that category indicate the need for direct experience and practical knowledge with VR glasses, in addition to, for some of them, a personal interest.
  E.g. "Must be able to master using it so that it will be useful for the pupil." Must know what works and doesn't work oneself."

- **Course / training about VR use**
  Responses in that category point out a need for a short course or an introduction/training program for VR.
  E.g. "Short course", "Training for use and taking the glasses into account"

- **Pedagogical competence**
  A small amount of the respondents thinks that pedagogical competence for the driving teachers is needed for using VR glasses.
  E.g. "Good pedagogical skills"

- **No competence or little competence is needed**
  Some of the respondents think that no competence or very little technical competence is needed for using VR glasses. They think that just seeing how VR glasses work should be enough for using it. *E.g. "None, a demonstration of how it works, we're good to go"*

- **I do not know/unsure**
  Responses in that category indicate that some of the respondents are unsure or do not know what type of competences would be needed for use of VR glasses.

- **Other**
  Rare or unclear responses that did not fit into other categories were categorized under this group.
  E.g. "Simulation"

Question 5: In what ways do you think VR technology can impact pupils' learning outcomes? (Short description and explanation)

A total of 84 answers/responses were submitted regarding this question. The answers are categorised into 6 categories. The categorised responses and percentages are given below.

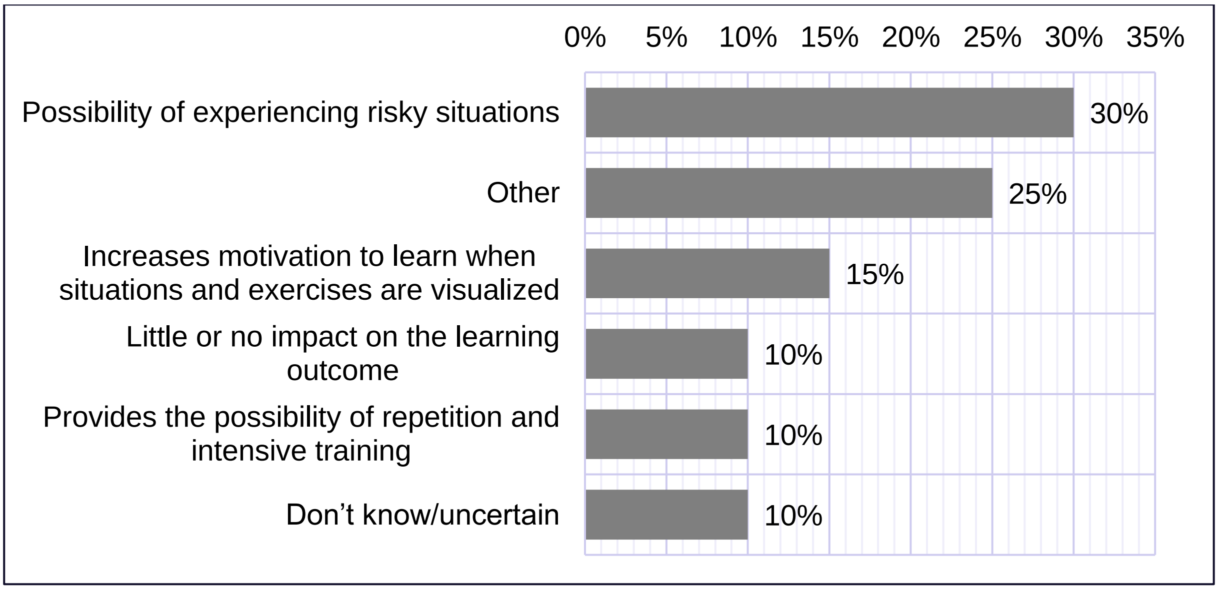

Figure 8 – How VR can affect students' learning outcomes

where:

- **Possible to experience risky situations**
  The category provides examples of responses and comments on how experiencing risky situations will strengthen pupils' learning outcomes
  E.g.: "Simulating situations that never or rarely appear in regular training provide a 'sense of reality' regarding dangerous situations, realistic traffic situations including risk, experience situations such as overtaking larger vehicles/parked buses, risk assessment, provide better understanding, avoiding too much talk, the instructor can construct situations that are important, understand emergency situations, clarify situations, experience/illustrate consequences of incorrect actions, situations can be paused and then discussed without risk to others, especially good in steps 3 and 4 – assess future risky situations"

- **Other**
  The category provides examples of answers and comments on factors other than those listed in the above categories and that help strengthen pupils' learning outcomes
  E.g.: "Can test pupils in situations one doesn't experience in normal lessons, personal experience that new pupils benefit form, greatly contributes to increasing pupils' understanding (Bloom's taxonomy), possible to rewind/fast-forward and pause - increases reflective value, perfect to use when driving in the dark - situational descriptions)"

- **Increases motivation to learn when situations and exercises are illustrated and visualised**
  The category provides examples of responses and comments on how illustration and visualisation will strengthen pupils' learning outcomes

E.g.: "Very useful for beginners to see situations and exercises, provides a better understanding compared to words, the future - pupils are used to technology, increasing motivation – inspiring and fun, experiencing driving environments (urban environment, motorways) that are not found at the training site, can contribute to pupils learning faster (saves time), fun combined with innovation, especially beneficial for foreign-language pupils, VR is realistic"

- **Little or no impact on learning outcomes**
  The category provides examples of responses and comments on why VR technology ***won't*** strengthen pupils' learning outcomes
  E.g.: "It isn't real - games - game over, currently, there are many bad driving simulators, don't get to experience the spontaneity of the traffic situation, pupils won't take it seriously, unrealistic, cool to talk about but not enough learning outcome, unfavourable for pupils who are frightened of technology, much like in a simulator?, don't know enough - needs more research, can be beneficial for some, but can't replace practical training, can be useful in step 2 - very unfavourable otherwise"

- **Allows for repetition and intensive training**
  The category provides examples of responses and comments on VR technology allowing repetition and intensive training that will strengthen pupils' learning outcomes
  E.g.: "Pupils can practice using VR at home - especially useful for those who otherwise do not have the opportunity, intensive training in areas the pupil struggles with, makes it easy to repeat, can facilitate theoretical learning"

- **Don't know/unsure**
  The category provides examples of uncertainty on whether VR technology in general will strengthen pupils' learning outcomes
  E.g.: "Entirely dependent on the software/scenarios - a lot of bad simulators, needs more research, uncertain, have to try more first, thinks that pupils gain little benefit from using VR glasses - but are willing to hear more about it"

Question 6: If VR glasses are to be used in driver training, in which topics and in which parts of the 'relevant content' in the Basic Traffic Course do you think VR glasses will be best suited in strengthening pupils' learning outcomes and motivation to learn? (Describe and explain in your own words).

A total of 84 answers/responses were submitted regarding this question. The answers are categorised into 4 categories
The categorised responses and percentages are given below.

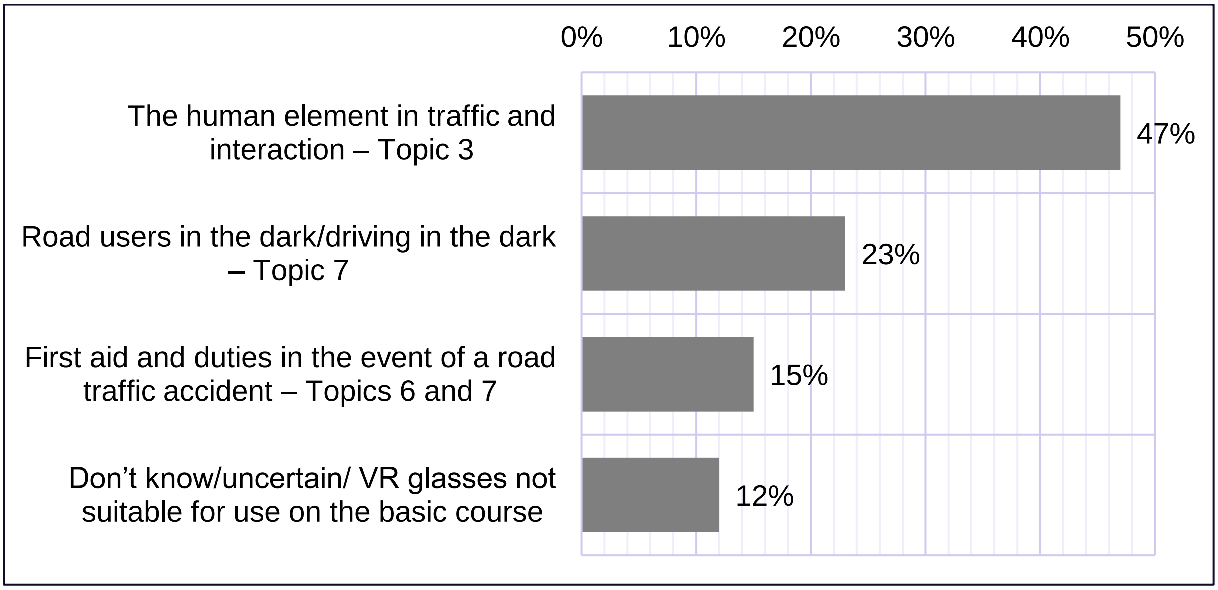

Figure 9 – Topics inside the Basic Course that are suitable for use of VR

where:

- **The human element in traffic and interaction (topic 3 in the curriculum, Category B)**
  The category provides examples of content elements that can be exemplified and that will strengthen pupils' learning outcomes in this topic
  E.g.: "human capacity, the road users various prerequisites, attitudes and attitudes to risk, driving process and reaction times, challenges facing other road users and groups of road users (children, elderly, heavy vehicles), human error, driving methods (speed, position and obligation to give way), planning/strategy), what is obligation to give way, changing lanes and roundabouts, urban driving, understanding regulations and risks , risk assessments, showing traffic as a system, discussion based on real traffic situations, gain experience as a driver"

- **Road users in the dark/driving in the dark (topic 7 in the curriculum, Category B)**
  The category provides examples of content elements on driving in the dark that can be exemplified so that pupils' learning outcomes will be strengthened in this topic
  E.g.: "Use of dipped headlights and full beam lights, explain/show traffic situations, create situations, risk assessments, make situations more easy to understand, concretise"

- **First aid and duties in the event of a road traffic accident (topics 6 and 7 in the curriculum, Category B)**
  The category provides examples of content elements that can be exemplified so that

pupils' learning outcomes will be strengthened in this topic
E.g.: "first to arrive at the scene of an accident, behaviour at the scene of an accident, administer first aid/taking proper action"

- **Don't know/unsure/ VR glasses unsuitable for Basic Traffic Course**
  The category provides examples of uncertainty on whether VR technology will strengthen pupils' learning outcomes in the Basic Traffic Course
- *E.g.: "unsure of the usefulness, takes too long, completely useless, difficult to say with the little knowledge I have of VR, expensive to acquire VR class sets"*

Question 7: In which of the non-compulsory parts in step 2 of the curriculum Category B do you think VR glasses will be best suited in strengthening pupils' learning outcomes and motivation to learn? (Describe and explain in your own words).

A total of 77 answers/responses were submitted regarding this question. The answers are categorised into 6 categories
The categorized responses and percentages are given below.

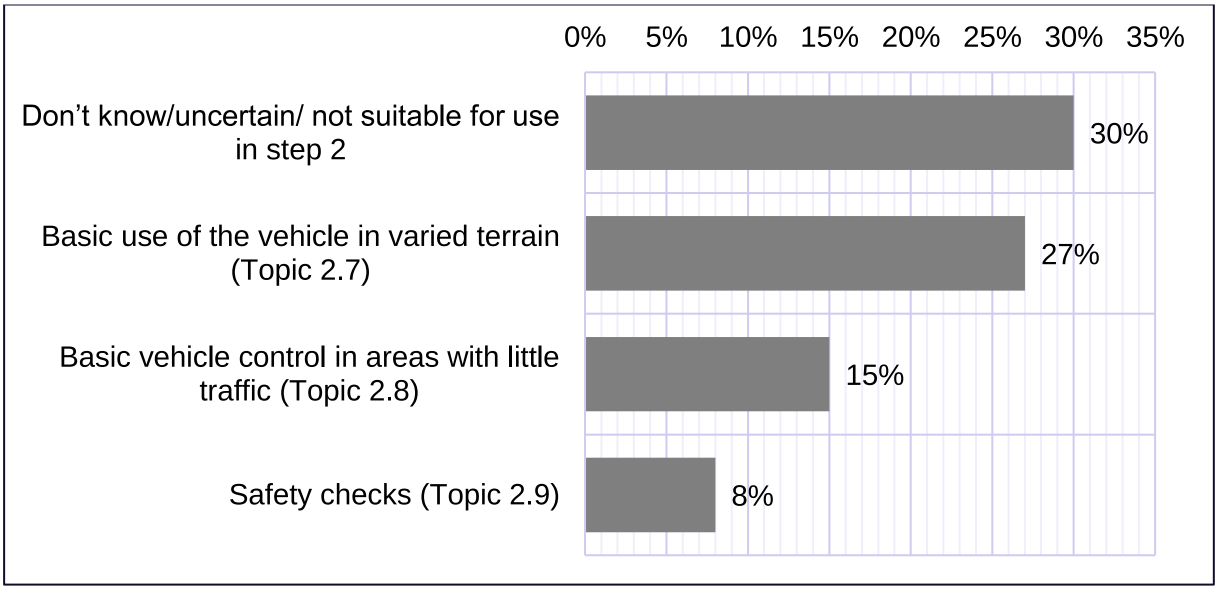

Figure 10 – Topics inside the Step 2 that are suitable for use of VR

where:

- **Don't know/unsure/ VR glasses unsuitable in step 2**
  The category provides examples of uncertainty on whether VR technology is suited to/will strengthen pupils' learning outcomes in step 2 of the training
  E.g.: "Don't think this belongs in step 2, don't think there will be major learning outcomes in step 2, difficult to motivate oneself, too time consuming and expensive, why not just drive a car?, need to have a driving simulator in addition to VR as an accessory - glasses on their own aren't enough - must be a complete package to have an effect otherwise you might as well show a film, must be well adapted in relation to pedals and gears (should be available on both manual and automatic simulators?)"

- **Basic use of the vehicle in varied terrain (topic 2.7 in the curriculum, Category B)**
  The category provides examples of content elements that can be exemplified and that will strengthen pupils' learning outcomes in the topic 2.7
  E.g.: "Keywords and statements/topics: "Basic training/understanding of observation sequence, starting and stopping - choice of gears after braking, use of mirror and blind zone, gearing, reversing, parking, right and left turns at road junctions, braking technique, short stop new start"

- **Basic vehicle control in areas with little traffic (topic 2.8 in the curriculum, Category B)**
  The category provides examples of content elements that can be exemplified and that will strengthen pupils' learning outcomes in relation to basic vehicle control

E.g.: "Continuous driving in light traffic, showing the use of various technical exercises/details in real situations – motivation, functional practice, train situations/driving methods in areas with little traffic, experiencing real situations, what-how and why technical elements are automated, many repetitions, all of step 2 practical parts in general"

- **Safety checks (topic 2.9 in the curriculum, Category B)**
  The category provides examples of content elements that can be exemplified and that will strengthen pupils' learning outcomes in the topic of Safety Checks
  E.g.: "The structure of the vehicle, warning devices, safety checks (in practice?)"

Question 8: In which of the non-compulsory parts in step 3 of the curriculum Category B do you think VR glasses will be best suited in strengthening pupils' learning outcomes and motivation to learn? (Describe and explain in your own words).

A total of 76 answers/responses were submitted regarding this question. The answers are categorised into 7 categories
The categorized responses and percentages are given below:

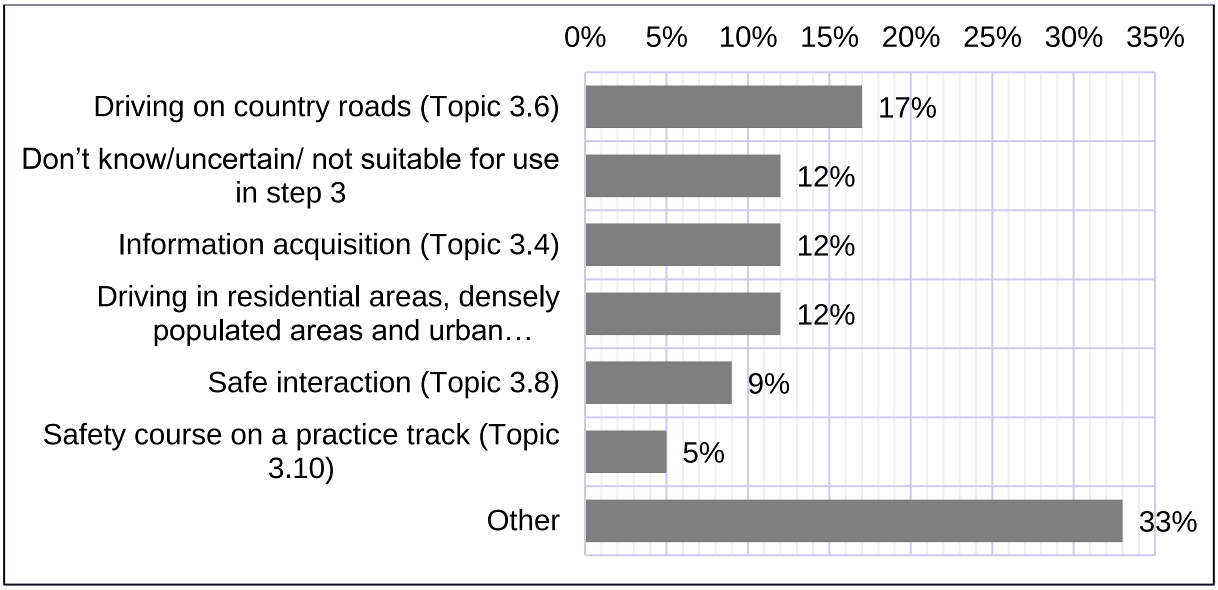

Figure 11 – Topics inside the Step 3 that are suitable for use of VR

where:

- **Driving on country roads (topic 3.6 in the curriculum, Category B)**
  The category provides examples of content elements that can be exemplified and that will strengthen pupils' learning outcomes in topic 3.6 of the curriculum
  E.g.: "Driving on country roads, choice of speed in relation to visibility, driving technique on bends, dangerous junctions (particular risks), overtaking, entering and exiting major roads, motorways"

- **Don't know/unsure/ VR glasses unsuitable in step 3**
  The category provides examples of uncertainty on whether VR technology is suited to/will strengthen pupils' learning outcomes in step 3 of the training
  E.g.: "Little effect on learning outcomes, only for those who really struggle with very specific things, too time consuming, losing reality, I'm sceptical, no effect"

- **Information acquisition (topic 3.4 in the curriculum, Category B)**
  The category provides examples of content elements that can be exemplified and that will strengthen pupils' learning outcomes in topic 3.4 of the curriculum
  E.g.: "Information acquisition, obligation to give way – behaviour, reading the traffic situation, understanding why, this must be a great tool to use when working with the driving process, identifying traffic elements, blind zones and observation techniques"

- **Driving in residential areas, densely populated areas and urban environments (topic 3.5 in the curriculum, Category B)**
  The category provides examples of content elements that can be exemplified and that will strengthen pupils' learning outcomes in topic 3.5 of the curriculum

E.g.: "Driving in cities, roundabouts, speed and position, different types of junctions, multiple lanes, visualising what pupils will practice later, sudden events (risk?), developing good perception of risk"

- **Safe interaction (topic 3.8 in the curriculum, Category B)**
  The category provides examples of content elements that can be exemplified and that will strengthen pupils' learning outcomes in topic 3.8 of the curriculum
  E.g.: "The need for interaction and the importance of interacting with others is made clear, challenging (complex) situations can be constructed, special junctions, execution"

- **Safety course on a practice track (topic 3.10 in the curriculum, Category B)**
  The category provides examples of content elements that can be exemplified and that will strengthen pupils' learning outcomes in the topic 3.10
  E.g.: "Safety course on a practice track and link to step 4, slippery conditions, practice track (virtual?)"

- **Other**
  The category provides examples of factors other than those listed in the above categories and that help strengthen pupils' learning outcomes in step 3 of the training
  E.g.: "I think it could be used in all the non-compulsory parts eg, new technology such as VR glasses can make it easier to understand, in pretty much all of the parts that deal with roads, road systems and driving methods, practice traffic situations in a safe classroom, think that VR glasses could have had an effect and relevance in step 3 with regard to visualising possible outcomes, particular risks, interaction with emergency vehicles - here, one can create situations that seldom occur outside"

Question 9: "If you think VR glasses support learning processes for pupils who have language difficulties, could you please explain in what ways?"

Seven response categories were obtained for question 9 based on the answers from the respondents. The response categories and their percentages are given below.

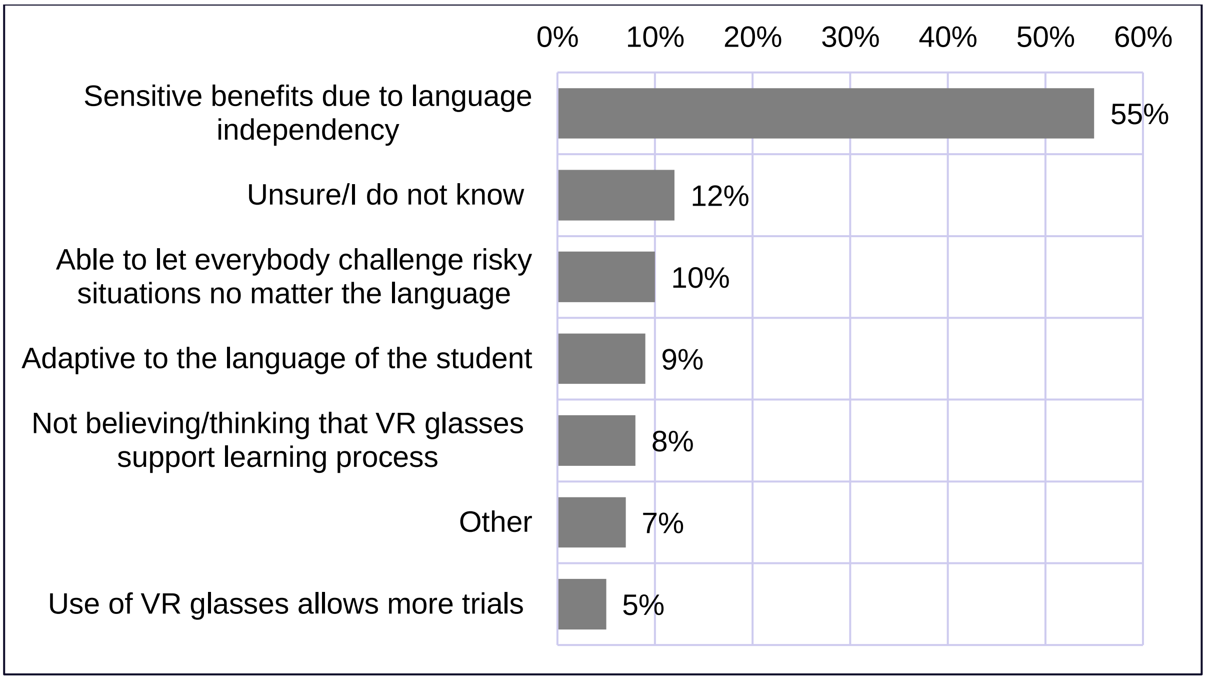

Figure 12 – Opinions about using VR with students with language problems

where:

- **Sensitive benefits due to language independency**
  Responses in that category were mainly about the benefits of using visual material and tools in learning, such as making learning process more quick, effective and easy since it does not depend on the language
  E.g. "VR glasses can help demonstrate situations that are graphically simulated instead of trying to explain by using language that can be difficult to understand. I think it's easier to explain things to pupils who have language difficulties via VR, simulators, demonstrations and other tools, seeing as talking to them and explaining things to them doesn't necessarily help. VR will be a good situation to simulate different situations that they need to solve, then try to talk to them again"

- **Unsure/I do not know**

- **Able to let everybody challenge risky situations no matter the language**
  Responses in this category highlighted that using VR glasses allows to demonstrate risky situations in a safe way even for those who do not master the language
  E.g.: "You can show videos about how things can be done and they can try things out and make mistakes in a safe manner"

- **Adaptive to the language of the student**
  Using VR glasses would allow to change the language or provide translation according to the need of the student
  E.g.: "You can have different programmes in different languages, Can get info and explanations in languages they understand"

- **Able to let everybody challenge risky situations no matter the language**
  Responses in this category highlighted that using VR glasses allows to demonstrate risky situations in a safe way even for those who do not master the language
  E.g.: "You can show videos about how things can be done and they can try things out and make mistakes in a safe manner"

- **Not believing/thinking that VR glasses support learning process**
  E.g. "Don't think it helps", "Actual driving experience is the only way to do it"

- **Use of VR glasses allows more trials**
  E.g.: "A lot of repetition over a short period of time, They can try things out and make mistakes many times"

- **Other**
  E.g.: "Didn't understand the question"

4.3. *Results from the survey related to the VR var game test session*

4.3.1. Sample Characteristics

17 people answered the survey related to the playing of the VR car game. 13 of these were men whilst 4 were women. Twelve out of the 17 are traffic teachers. Only 12 answers that they played / tested the game during the conference.

4.3.2. VR use experience & Purpose of use

11 out of the 17 had tried VR previously. Four of them had used VR 2-5 times previously, two had tried it 6-10 times, three had tried it 11-20 times and 2 had tried it more than 20 times. Nine of the respondents had used VR for gaming purpose, three in relation to work and two gave "other" as an answer.
There is a broad agreement on the fact that VR will function very well for learning purposes and they all agree that VR is easy to use and mostly comfortable.

4.3.3. User acceptance, usefulness and learning outcomes from the use of VR

All 17 respondents indicate that they find VR motivating, interesting, fun, pleasant and so on. And, all 17 agree to the fact that VR will function well as a tool for better visualizing of the traffic situation.
A more detailed overview on the respondent's' answers are showed in the tables below. High score indicates that the respondent agrees. A low score indicates that the respondent disagrees. 1 = Strongly disagrees whilst 5 = Strongly agree. Mean values are calculates based on the answers of the respondents.

Table 8 – Statements on the use of VR for educational purposes

Consider the following statements (N = 11)	**Average**
Using VR glasses will make it easier for me to learn something new *	4.73
I think the use of VR glasses in education and training will be very useful *	4.82
VR glasses are not a good aid that will support my learning *	2.27
VR glasses will help to learn things faster *	4.27
I don't think VR glasses will provide a realistic picture of the physical environment and the task to be learned *	2.45
Visualisation of the learning task using VR glasses will increase learning efficiency *	4.64
I don't think VR glasses simulate realistic situations *	1.91
I think VR glasses support learning processes for pupils who have language difficulties *	4.18
I think the use of VR glasses will motivate people to learn *	4.45

Table 9 – Statements on ease of use

Consider the following statements (N = 11)	**Average**
I thought it was very easy to use the VR glasses *	3.64
Trying to find out how to use the glasses was demanding *	1.18
VR glasses make it easier to understand the task I have to solve *	3.36
Using the VR glasses made me feel unwell *	2.18
I didn't feel any discomfort when using VR glasses *	3.45
I found it quite uncomfortable using VR glasses *	2.00
I became nauseous and almost vomited when I used the VR glasses *	1.55
Using the VR glasses was impractical because they were too heavy *	1.64
VR glasses are expensive to buy *	3.09
Learning something new was quite time consuming when using VR glasses *	1.36

Table 10 – Statements on fun, motivation, etc.

Consider the following statements (N = 17)	**Average**
I think using VR is interesting	4.47
I think using VR seems comfortable	3.82
I think using VR is fun	4.06
I feel happy when I use VR	3.71
Using VR gives me a good feeling	3.88
I think using VR will be motivating	4.29

When asked in what way they think VR will function well as a tool for a better visualization of the traffic situation, the emphasis is on the following:

- Being able to rehearse scenarios that one cannot rehearse during the driving lessons
- Being able to rehearse scenarios that are not very common (either in general or that are not common at the physical location of the driving school)
- Start-up practice, adapted to the needs of the student, rehearsing the technical elements of handling a car

When it comes to the experience of playing the VR car game, all respondents are positive and comments on that it feels fairly realistic and immersive, though missing some typical haptic feedback.

When commenting on needed competences for using VR in education, it is clearly stated that both technical and pedagogical competence is needed.

Seven out of 12 respondents think VR will have good or very good effect of the students' learning outcomes.

When it comes to the effect of VR on students' learning outcomes, comments mostly relate to the fact that VR is useful and less stressful, giving the student the possibility of practicing over and over again and VR seems to be a good addition to the physical part of the actual car driving.

5. Discussion

In this final part of the report all the results shown in chapter 4 will be discussed under the light of the research questions (RQ) presented in chapter 1.2.

5.1. *Technology Readiness*

5.1.1. Is VR Technology ready for this specific purpose? (RQ1)

Looking at recent experiences, the testing of the VR game (as part of this project) and based from the later research on VR and realism, we can state that VR Technology is ready for the purpose of teaching driver students skills and knowledge on given topics.

The ones who played the VR car game during the collecting of data for this project give high scores on the use of VR in education. Some of the highest scores are found when it comes to factors like motivation, usefulness, effectiveness, interesting and fun. Players also reported that the game felt reasonably realistic and immersive, though missing some typical haptic feedback

In addition, later international research shows that "complete realism" is not necessary for an immersive learning experience (Gisbergen, Kovacs, Campos, van der Heeft, & Vugts, 2019).

Gisbergen et al. (2019) indicate that low and high realism stimulated the same natural VR behavior and that there were no differences in what elements in the game world was noticed and not. All in all they state that "No differences were found in experience between a low and high level of realism measured by means of presence, negative effects, naturalness and engagement" and "[…] it is clear that investing effort and costs in creating a higher level of realism to obtain a better VR experience and more natural VR behaviour is not always needed ".

Although, Hvass et al. (2017) indicates that a higher degree of visual realism was accompanied with a stronger sensation of presence and increased fear responses.

An important element when it comes to realism, or perceived realism of VR environments is the fact that affordances and simulations matches users' expectations (Gilbert, 2016).

5.1.2. What is the time frame for this implementation? (RQ2)

Giving a reasonably confident answer to this question largely depends on specifying in detail the content and services required for each type of scenario. With a sufficiently detailed plan development can be both quick and robust, but without careful planning any development process – be it software systems or XR content – can be both drawn out and have low quality. One would have to expect development of well-planned content and scenarios to take up to two years, including testing and preparing for deployment. Then, implementing the software to driving schools should not take more than 4-6 months. As part of this, there needs to follow easy understandable instructions on both how to install it and how to efficiently use the systems.

In the case of relevant software being made available through the already existing online shops for VR software, the cost for new users (i.e. driving schools or private customers) will possibly be significantly lower. If an initiative to develop XR-content related to already existing or newly developed paper-based teaching material could be realized, the total cost could also be reduced, since the content development would be in parallel with the already existing or planned content for a different format, the book.

5.1.3. Is there a need for setting up some standards? (RQ3)

Content development for XR including VR use is currently a non-standardized area within digital content production. The Khronos Group, an open industry consortium of hardware and software companies, are spearheading the Open XR standardization project attempting to establish an open standard for software development for XR purposes. Version 1.0 of their proposed standard was released on July 29th 2019. (“OpenXR Official Website”, 2020)

Locally – in a limited project scope – setting up a specification for hardware and software compatibility, including language and visual guidelines may prove beneficial when developing content for any hardware and software platform.

[The standardization efforts being undertaken are addressing the easily definable components in the value chain of XR development, hardware and core software. Content development relies on the content encoding and visual presentation methods, and cannot as easily be standardized]

5.1.4. User acceptance & possible limitations towards VR? (RQ4)

Based on the results and the answers obtained to the survey, the following assumptions can be made.

User acceptance and limitations related to use of VR glasses were measured by the attitudes, perceived usefulness and ease-of-use scales. Overall results show that the respondents find VR glasses highly useful and easy to use and they have quite positive attitudes regarding the use of VR glasses in education. However, some potential limitations related to use of VR glasses also arise based on the ratings of the respondents for some items. The findings indicate that the respondents have some concerns about how realistic the scenarios created by the VR technology are. In addition, high purchase price for the VR glasses and feeling uncomfortable and bad while using VR glasses in some occasions appear as limitations. In terms of the intentions and familiarity related to VR glasses, those who have not tried to use VR glasses before reported a high willingness to use VR glasses in future, which supports user acceptance. On the other hand, they reported a lower score for having plans to use VR glasses in near future. It is likely that although the respondents are overall willing to use VR glasses, they are not planning to use them in near future due to some practical reasons, such as VR glasses are not commonly available, or they are expensive to buy. It is also worth to mention that familiarity with VR glasses was rather low among the non-users, which indicates the need to increase knowledge and familiarity about VR glasses among all possible users.

Based on the present findings we can conclude despite of a few limitations, user acceptance and intentions for the use of VR glasses for educational purposes is quite high in the present sample.

5.1.5. NPRA & Driving Instructors needed competences for VR (RQ5)

This research question has been initially introduced to evaluate what kind of competence is needed both among NPRA and driving instructors operating in Norwegian Driving School and, therefore, it was initially intention of the research group to investigate both aspects. In order to address this double-sided question, in addition to the online survey (that addresses driving instructors pretty exhaustively), it was supposed to perform, and analyze, some interviews with key operators in NPRA. Unfortunately, the research group had not the chance to perform such interviews (due to time limitation, budgeting and privacy issues), therefore the NPRA side have not been investigated.

Instead, in order to investigate on the driving instructor perspectives about this RQ, a dedicated question has been asked in the survey, which literally stated: *What skills do you think the driving instructor needs in order to apply VR technology to his/her teaching?*

According to the results obtained (see 4.2.7), one respondent over four (25%) stated that technological competences are needed to handle such instrumentation, and around 18% suggested to go through a small course to be introduced to the technology. This means that 43% of the respondents feel in need to have more technical education in order to properly use VR technologies in driving education. On top of this “technology worried” section of respondents, there is a further 21% that, similarly, is worried about technical competence, but is more confident on personal knowledge, direct experience and interest with/in VR to have everything in control.

Therefore, it is possible to state that 64% of respondents are somehow worried exclusively about handling the technology and make it work properly and smoothly, either with external technical education or based on their own experience and practice.

To complete the audience, 10% are overconfident in VR and thinks that the technology is almost “plug & play”, ready to be used without any specific preparation. On the contrary, 3% of the respondent do not know, or cannot imagine, what kind of competence they might need.

Significantly, only 3% of respondents said that some further pedagogical competence might be needed, which represent a very interesting result because it shows that Driving Instructors are not worried that much about being able to reach their learning outcomes through VR. Considering that the vast majority (68%) of VR users have had less than 5 experiences with VR, and 83.5% of them have used it only for entertainment purposes, a possible interpretation of this low concern about the pedagogical aspects of using VR might be that a founded reflection on this topic might need a more consistent use of this technology, especially outside entertainment applications. Therefore, it might be that using VR with more frequency in educational context might rise also the interest towards the pedagogical implications of this technology.

Summarizing, the vast majority of current driving instructors are mostly worried about being able to properly control and dominate the technical aspects of VR in spite of investigating among the pedagogical aspects, maybe (but not surely) due to a lack of experience and reflections on the topic. Therefore, a suggestion that might be made by the research group is to eventually evaluate the development of a dedicated course on these aspects with a specific structure that can aim to, from one side, train users with the technical handling of the equipment, but also challenge them in considering the pedagogy behind it, in order to raise the awareness of this aspect as well.

5.1.6. Risky situations and/or real maneuvers simulation ability (RQ6)

It is hard to answer this research question fully based on the survey; however, some of the items included in the perceived usefulness scale (see item number 5 and 7) were related to VR glasses’ adhesion to reality. Although the mean scores for these items were not so low, they were relatively lower compared to the means scores for the other items. This indicates that the respondents do not think that situations created by VR technology highly reflect reality. Therefore, based these findings it can be argued that users have some concerns about the level of realism of the scenarios/situations created by VR technology and there is a need to improve adhesion to reality with the VR glasses.

At the same time, as previously pointed out, Gisbergen et al. (2019) concludes that indicate that "complete realism" is not necessary for an immersive learning experience and there does not seem to be huge differences related to realism (measured by presence, negative effects naturalness and engagement). It seems that affordances and the matching of users' expectations is of more relevance (Gilbert, 2016).

5.2. *Ability to replace or supplement current Driver Training*

In relation to the main question about whether the use of VR glasses/technology represents an area of opportunity that will strengthen and enhance pupils' learning outcomes, there are several factors that need to be established and discussed before final conclusions are drawn. Among other things, it is necessary to determine whether VR glasses should be used in a class context, at group level (smaller groups) or on an individual basis in relation to the practical training sections that take place in cars. This will provide guidelines regarding which scenarios should be developed, how the scenarios are presented and processed by pupils and teachers before and after, and whether they should be demonstrations/presentations or interactive. The responses/comments from driving instructors in (see chapters 4 and 5) provide guidelines showing that driving instructors envision VR glasses being used for different purposes during teaching. Some describe the use of VR glasses as a type of 'video-like' demonstration of various practical exercises or theoretical courses, either as an introduction to practical exercises or as a basis of discussion both individually, in group situations or class situations. Some of the responses from driving instructors also indicate that if the technology is to strengthen pupils' learning outcomes and motivation to learn, one envisions the use of VR glasses in combination with a car simulator equipped with a steering wheel, gears and pedals. It is important to note that currently there are several digital tools that driving instructors may use in their teaching to illustrate traffic situations and different driving methods, such as pure theoretical tasks, and topics used as a basis for discussions in class situations that pupils can use to prepare for lessons and as follow-up work. Several of these can be uploaded and used on PCs, tablets and smartphones.

5.2.1. Effective learning, motivation & scenarios in Step 1, 2 and 3 (RQ7 & RQ9)

This subchapter discusses the research questions (RQ) 7 (*With regard to the Category B driver training Curriculum, what are the possible topics that that might be covered by using VR?*) and RQ9 (*Can VR increase motivation and effective learning, or provide Driving Instructors with better tools for visualization?*) as an integrated part in addition to the open-ended questions 5 – 8 in part 5 of the questionnaire.
One can envision various solutions of how driving schools can organise the use of VR glasses in teaching. One solution may be that driving schools acquire class sets that pupils use when participating in lessons at the driving school. Another scheme may be that pupils rent/borrow VR glasses while they are pupils at the driving school that can be used at school and taken home. This allows them to familiarise themselves with specific situations or topics. The glasses can be used for plenary sessions (everyone 'sees' the same thing at the same time), and in smaller groups where each group is given different tasks/scenarios and individual tasks.

The answers to Question 5 (In what way do you think VR technology can impact pupils' learning outcomes?) in the open questions in section 5 of the survey show that driving instructors have different views on how well-suited VR glasses are in strengthening pupils' learning outcomes. After reviewing the answers, there is reason to assume that the differences are largely due to the fact that driving instructors have varying experience regarding the use of technology in general, and perhaps especially in relation to VR technology. There is also reason to assume that a general 'technological scepticism' plays a role. It seems that many of those who have responded view VR glasses as another way of conveying scenarios in a simulator.
Approximately 30% of the keywords/statements in the answers pointed to the possibilities of allowing pupils to experience dangerous situations/risky situations that would strengthen pupils' understanding of risk, that they would otherwise not experience in traditional training. Furthermore, several responses point to the possibility of increasing motivation to learn by visualising situations and exercises/learning tasks. Statements such as 'one can clarify situations, pupils experience consequences of mistakes and the technology helps to increase motivation to learn' are the most common arguments. The possibility of visualisation and illustration of situations and learning elements are also highlighted as being important to foreign-language pupils. Several answers also point to the possibilities this technology provides in strengthening intensive training at home for pupils who otherwise aren't able to practice at home. This requires that pupils have VR glasses at home, or alternatively that pupils can rent/borrow such equipment from driving schools. The opportunity to experience/visualise/demonstrate specific exercises or situations that pupils struggle with is also highlighted as a positive factor. All these statements are considered positive and supportive regarding the use of VR technology in teaching.

Other statements emerged noting that "VR glasses would be well-suited to situational descriptions when driving in the dark (Road users in the dark) and in strengthening pupils' ability to reflect by 'pausing' situations and making them the subject of discussions".
Several of those who responded expressed that they were uncertain how the technology affected pupils' learning outcomes, and it was obvious from some of the answers that such technology would negatively affect learning outcomes and should therefore not be applied. Statements such as "unrealistic, just a game, pupils won't take it seriously, more research needs to be done on the effects, and we've seen that driving simulators have very bad scenarios" were highlighted as being negative. The answers indicate different perceptions of and attitudes to adopting new technology in driver training, suggesting that there is a need for information in this line of business. At the same time, there are also many people who see educational potential in adopting such learning tools.

Step 1 – Basic course

The responses and statements given by the driving instructors in relation to question 6 of the open questions in section 5 (If VR glasses are to be used in driver training, in which topics and in which parts of the 'relevant content' in the Basic Traffic Course do you think VR glasses will be best suited in strengthening pupils' learning outcomes and motivation to learn? Describe and explain in your own words) were mainly associated with the sections (a clear majority of 47% of the statements/topics) involving parts 3, 5, 6 and 7 of the curriculum in the Basic Traffic Course, 'The human element in traffic and interaction'. The other topics were topic 7 'Road users in the dark' (23%) and topics 5 'First aid and duties in the event of a road traffic accident' and 6 'Procedures in the event of a road traffic accident' (in total, topics

5 and 6 amounted to approximately 15%). It is possible, in all of these topics, to use VR technology in terms of visualisation, demonstration and in interactive scenarios where pupils are challenged and encouraged to make choices in relation to a situation or event.
Based on experiences and theory of learning as described in a previous chapter, the use of VR glasses is likely to be most effective, create motivation to learn and greatly contribute to strengthening pupils' learning outcomes if pupils recognise situations and scenarios and are thereby able to immerse themselves in what is presented to them. Even if VR glasses are used as an ordinary video without interactivity (e.g. as a visual demonstration), they will be able to create a perceived reality and allow pupils to experience empathy and focus. This is because the glasses shut out most of the unwanted 'noise' in the form of other visual impressions and sounds that occur in the room. This differs from using a regular screen to show videos or an open driving simulator, for example.
As previously mentioned in this report, VR glasses are seen as a learning tool or aid that driving instructors can use in their teaching and not as a substitute for the instructor. The different scenarios and exercises that pupils take part in on the Basic Traffic Course can form the basis for other learning activities such as pair and/or group discussions.

The majority of statements and suggestions/keywords given by driving instructors are related to specific traffic situations such as the obligation to give way, changing lanes, position, speed adjustment and roundabouts. Here, VR glasses can help to illustrate, clarify and demonstrate/show both risk factors and driving methods in various situations in order to emphasise that a traffic system places demands on users if it is to work optimally. In relation to the Curriculum for Driving Licences, Categories B and BE, all of the above situations can be included in topic 3 under relevant content such as communication and interaction between road users, interpretation of traffic situations and road user groups and conflicts of interest (e.g. cyclists and pedestrians and/or motorcyclists). Initially, the situations presented do not need to be interactive, but can, by using visualisation and exemplification, form the starting point for discussions and/or other learning tasks or activities for pupils afterwards.

This type of approach can also be used to illustrate the training process and intentions involved in driver training (part 4 of the Basic Traffic Course) with the various learning tasks and challenges pupils will face in the various steps. Key courses and topics in steps 1 to 4 can be visualised and exemplified, preferably using an 'instructor' who elaborates and explains at the same time as situations are being illustrated. This type of illustration will be useful to all pupils, especially pupils with linguistic/verbal challenges. These pupils often benefit greatly from visual learning support.
Good training situations that take place in both private and driving school cars can be portrayed, where rules and routines associated with driver training and the importance of a lot of practice are emphasised. The sequences may include tasks or challenge pupils to discuss things afterwards in different ways. This could include topics such as communication between pupil and partner/instructor, training elements, time of training, and training areas. For example, this can be illustrated by the pupil wearing VR glasses having a kind of 'observer role', but who receives questions and comments from those who are practicing their driving. These questions and comments can then be discussed with fellow pupils when the sequence is finished.
In order to highlight nuanced driving skills, one solution may be to develop a scenario where a pupil (wearing VR glasses) takes part on a drive as a 'backseat passenger/observer' (with a good overview), and an experienced driver comments on their own driving and answers questions from a virtual passenger who doesn't necessarily agree with everything. Here, one could highlight a type of 'ideal image' of skilled driving. One could focus on risky situations,

other road users and their challenges etc. A session of this type could be made interactive where pupils using the controls can mark off situations, statements or similar things that they want to address in a subsequent discussion. This kind of approach can provide many opportunities and perspectives in a teaching situation.

Topics related to first aid and procedures in the event of a road traffic accident (parts 5 and 6 of the Basic Traffic Course) were also highlighted in the responses given by driving instructors as relevant topics regarding the use of VR glasses as a learning tool. Elements such as ‘first to arrive at the scene of an accident, behaviour at the scene of an accident and administering first aid’ are mentioned in the responses given by instructors. Currently, these parts of the Basic Traffic Course have a large degree of practical pupil activity that is desirable to retain. Therefore, the use of VR glasses in this section can be an approach that supports practical training by illustrating and demonstrating the routines, procedures and measures that one wishes to implement at the scene of an accident. The sequence can either be conducted as an introduction in advance of the exercises pupils are to carry out in practice, or as follow-up reading or a summary to strengthen pupils’ learning outcomes.

A relatively large proportion (approximately 23%) of the driving instructors who have responded think that the use of VR glasses in topic 7, Road users in the dark (Basic Traffic Course), will help strengthen pupils’ learning outcomes and motivation to learn. The keywords and statements listed in the answers are “use of full beam lights and dipped headlights, risky situations, traffic situations and concretisation”. These can be linked to relevant content in the curriculum such as appropriate use of lights, risk factors for road users in the dark, lines of sight and clothing and reflective equipment. As in topics 5 and 6, Road users in the dark is also a topic where the intentions are for pupils to actively participate in the exercises and experience the challenges of driving in the dark, both from a driver’s perspective and from a cyclist/pedestrian’s perspective. The challenge will be to develop good VR scenarios that support the practical exercises pupils participate in, or even completely or partly replace them.

One possibility may be to show/demonstrate lines of sight and visibility by using VR glasses where pupils can switch between driver and pedestrian perspectives in the same situation. There is also the possibility of introducing elements that influence typical accident situations in the dark and the importance of reflective clothing etc. A ‘demonstration’ like this that uses VR glasses is very similar to the practical demonstration that is currently conducted outside. One might imagine that good scenarios using VR glasses provide experiences that are so close to reality that they could replace outdoor demonstrations in the future. This will also make the demonstrations less dependent on the weather and perhaps highlight elements that are difficult to achieve at an outdoor demonstration. One could also imagine that such a model will save resources for both pupils and driving schools.

The topic ‘Road users in the dark’ also includes a ‘demonstration’ sequence in a car in which two pupils are passengers while the driving instructor comments on their choices and driving methods. One could also imagine the possibility that this part can also be completely or partly replaced by ‘a demonstration trip’ using VR glasses. This type of ‘driving trip’ can also be made interactive and enable pupils to assess risks and make active choices about factors such as speed, if they think the situation requires it. Here, too, one could imagine the possibility of letting pupils switch from a driver’s perspective to a ‘pedestrian’ perspective, which is also an important learning element of the topic; risk factors are just as important for pedestrians as they are for motorists.

The advantage of using VR glasses will primarily be the opportunity to design risky situations in different traffic environments that might not be possible to achieve to the same degree in a traditional demonstration, and that pupils are more involved in the learning process. A joint follow-up reading/summary by the group would also be advantageous after the above activities are completed. An approach such as this represents an area of opportunity that, in our opinion, should be examined and investigated more closely as a work method or way of implementing the Road users in the dark course.

Step 2 – Basic Car Handling, Not compulsory practical themes

The step deals with learning basic vehicle control and consists mainly of basic technical driving exercises. As shown in the categorisation of question 7 (see chapter 3), approximately 1/3 of the driving instructors were of the opinion that VR glasses won't, to any significant degree, strengthen learning outcomes and pupils' motivation to learn in this step. Typical statements and keywords are 'don't think this belongs in this step, difficult to motivate oneself, time consuming and expensive, why not just drive a car?, need to have a driving simulator in addition to VR as an accessory. Answers that are perhaps a little surprising, but also understandable. This step deals a lot with practical skills that largely include the use of pedals, the steering wheel and the gear stick, and these are elements that aren't usually included when using VR glasses unless one has additional aids.

Despite this, however, there are almost as many people who believe that VR glasses will strengthen the learning process in several of the content elements found in topic 2.7 of the Category B curriculum 'Basic use of the vehicle in varied terrain'. In this section, keywords and statements are highlighted that deal with observational routines such as 'Basic training/understanding of observation sequence, starting and stopping - choice of gears after braking, use of mirror and blind zone', but also statements that point more in the direction of utilising pedals, the steering wheel and gear stick. This might include turning right and left at road junctions, braking technique, reversing, parking and more. These are exercises that, like the above, require extra equipment to provide a good learning outcome, and for that reason they are not that well suited, in our opinion, for the use of VR glasses.

Some of the driving instructors have also pointed to the topics 2.8 'Basic vehicle control in areas with little traffic' (approximately 15%) and 2.9 'Safety checks' (approximately 8%) as being possible topics where the use of VR glasses will be able to strengthen learning outcomes and motivation to learn.

Statements and keywords highlighted in topic 2.8 are the possibilities to illustrate 'functional practice through continuous driving in areas with little traffic, show the use of various technical exercises in real situations, what - how - why the technical elements should be automated etc. Most of the elements can be linked to the topic's suggested relevant content 'Functional practice through continuous driving in areas with little traffic' and 'Economical and eco-friendly driving'. With regard to this perspective, there are opportunities to use VR glasses. For example, one could imagine designing a 'driving trip' that is similar to the one mentioned in the Basic Traffic Course. One scenario may be that the pupil is a passenger and a virtual (or real) instructor uses technical exercises in traffic situations while explaining them. This type of approach could help the pupil see the big picture and the usefulness of the sub-exercises, and it will give pupils a good 'practice overview' that enables them to manage or regulate their own learning process the next time around.

Approximately 8% of driving instructors suggested that the Safety Checks topic isn't a topic where VR glasses could strengthen learning. Nevertheless, the use of VR glasses can contribute to a better learning outcome and motivation to learn by allowing one to delve deeper into various features found in a vehicle (electronics, safety devices, support systems, warnings etc). Statements and keywords listed by driving instructors are 'the structure of the vehicle, warning devices and practical safety checks'. This can be related to most of the elements in the topic's relevant content.

By using different scenarios, pupils can receive a demonstration of a vehicle safety check or perform the check themselves using the controls (for example, select a demonstration or an interactive 'do-it-yourself' option), the different support systems that can be activated/deactivated and the visual warnings that appear in the field of view can be visualised and demonstrated. Although it is not directly included in the content of the 'Safety Checks' topic, one could imagine a visualisation of how some of the driver support systems actually work and help the driver in various situations so that potential mistakes or accidents are avoided. Despite one not experiencing the actual feeling of the car taking control, the visual experience can still strengthen learning. In this way, one can also highlight how support systems such as 'Lane Assist and ESP' help to avert critical situations. The question that usually gets asked then is 'can't this be done in an ordinary car'? The answer to that is 'only partially'. There are a number of conditions that can be virtually demonstrated, shown and performed that one isn't able to highlight in a real setting with an ordinary vehicle.

Step 3 – Road Traffic, Not compulsory practical themes.

Step 3 deals with the basic driving exercises in Norwegian driver training. The categorisation of question 8 (see chapter 3) shows a relatively even response distribution in relation to the step's practical topics. It is interesting to note that a few of the driving instructors (12%) don't think that the use of VR glasses will strengthen pupils' learning outcomes and motivation to learn to any degree. The main arguments against the use of VR glasses are 'little effect on learning outcomes, only for those who struggle, too time-consuming, lose reality, sceptical etc. It is interesting to note that VR glasses are highlighted as a useful learning tool for pupils who struggle with training elements without any further explanation of why they will be more useful for these pupils compared to others.

In general, the majority of the statements are evenly distributed between the curriculum topics 3.4, 3.5 and 3.6 (a total of approximately 40%), which are also the step's most key practical and theoretical topics. The elements mentioned are key and known training elements (the statements from topics 3.4, 3.5 and 3.6 are grouped together here, for more details see question 8 in chapter 4.2.6) such as 'driving around roundabouts, obligation to give way, information acquisition, changing lanes, speed and position, visualising what pupils will later practice, driving technique on bends, overtaking etc. We find more of these elements in the Category B curriculum's listing of relevant content in topics 3.6 and 3.8, such as particular risks, overtaking, driving technique on bends, interaction, execution and complete overview etc. These learning elements are possible to show/demonstrate and are also made interactive by using the controls so that pupils can make active choices and/or change perspectives without VR glasses necessarily having to be connected to a simulator or simulator-like equipment such as a play station. The scope of possibility for such scenarios will mainly be related to 'sense - perceive and determine/decide' in the driving process (information processing model).

VR glasses have the potential and scope of possibility to provide good learning support and motivation to learn in connection with the development of pupils' perception of risk, understanding of risk and ability to interact. All the terms are expressed in some form in the statements and keywords given by the driving instructors as 'sudden events, perception of risk, particular risks and interaction with others', all of which affect key areas both in step 3 and in driver training in general.

One advantage of VR simulations based on simulating a non-photorealistic virtual world is that one can recreate unfavourable or potentially dangerous situations with the possibility of providing a better overview of the situation, in a way that is not possible in reality. This can help create better learning situations.

For example, one could envision scenarios where pupils are equipped with VR glasses and controls and given the task of using the controls to intervene in 'risky situations' they believe are about to take place (it is pointed out here that an accident will never occur if pupils do not intervene; the system (driver support system) or a virtual instructor takes control and 'saves' the situation). When pupils intervene, they will receive a response in the form of a presentation and commentary of the risky situation that was avoided.

Below are some bullet points with examples of learning tasks and events/situations that can be exemplified solely as demonstrations and/or as interactive sequences:

- Blind zone and heavy goods vehicles. Here, one could imagine an illustration where a heavy goods vehicle wishes to change from the left lane to the right lane and where the pupil's vehicle is located in the heavy goods vehicle's blind zone. If the pupil does not intervene and move their vehicle out of the blind zone using the controls, the driver of the heavy goods vehicle will indicate and start the manoeuvre. If the pupil still does not actively intervene, the driver support systems takes over both the heavy goods vehicle and the passenger car and averts the situation.
- Overtaking a heavy vehicle in a passenger car with oncoming traffic and traffic entering from a side road. A situation on a stretch of straight road where the pupil nears a heavy goods vehicle that is travelling relatively slowly. The car that the pupil is 'driving' begins to overtake without involvement from the pupil (natural situation due to speed difference and visibility ahead). There is a blind bend further ahead, a car is approaching from a side road adjoining the main road, the road marked with lane lines. The pupil is then asked (verbally and/or with text) whether he/she wishes to continue or abort. The situation becomes risky and the 'support system' intervenes and aborts overtaking to avert an accident.

In this context, step 3 is the step where the scope of possibility regarding the use of VR technology has the greatest potential to strengthen learning outcomes and motivation to learn among pupils in practical exercises in different traffic environments and various challenges. The examples above are not intended to be exhaustive, many opportunities can be found in the relevant content that can be used to design good learning tasks that use VR glasses.

One could envision various solutions of how driving schools can organise the use of VR glasses in teaching. One solution may be that driving schools acquire class sets that pupils use when participating in lessons at the driving school. Another scheme may be that pupils rent/borrow VR glasses while they are pupils at the driving school that can be used at school and taken home. This allows them to familiarise themselves with specific situations or topics. The glasses can be used for plenary sessions (everyone 'sees' the same thing at the same time), and in smaller groups where each group is given different tasks/scenarios and individual tasks.

5.2.2. VR application for students with language issues (RQ8)

Most of the respondent (55%) reported that using visual demonstrations by VR might be beneficial for the students with language problems as students can understand the visual demonstrations more easily and effectively compared to oral instructions that depends on language skills. Nine percentage of the respondents reported that using VR glasses would be helpful for the students with language problems because it can allow changing the language or translation depending on the need of the student. There is also a small group of respondents (8%) who reported that they do not believe in the benefits of VR glasses for helping students with language difficulties. Overall the responses to this open-ended question indicate that most of the respondents think that VR glasses might be an effective and beneficial tool for students with language difficulties.

5.3. *Economical sustainability*

5.3.1. Procurement, develop and implement cost of VR in training? (RQ10)

Acquiring VR equipment is not highly expensive. As shown previously in the report, this estimate to about 10.-15.000 NOK.

The development costs will be at a much higher level, as this must be set up as a development project with numerous developers and a very close collaboration with the users (Driver Teacher education and Driving Schools) and preferably with researchers as well. During the development project, one will have to set up scenarios on what, where and when, related to the educational context. Then, one would have to hire development companies to develop all the content and the scenarios needed, etc., etc. This means +/- 10 mill NOK. This is all depending on the level of development, the needs and more.

The implementation of a system like this at Driver Schools would not give any big direct costs (the mere implementation of the software on a computer with an attached VR kit / system). But, implementing it successfully would mean that the activity is well planned and carried out, which again will add costs on hours spent. Some of the costs here would naturally be returned through student’s payment as part of the driver training.

5.3.2. Operation, maintenance and updates costs? (RQ11)

Cost related to operation would function in the same manner as running computers with a given software and following software licenses. One can expect the need to switch out the hardware every 4-5 years. Maybe more frequent during the first years.

6. Conclusion & future developments

This report presents the results of a 5 months project in which different expertise, backgrounds and competences have merged together in order to answer the, overall, following questions: *What are the possibilities of using VR in Driving Education in Norway?* Different methodologies have been applied and different answers have been given, and for the details we hereby refer to the text available in chapter 5.

After this valuable work, numerous new questions, doubts and curiosities have risen among the research group regarding this topic and several needs for further research have been individuated.

Firstly, the strong necessity to test on the field the real possibilities of VR and, in general, new immersive technologies in Driving education has been clearly identified as a major line of further development. In fact, in this research report substantial work has been done when it comes to evaluate the feelings, intentions and interests of users related to VR. The results have clearly showed that there is a general positive mood towards VR and simulative technologies, but still few experiences out of the gaming environment are available. Therefore, in order to better gain the advantages (but also to further investigates the cons and properly address them), a real testing research campaign should be developed that might define a tangible step further on in this research field. In this sense, the development of a dedicated research environment (lab), specially focused on such technologies in driving education (but also, on a wider perspective, on Transportation) can be on optimal arena for that. In this sense, the cooperation between the two departments of Nord University that have been involved in this study (Stenkjer and Stjørdal) will be strengthen in order to further build such environment, also thanks to possible external funding from stakeholders and research organizations.

Furthermore, in addition to VR, that has been widely addressed in this report, new AR (Augmented Reality) solutions also represent possible useful tools in Driving education and Transportation in general that deservers further research.

When it comes to eventually implement VR in actual Driving Education in Norway, the experimental results have shown that there is a substantial need from the operators (driving instructors and driving schools in general) to be trained with the equipment and feel confident when using it. This training, on top of generating confidence among the users, might help to overcame the initial worries about the technical aspects and focus more on what it is the most important aspects: the pedagogical impact of VR. Therefore, a pilot project in which several Driving schools are introduced to use VR in their daily operations, with specifically developed scenarios might be a very effective way to further boost the knowledge about VR in this context, but also reduce possible against resistances.

A final, crucial aspect that deserves to be properly analyzed and discussed is the financial aspects of using VR in Driving Education. In this report it has not been possible, due to time and financial limitations, to go deep into this aspects to better estimate the economical impact of VR. Anyhow, it is clearly that the best technology in the world will never be a breakthrough one if it is economically impossible to be implemented. Therefore, further investigations on this aspect are highly valuable and recommended.

Reference list

Journal Articles

Bloom, B. S. (1956). Taxonomy of educational objectives. Vol. 1: Cognitive domain. *New York: McKay*, 20-24.

Chen, C., Toh, S., & Fauzy, W. (2004). The Theoretical Framework for Designing Desktop Virtual Reality-Based Learning Environments. *Journal of Interactive Learning Research, 15*(2), 147.

Combs, A. W. (1981). Humanistic education: too tender for a tough world? *Phi Delta Kappan, 62*, 446.

Dalgarno, B., & Lee, M. J. W. (2010). What are the learning affordances of 3 ‐ D virtual environments? *British Journal of Educational Technology, 41*(1), 10-32. doi:10.1111/j.1467-8535.2009.01038.x

Davis, F. D. (1993). User acceptance of information technology: system characteristics, user perceptions and behavioral impacts. *International Journal of Man-Machine Studies, 38*(3), 475-487. doi:https://doi.org/10.1006/imms.1993.1022

Dillon, A., & Morris, M. G. (1996). User Acceptance of Information Technology: Theories and Models. *Annual Review of Information Science and Technology (ARIST), 31*, 3-32.

Fowler, C. (2015). Virtual reality and learning: Where is the pedagogy? *British Journal of Educational Technology, 46*(2), 412-422. doi:10.1111/bjet.12135

Gilbert, S. B. (2016). Perceived Realism of Virtual Environments Depends on Authenticity. *PRESENCE: Teleoperators and Virtual Environments, 25*(4), 322-324. doi:10.1162/PRES_a_00276

Huang, H.-M., Liaw, S.-S., & Lai, C.-M. (2016). Exploring learner acceptance of the use of virtual reality in medical education: a case study of desktop and projection-based display systems. *Interactive Learning Environments, 24*(1), 3-19. doi:10.1080/10494820.2013.817436

Huang, H.-M., Rauch, U., & Liaw, S.-S. (2010). Investigating learners’ attitudes toward virtual reality learning environments: Based on a constructivist approach. *Computers & Education, 55*(3), 1171-1182. doi:https://doi.org/10.1016/j.compedu.2010.05.014

Kaufmann, H., Schmalstieg, D., & Wagner, M. (2000). Construct3D: A Virtual Reality Application for Mathematics and Geometry Education. *The Official Journal of the IFIP Technical Committee on Education, 5*(4), 263-276. doi:10.1023/A:1012049406877

Lainema, T., & Kriz, W. C. (2009). Perspective Making: Constructivism as a Meaning-Making Structure for Simulation Gaming. *Simulation & Gaming, 40*(1), 48-67. doi:10.1177/1046878107308074

Martín-Gutiérrez, J., Mora, C. E., Añorbe-Díaz, B., & González-Marrero, A. (2017). Virtual Technologies Trends in Education. *Eurasia Journal of Mathematics, Science and Technology Education, 13*(2), 469-486. doi:10.12973/eurasia.2017.00626a

Mayes, J. T., & Fowler, C. J. (1999). Learning technology and usability: a framework for understanding courseware. *Interacting with computers, 11*(5), 485-497.

Norwegian Public Road Administrations. (2018). Curriculum for Driving Licence -Categories B, B Code 96 and BE. (V851E), 55.

Ott, M., & Freina, L. (2015). A literature review on immersive virtual reality in education: state of the art and perspectives. *Conference proceedings of »eLearning and Software for Education« (eLSE)*(1), 133-141.

Wu, W. H., Hsiao, H. C., Wu, P. L., Lin, C. H., & Huang, S. H. (2012). Investigating the learning‐theory foundations of game‐based learning: a meta‐analysis. *Journal of Computer Assisted Learning, 28*(3), 265-279. doi:10.1111/j.1365-2729.2011.00437.x

Books

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behaviour: An introduction to theory and research* (Vol. 27).

Gisbergen, M. S., Kovacs, M., Campos, F., van der Heeft, M., & Vugts, V. (2019). Augmented Reality and Virtual Reality. Progress in IS. In M. t. Dieck & T. Jung (Eds.), *Augmented Reality and Virtual Reality* (pp. 45-59): Springer.

Grippin, P., & Peters, S. (1984). *Learning theory and learning outcomes: The connection*: Univ Pr of Amer.

Hogg, M. A., & Vaughan, G. M. (2011). *Social psychology*. Harlow: Prentice Hall.

Jonassen, D. H. (1999). Designing constructivist learning environment. In C. M. Reigeluth (Ed.), *Instructional-design theories and models: A new paradigm of instructional theory* (pp. 215-239): Routledge.

Kolb, D. A. (1984). *Experiential learning : experience as the source of learning and development*. Englewood Cliffs, N.J: Prentice-Hall.

Lindeman, E. C. (1984). *The meaning of adult education* (Vol. 1): Ravenio Books.

Peräaho, M., Keskinen, E., Hatakka, M., & Universitetet i Åbo, t. (2004). *Førerkompetanse i et hierarkisk perspektiv : konsekvenser for føreropplæringen*.

Vygotskij, L. S., Cole, M., John-Steiner, V., Scribner, S., & Souberman, E. (1978). *Mind in society : the development of higher psychological processes*. Cambridge, Mass: Harvard University Press.

Conference Contributions

Hvass, J. S., Larsen, O., Vendelbo, K. B., Nilsson, N. C., Nordahl, R., & Serafin, S. (2017). *Visual realism and presence in a virtual reality game*. Paper presented at the The True Vision - Capture, Transmission and Display of 3D Video (3DTV-CON), Copenhagen. https://doi.org/10.1109/3DTV.2017.8280421

Reports

Moe, D. (2019). *Læringskonsept basert på MBE (Mind, Brain and Education) og bruk av VR (Virtual Reality)*. Retrieved from

Web Content

Costello, K., & Van der Meulen, R. (2018). Gartner Identifies Five Emerging Technology Trends That Will Blur the Lines Between Human and Machine [Press release]. Retrieved from https://www.gartner.com/en/newsroom/press-releases/2018-08-20-gartner-identifies-five-emerging-technology-trends-that-will-blur-the-lines-between-human-and-machine

Hamilton, I. (2018). Virtual Reality Headset History 2012 To 2018. Retrieved from https://uploadvr.com/vr-headset-history-2012/

Oculus Official Website. (2020). Retrieved from https://www.oculus.com/

OpenXR Official Website. (2020). Retrieved from https://www.khronos.org/openxr/

Pale Blue Official Website. (2020). Retrieved from https://pale.blue/

Panetta, K. (2018). 5 Trends Emerge in the Gartner Hype Cycle for Emerging Technologies, 2018. Retrieved from https://www.gartner.com/smarterwithgartner/5-trends-emerge-in-gartner-hype-cycle-for-emerging-technologies-2018/

Rimol, M., & Goasduff, L. (2019). Gartner Identifies Five Emerging Technology Trends With Transformational Impact [Press release]. Retrieved from https://www.gartner.com/en/newsroom/press-releases/2019-29-08-gartner-identifies-five-emerging-technology-trends-with-transformational-impact

Tsyktor, V. (2019, 27/03/2019). What Is Non-Immersive Virtual Reality? – Definition & Examples. Retrieved from https://cyberpulse.info/what-is-non-immersive-virtual-reality-definition-examples/

Virtual Reality. 2020. In *Merriam-Webster.com.*

Vive Official Website. (2020). Retrieved from https://www.vive.com/eu/

VR Motion Corp Official Website. (2020). Retrieved from https://vrmotioncorp.com/

Way Official Website. (2020). Retrieved from https://way.no/

XR Tech. Conference. (2019). Retrieved from https://www.xrtechconference.com/

7. Attachments

7.1. *Electronic Survey*

7.1.1. Introduction

Use of Virtual Reality (VR) technology in driver training
VR (Virtual Reality) glasses function much like a video shown on a screen, the difference being that the screens that show the film/images are in VR glasses that are positioned very close to the eyes, just like skiing goggles, just a little larger. The film is interactive in some VR glasses, which means that what is shown on the screen in the glasses depends on the user's actions.
The purpose of this survey is to assess whether VR glasses can be adapted and used in driver training. Among other things, we want to assess the maturity of the technology, whether its use can replace parts of the training and/or be used as a supplement to provide better quality. Your thoughts and opinions on the use of VR technology in driver training are very important to us.
Participating in the survey is voluntary, and all information that we gather is kept confidential. Please try to answer all the questions and contact the project manager if you have any questions related to the survey.
Thank you very much for participating!

Project Manager
Giuseppe Marinelli, Associate Professor
Nord University Business School
Email: giuseppe.marinelli@nord.no
Tel +47 748 23 741

I agree to participate in the survey.
- Yes

7.1.2. About you

In this part of the survey, we would like to get some information about you

Age
- 10-18
- 19-25
- 26-35
- 36-50
- 51-65
- more than 65

Gender

- Male
- Female
- Other
- Do not want to respond

Occupation/status

You must select at least one option.

- Driving Instructor
- Driving Instructor student
- Pupil at a driving school
- Other

7.1.3. Your experience of VR

This section is about how often you have used VR glasses and what you have used them for.

Have you tried VR glasses before?

- Yes
- No

How many times have you used VR glasses for a certain purpose?

This element only appears if the 'Yes' option is selected in the question 'Have you tried VR glasses before?'

- Just once
- 2 to 5 times
- 6 to 10 times
- 11 to 20 times
- more than 20 times

In what contexts have you usually used VR glasses?

This element only appears if the 'Yes' option is selected in the question 'Have you tried VR glasses before?'

You must select at least one option.

- In a gaming context
- In an education-training context
- In a health context
- In a work context
- In a research context
- Other

This element only appears if the 'Yes' option is selected in the question 'Have you tried VR glasses before?'

7.1.4. Your opinions on the use of VR glasses

This element only appears if the 'Yes' option is selected in the question 'Have you tried VR glasses before?'

This section is about your opinions on the use of VR glasses for training in general

This element only appears if the 'Yes' option is selected in the question 'Have you tried VR glasses before?'

Imagine that VR glasses are to be used for some form of training.
Consider the statements below by ticking one of the alternatives on a scale of 1 (strongly disagree) to 5 (strongly agree)

	1	2	3	4	5	Don't know
Using VR glasses will make it easier for me to learn something new						
I think the use of VR glasses in education and training will be very useful						
VR glasses are not a good aid that will support my learning						
VR glasses will help to learn things faster						
I don't think VR glasses will provide a realistic picture of the physical environment and the task to be learned						
Visualisation of the learning task using VR glasses will increase learning efficiency						
I don't think VR glasses simulate realistic situations						
I think VR glasses support learning processes for pupils who have language difficulties						
I think the use of VR glasses will motivate people to learn						

This element only appears if the ‘Yes’ option is selected in the question ‘Have you tried VR glasses before?’

Below are statements that centre around how simple and comfortable you think using VR glasses was.
Consider the statements below by ticking one of the alternatives on a scale of 1 (strongly disagree) to 5 (strongly agree)

	1	2	3	4	5	Don't know
I thought it was very easy to use the VR glasses						
Trying to find out how to use the glasses was demanding						
VR glasses make it easier to understand the task I have to solve						
Using the VR glasses made me feel unwell						
I didn’t feel any discomfort when using VR glasses						
I found it quite uncomfortable using VR glasses						
I became nauseous and almost vomited when I used the VR glasses						
Using the VR glasses was impractical because they were too heavy						
VR glasses are expensive to buy						
Learning something new was quite time consuming when using VR glasses						

Consider what you think about using VR glasses in Category B driver training (passenger car) by ticking one of the boxes from 1 to 5
Using VR in driver training is / would be:

1- Useless	2	3	4	5- Useful
1- Bad	2	3	4	5- Good
1- Difficult	2	3	4	5- Simple
1- Boring	2	3	4	5- Fun
1- Expensive	2	3	4	5- Affordable
1- Unimportant	2	3	4	5- Important

7.1.5. Intentions of using VR glasses

This section centres aroundtendency and experience of using VR glasses.

This element only appears if the ‘Yes’ option is selected in the question ‘Have you tried VR glasses before?’

	1 Not at all	2	3 neither agree nor disagree	4	5 very familiar	Don't know
How familiar are you with VR technology and VR glasses?						
I am willing to use VR glasses in the future						
I plan to use VR glasses in the near future						

7.1.6. Use of VR technology in driver training

This section centres around your opinions on the driving instructor’s prerequisites for using digital tools in driver training as an instructor.

This element only appears if the ‘Driving Instructor’ option is selected in the question ‘Occupation/status’

How often do you use any type of digital tool when teaching in a car or classroom?

	Never	Rarely	Sometimes	Often	Very often
PC / Laptop					
Smartphone					
Tablet					
Software like Word, Powerpoint, Excel, etc...					
Projector					
Smart board					
Driving simulator					
VR glasses					
Eye trackers					
Other					

How often do you think digital tools are used in driver training in Norway today?
This element only appears if the 'Driving Instructor' option is selected in the question 'Occupation/status'

- Never
- Rarely
- Sometimes
- Often
- Very often

What skills do you think the driving instructor needs in order to apply VR technology to his/her teaching? (Short description)

How much do you think using VR technology will impact pupils' learning outcomes?
This element only appears if the 'Driving Instructor' option is selected in the question 'Occupation/status'

(1= very little, 5= a lot)

- 1
- 2
- 3
- 4
- 5

In what ways do you think VR technology can impact pupils' learning outcomes? (Short description and explanation)
This element only appears if the 'Driving Instructor' option is selected in the question 'Occupation/status'

If VR glasses are to be used in driver training, in which topics and in which parts of the 'relevant content' in the Basic Traffic Course do you think VR glasses will be best suited in strengthening pupils' learning outcomes and motivation to learn? (Describe and explain in your own words).
This element only appears if the 'Driving Instructor' option is selected in the question 'Occupation/status'

In which of the non-compulsory parts in step 2 of the curriculum Category B do you think VR glasses will be best suited in strengthening pupils' learning outcomes and motivation to learn? (Describe and explain in your own words).

This element only appears if the 'Driving Instructor' option is selected in the question 'Occupation/status'

NB! The question applies to step 2!

In which of the non-compulsory parts in step 3 of the curriculum Category B do you think VR glasses will be best suited in strengthening pupils' learning outcomes and motivation to learn? (Describe and explain in your own words).

This element only appears if the 'Driving Instructor' option is selected in the question 'Occupation/status'

NB! The question applies to step 3!

If you think VR glasses support learning processes for pupils who have language difficulties, could you please explain in what ways?

This element only appears if at least one of the options 'Driving Instructor student' or 'Driving Instructor' is selected in the question 'Occupation/status'

7.2. *VR Game Test Session - Electronic Survey*

7.2.1. Introduction

Use of Virtual Reality (VR) technology in driver training
VR (Virtual Reality) glasses function much like a video shown on a screen, the difference being that the screens that show the film/images are in VR glasses that are positioned very close to the eyes, just like skiing goggles, just a little larger. The film is interactive in some VR glasses, which means that what is shown on the screen in the glasses depends on the user's actions.
The purpose of this survey is to assess whether VR glasses can be adapted and used in driver training. Among other things, we want to assess the maturity of the technology, whether its use can replace parts of the training and/or be used as a supplement to provide better quality. Your thoughts and opinions on the use of VR technology in driver training are very important to us.
Participating in the survey is voluntary, and all information that we gather is kept confidential. Please try to answer all the questions and contact the project manager if you have any questions related to the survey.
Thank you very much for participating!

Project Manager
Giuseppe Marinelli, Associate Professor
Nord University Business School
Email: giuseppe.marinelli@nord.no
Tel +47 748 23 741

I agree to participate in the survey.

- Yes

7.2.2. About you

In this part of the survey, we would like to get some information about you

Age

- 10-18
- 19-25
- 26-35
- 36-50
- 51-65
- more than 65

Gender

- Male
- Female
- Other
- Do not want to respond

Occupation/status

You must select at least one option.

- Driving Instructor
- Driving Instructor student
- Pupil at a driving school
- Other

7.2.3. Your experience of VR

This section is about how often you have used VR glasses and what you have used them for.

Have you tried the VR car game that was shown at the exhibition?

- Yes
- No

How would you describe the experience of playing the car game?

This element only appears if the 'Yes' option is selected in the question 'Have you tried the VR car game that was shown at the exhibition?'

Have you tried VR glasses before?

- Yes
- No

How many times have you used VR glasses for a certain purpose?

This element only appears if the 'Yes' option is selected in the question 'Have you tried VR glasses before?'

- Just once
- 2 to 5 times
- 6 to 10 times
- 11 to 20 times
- more than 20 times

In what contexts have you usually used VR glasses?
This element only appears if the ‘Yes’ option is selected in the question ‘Have you tried VR glasses before?’
You must select at least one option.

- In a gaming context
- In an education-training context
- In a health context
- In a work context
- In a research context
- Other

This element only appears if the ‘Yes’ option is selected in the question ‘Have you tried VR glasses before?’

7.2.4. Your opinions on the use of VR glasses

This element only appears if the ‘Yes’ option is selected in the question ‘Have you tried VR glasses before?’

This section is about your opinions on the use of VR glasses for training in general

This element only appears if the ‘Yes’ option is selected in the question ‘Have you tried VR glasses before?’

Imagine that VR glasses are to be used for some form of training.
Consider the statements below by ticking one of the alternatives on a scale of 1 (strongly disagree) to 5 (strongly agree)

	1	2	3	4	5	Don't know
Using VR glasses will make it easier for me to learn something new						
I think the use of VR glasses in education and training will be very useful						
VR glasses are not a good aid that will support my learning						
VR glasses will help to learn things faster						
I don’t think VR glasses will provide a realistic picture of the physical environment and the task to be learned						
Visualisation of the learning task using VR glasses will increase learning efficiency						
I don’t think VR glasses simulate realistic situations						
I think VR glasses support learning processes for pupils who have language difficulties						
I think the use of VR glasses will motivate people to learn						

This element only appears if the 'Yes' option is selected in the question 'Have you tried VR glasses before?'

Below are statements that centre around how simple and comfortable you think using VR glasses was.
Consider the statements below by ticking one of the alternatives on a scale of 1 (strongly disagree) to 5 (strongly agree)

	1	2	3	4	5	Don't know
I thought it was very easy to use the VR glasses						
Trying to find out how to use the glasses was demanding						
VR glasses make it easier to understand the task I have to solve						
Using the VR glasses made me feel unwell						
I didn't feel any discomfort when using VR glasses						
I found it quite uncomfortable using VR glasses						
I became nauseous and almost vomited when I used the VR glasses						
Using the VR glasses was impractical because they were too heavy						
VR glasses are expensive to buy						
Learning something new was quite time consuming when using VR glasses						

7.2.5. Use of VR technology in driver training

This section centres around your opinions on the driving instructor's prerequisites for using digital tools in driver training as an instructor.

What skills do you think the driving instructor needs in order to apply VR technology to his/her teaching? (Short description)

How much do you think using VR technology will impact pupils' learning outcomes?
This element only appears if the 'Driving Instructor' option is selected in the question 'Occupation/status'

(1= very little, 5= a lot)

- 1
- 2
- 3
- 4
- 5

In what ways do you think VR technology can impact pupils' learning outcomes? (Short description and explanation)

This element only appears if the 'Driving Instructor' option is selected in the question 'Occupation/status'

If VR glasses are to be used in driver training, in which topics and in which parts of the 'relevant content' in the Basic Traffic Course do you think VR glasses will be best suited in strengthening pupils' learning outcomes and motivation to learn? (Describe and explain in your own words).

This element only appears if the 'Driving Instructor' option is selected in the question 'Occupation/status'

If you think VR glasses support learning processes for pupils who have language difficulties, could you please explain in what ways?

This element only appears if at least one of the options 'Driving Instructor student' or 'Driving Instructor' is selected in the question 'Occupation/status'

VR and motivation.

Consider the following statements

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
I think using VR is interesting					
I think using VR seems comfortable					
I think using VR is fun					
I feel happy when I use VR					
Using VR gives me a good feeling					
Visualisation of the learning task using VR glasses will increase learning efficiency					
I think using VR will be motivating					

Do you think the use of VR will work well as a tool to improve the visualisation of traffic situations?

- Yes
- No

In what ways will the use of VR work well as a tool to improve the visualisation of traffic situations?

This element only appears if the ‘Yes’ option was selected in the question ‘Do you think the use of VR will work well as a tool to improve the visualisation of traffic situations?’

Why don’t you think that VR will work well as a tool to improve the visualisation of traffic situations?

This element only appears if the ‘No’ option was selected in the question ‘Do you think the use of VR will work well as a tool to improve the visualisation of traffic situations?’