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Is the education of driver instructors in Norway in line with the technological development?

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The traffic accident rate in Norway has been declining for many years. Improved training, better infrastructure, and targeted control have reduced the number of accidents. This, as well as technological developments that have made cars safer, has led to fewer people dying in road traffic accidents. Nonetheless, road traffic is still considered a high-risk context. A two-year university degree is required to become an authorized Norwegian driving instructor. Thus, the education of driving instructors is of utmost importance for sufficient competence in this industry. However, previous studies have shown that trained driving instructors lack knowledge about new automated technology and have received few opportunities to utilize different technological systems during their education (Wigum and Sætren 2022). The study will explore how Nord University's curriculum is interpreted when it comes to the car's technological equipment. It will further aim to examine how teaching is organized in relation to current curriculums and various legal aspects of using new technology (Helde 2019). Thus, our research question is: *Is the education of driver instructors in Norway in line with the technological development?*
The study looked at current driver instructor education's approach to the use of ADAS (Advanced Driver Assistance Systems) in Norway. Four informants with key roles in education were interviewed. Reflexive thematic analysis was used to examine the data.

Keywords: technology, levels of automation, human factors, driving instructor, traffic training.

1. Introduction

Cars are rapidly being developed with new advanced automated technology, which can be divided into different levels -- from level 0, where the driver performs all operations, to level 5, where the car is fully autonomous, and the person in the car has changed status from driver to passenger (SAE 2021). Research in human factors has revealed that new technological solutions often lead to different human errors and change the risk factors rather than eliminating them (Sætren and Laumann 2015); therefore, it is necessary to consider which new skills and competencies current and future drivers need and how they should be acquired (Sætren et al. 2018).

There are different ways of becoming a driving instructor in Norway, but most are educated through Nord University. Nord University has national responsibility for the education of traffic instructors and offers education for personnel who will carry out driver's license training (Lovdata 2023). The Business School at Nord University has a broad-based transport and traffic professional environment of around 50 academic staff, mainly linked to the Stjørdal and Bodø campuses. The specialist group's core competence is linked to driver training and road transport. Subjects covered include road user behavior, law, road safety, pedagogy, and didactics. The specialist group has an infrastructure consisting of training vehicles, heavier vehicles, motorcycles, driving simulators, and other new technology (Nord 2023). Based on Nord's national responsibility for the education of traffic instructors, along with the rapid development in advanced automated car technology, our research question was: How is technological development a part of driving instructor education?

2. Theoretical framework

2.1. Driver training

Norwegian driver training, regardless of license class, is divided into four levels (Lovdata 2005). The background for this division was McKnight et al. (1970), which divided driver tasks into 45 main groups with 1700 subgroups. This was further developed by J. Michon, who systematized the tasks into three main types: operational, tactical, and strategic competence. These represent the skill areas that car drivers must master (Michon 1985). After various revisions, the current driver education regulations (Lovdata 2005) and curricula (NPRA 2016) were developed based on GDE (Goals for Driver Education) (Peräaho at al. 2003). The GDE matrix is a theoretical model that was presented internationally in connection with a larger European research project, The GADGET project, in 1999. It presents a hierarchical perspective on training. The matrix contains four levels, where the student's self-awareness and participation are important for achieving lasting learning outcomes and thereby reducing the risk of accidents. The matrix contains operational, tactical, and strategic choices like Michon's model (Michon 1985) but has a greater focus on impact analysis and self-insight. The matrix was later given a fifth level, which dealt more with group processes and social interaction (Keskinen et al. 2010).

Fig 1. The five-level driving hierarchy. Keskinen et al. (2010)

Level 1 has one theoretical and two practical parts. The theoretical part deals with the role of humans in traffic. Students at this stage should be able to discuss the extent to which personality can influence behavior and how the social context can change behavior. The two practical parts deal with driving in the dark and first aid. The practical implementation of driving in the dark can include new technology if the teacher chooses a learning outcome that involves adaptive lights. Level 2 deals with the driver and the vehicle. The learner driver must know how to maneuver and operationalize the vehicle. He must also familiarize himself with the car's technological equipment. Level 3 deals with the driver, the vehicle, and a dynamic traffic environment. Here, the driver must assess whether technology can be used in the situations he faces. Level 3 also has a track portion, which takes place in a closed area. Here, the student driver will get to experience different systems that can help in a crisis. ABS and ESP can intervene in difficult driving conditions.

Level 4 is a compilation of all the practical and theoretical knowledge and skills that the student driver has acquired to this point. He must decide for himself whether technology should be used in his driving. The driving takes place in different traffic environments, focusing on high-speed roads and environmental changes.

2.2. Technology in the Norwegian driver training Class B

New technology has changed some of the training that is given today. The operational level may be taken over by technology. Adaptive lights, clutch and gear change, adaptive cruise control, and directional stability in the form of automatic lane keeping are standard in modern cars and have led to a greater focus on technology. The matrix from the Society of Automotive Engineers (SAE 2021), focuses on what level of automation a car is equipped with. Adaptive cruise control or automatic lane keeping alone defines a car as Level 1 (SAE 2021). If systems are combined, e.g. the car includes both adaptive cruise control and automatic lane keeping, it is defined as Level 2 (SAE 2021). Both longitude and latitude directions are autonomous. Level 3 will only be reached when the car takes over the tactical choices for the driver. Examples might include the car making choices that lead to driving past the vehicle in front or changing lanes. The job of the driver is changed from vehicle handling and maneuvring (Keskinen et al. 2010) to monitoring the car's choices (Sætren et al. 2018). The tasks that the driver must control are thus different but can also be more challenging (Banks and Stanton 2017).

2.3. Nord University driving instructor education

Driving instructor education at Nord University is divided into four semesters. Students focus on specialized subjects in law, psychology, physics, car technology, pedagogy, and mobility in society. The practical education and training in Nord traffic school follows the Class B curriculum (NPRA 2016). The emphasis is on didactic and methodological tools.

2.4. Human automated technology interaction

Increasingly more automation features are being added to Human-Machine Interfaces (HMIs) in modern automobiles to assist with safe and efficient driving. HMIs vary across automobile manufacturers, which makes it challenging to provide standardized training for drivers; this is a long-term goal. However, even in the short term and with the current status of human-automation interaction, there is not enough support for drivers' understanding of automation systems (Muslim and Itoh 2021). This results in mistrust in automation and leads to either overreliance on or underuse of automation assistive features (Muir 1994; Itoh and Tanaka 2000). Adequate training and education about interactive systems is necessary for developing accurate mental models of the system, resulting in safer and more efficient driving (Muslim and Itoh 2021) and reduced mismatch between human and machine strategy (Hilburn 2016).

An important part of using automation is tthe activation of different levels of automation. This is done by either the human or the automation technology; the common denominator is the importance that the driver understands it and uses it safely. Furthermore, drivers can vary in their preferences towards levels of automation and in their need for them. A comprehensive training plan could help drivers adapt to automation systems and levels in ways that suit their needs and manage them accordingly (Thropp et al. 2018). According to Forster et al. (2019), such training and education programs could take the form of user's manuals or interactive tutorials, but it is also very important to have effective HMI design that requires minimal training.

2.5. Legal aspects

Training is carried out in stages, where goal achievement at one stage is a prerequisite for being able to benefit from the training at the next stage. The step-by-step training course appears in the traffic training regulations (Lovdata § 7-1). In Norway, all motor vehicle traffic, as well as other road traffic, is regulated by the Road Traffic Act. The law does not explicitly prohibit vehicles without drivers, but there is little doubt that it is assumed that a motor vehicle has a driver in the driver's seat. This is made apparent by the fact that some of the law's provisions make explicit demands on the driver's competence and behavior. According to § 6 (Lovdata 2017), the driver must adjust his speed according to traffic conditions and always "have full control over the vehicle."

Today, vehicles used for driving tests can have driver assistance systems. The candidate can use these as long as the systems and their use do not hinder the assessment of basic technical driving skills. The examiner must make a certain judgment of what is permitted and the candidate's skill in using the systems. An example of a system candidates may not use is a parking assistant that assesses the opening and performs some or all of the parking operation for the driver (Helde 2019, p. 278).

3. Methodology

For this study, a qualitative design was chosen, with semi-structured individual interviews. This study is part of a larger project exploring pedagogy and teaching of ADAS use for student drivers and driving instructors, called TEKTRA.

3.1. The researchers

The researchers vary in background and competence. Their skills span from basic driver training and teaching driving instructor students to experience in human-automated technology interaction. Further, they hold experience in pedagogy and teaching at the university level, as well as being highly knowledgeable about road traffic law.

3.2. The participants

For this study, university lecturers working as praxis teachers were interviewed. They all work in Nord University Business School's Road Traffic Department, performing daily teaching of driver instructor students. As a part of their everyday work tasks, they supervise practice for a group of students. The students practice teaching driving to student drivers. The sample included two females and one male.

3.3. The interviews

In all, three individual semi-structured interviews (Kvale 1996) were conducted in March 2023. Two of the interviews were conducted digitally, and one was done face-to-face. They each lasted about 45 minutes and were recorded and transcribed. Two or three researchers were present in each interview.

3.4. The interview guide

Prior to the interviews, a semistructured interview guide was made. The first set of questions focused on the background of the informants and their everyday work tasks. After this, there was a section on their general thoughts on the driving instructor education and driver training system in Norway, as well as their personal interest in advanced driver supported technology. Finally, they were asked questions concerning their thoughts on how advanced driver support technology and touchscreens are dealt with in the curriculum and in practice.

3.5. Validity

Validity is important for quality in qualitative research. Different approaches to validity in qualitative research exist (e.g., Kvale 1996; Yardley 2000). We chose the basics of Yardley (2000), which consist of the following characteristics: (1) sensitivity to context, (2) commitment and rigor, (3) transparency and coherence, and (4) impact and importance.

3.6. Analysis

We used thematic analysis (Braun and Clarke 2006), as this method provides a flexible analytical approach that is inductive and theory neutral.

4. Results

Table 1 Is the education of driving instructors in Norway in line with technological development?

Factors related to driving instructors and technical development	Illustrative explanation
1 Technology as a subject	Technology as a topic is taught to varying degrees. The teachers' own interest in the topic determines the result.
2 Unclear responsibilities	Teaching staff in the practical field believe that there are unclear responsibilities when it comes to what should be taught.
3 Technology availability	The practical teaching relies on a standardized set of vehicles with too little variation in technology.
4 Time availability	Time is a limited factor for both the driving instruction student and the student drive

4.1. Technology as a subject

Teachers feel that technology is an important element in today's driving education. Whether they prioritize the topic often depends on their own interest in technology. Self-study in the form of searching for documents or various social media forms the basis for the teachers' competence today. All participants in our study agreed with the statement, *"I would like a course and update on the topic."* Teachers feel that their teaching is not up to par with technological development. One of our informants said, *"The field of practice at Nord University mirrors the curriculum we work according to. The curricula mention technology in several places, but we have to try and test, both us teachers and the students."* Teachers want greater use of external forces and simulators in training related to new technology.

4.2. Unclear responsibilities

Teachers do not quite know who is responsible for guidelines regarding new technology. Is it the university's top management or is it the study program manager and subject manager who must request further development of the curriculum? They feel that their students demand a greater focus on technology. One of our informants said, *"The students want to know more. There are different things they want to know more about; it is based on their own assumptions as well. You know that you yourself fall short of your own students."* Teachers want clearer guidelines and would like the topic to be discussed in the study program portfolio. At the same time, they feel that the faculty management -- both the top management and the study program manager -- are supportive when it comes to new technology. One of the informants said when asked how the management reacts to new ideas, *"Yes, I feel they are very supportive of this. They encourage me to make suggestions."*

When asked how confident the teachers were about legal regulations on self-driving technology, one informant replied, *"Not at all. I don't know anything about this. I know i am the driver of the vehicle and have the responsibility anyway, but beyond that, I have little legal understanding of its use apart from my own responsibility. As I understand it, it is legal, but I am unsure."*

Another said, *"I feel that the law is a bit vague here. In my opinion, don't we have a set of regulations that can say something about the legal responsibility should something happen?"*

4.3. Technology availibility

All the teachers requested better access to new car technology. Nord University has 23 cars available to the driving education students and their student drivers. The following fleet of cars are available for student practice:

Available cars at Nord University		
Model	Number	Year
Peugeot 5008	6	2016
Peugeot 5008	5	2018
Peugeot 5008	4	2019
Peugeot 5008	4	2020
Ford Focus	2	2019
Ford Focus	2	2020

No cars are older than 2016, and no cars are newer than 2020. All cars are fossil fueled and have manual gearboxes. There are currently no electric or hydrogen-powered cars. Nord University has an operational traffic laboratory with various car simulators and eye-tracker and VR technology. One informant says, *"Of course we should have had newer cars, but I also believe that the simulator is a tool we can use to a much greater extent."* Employees are increasingly demanding a greater focus on technology in their everyday work, where available technology is made somewhat inaccessible to individuals.

4.4. Time availability

When surveyed about the time that the individual practice teacher has available to delve into various topics, one informant answered, *"We have the 3 days that go into practice. And then we have one day, which at least goes to administration of practice and preparation for practice, and then I have one day left, and as I am involved in other subjects, there may not be much time left."* Many teachers felt that the time spent with students took up much of the normalized working time. Several participants expressed a need for more time for deepening self-development when it came to new technology.

5. Discussion

5.1. *Technology as a subject*

Traffic studies education at Nord University is based on various governing documents. The Traffic Education Regulations (Lovdata 2023) and Class B and B96 curricula (NPRA 2016) govern what is covered in the practical teaching. These guidelines, together with methodological and pedagogical documents that Nord University has prepared, form the basis for the four semesters of the program (Nord University 2023). Nord University has prepared its own teaching plan based on compulsory and non-compulsory training that students must follow. The teaching plan is a dynamic document that changes based on internal processes and changes in regulations and curricula. New technology is mentioned in several places in the curriculum for passenger cars (NPRA 2016) but is mentioned to a lesser extent in the University's own teaching plan (Nord University 2023). The topic of new technology is dealt with in theoretical teaching in subjects such as physics and automotive technology and in practical teaching, e.g., in courses about training courses. Our informants lack a comprehensive teaching plan for how and where in the curriculum the car fleet's technology can be used. They lack guidelines for technology at SAE Levels 1 and 2 (SAE 2021).

5.2. Unclear responsibilities

The informants felt that they received support from management when they requested a greater focus on knowledge of new technology. On the other hand, they were uncertain about who was responsible for implementing the necessary measures. They expressed a need for further development from planning to practical knowledge. They were aware that the curriculum (NPRA 2016) dealt with this topic in several places, and they felt somewhat reactive in relation to being in line with developments. They felt it was difficult to be proactive regarding technology, due to its rapid development. The informants were also unsure about the legal aspect. To what extent can they test technological systems? Where does the legal responsibility lie (Lovdata 2017) when it comes to testing SAE Level 2 (SAE 2021) systems (Helde 2019)? Is it possible to practice and teach "hands off" technology where the car's latitude (e.g., lane keeping assist) and longitude systems (e.g., adaptive cruise control) are controlled?

5.3. Technology availability

The cars at Nord University are between three and seven years old. A seven-year-old car is deficient when it comes to the latest technological systems. The cars have driver support systems in relation to various adaptive systems at Level 1 and 2 in the SAE matrix (SAE 2021) but lack some systems that newer cars have. Some of the cars have touch screens, but these screens make small adjustments. Certain modern cars today have large touchscreens which, instead of being perceived as driver support systems, can be perceived as distractions (Sætren et al. 2018). Training is necessary for new driving instructors but also for their learner drivers, who should experience the latest available technology. New drivers require training in systems that they may encounter with their private cars. However, the current training at Nord does not feel completely in line with available technology (Wigum and Sætren 2021). The curriculum is vague when it comes to which technology should be taught at which level (NPRA 2016), but at the same time does provide some guidance for training if one interprets the traffic education regulations (Lovdata 2023) and the curriculum body (NPRA 2016). Newer technology is in demand for the car fleet. Our informants want a larger feature vehicle with an automatic transmission, electric cars, and cars that can contribute to a greater understanding of available technology. They also wish to make greater use of the traffic lab. Here one sees a large opportunity for developing one's own practice (Nord University 2023).

5.4. Time availability

Students apply based on general academic competence as well as accumulated points through traffic-related practice (Nord University 2023). The students must have good driving skills, but the basis is very different, as the students' ages range from 23 years and up. The practical supervisor's task in the first semester consists of further quality assurance of each student. Close collaboration with the student is required to achieve the necessary competence.

Nord University runs its own traffic school. 100 first-year students and 100 second-year students are selected as student drivers (Nord University 2023). The students have quantified requirements for completed teaching. The minimum requirements are 40 hours of practice in the second semester and 40 hours of practice in the third and fourth semesters. Each practice supervisor has 4-6 students, and the quantified requirement must then be multiplied by the number of students. The supervisor does not have the resources to participate in all the students' practical lessons and thus must prioritize based on the students' progress. Driving lessons that are mandatory in relation to the traffic education regulations (NPRA 2023) must be done with a supervisor. This is due to public registration systems for completed compulsory training (NPRA 2023). Most practice teachers have work related to promotion applications (Lovdata 2006). Practice teachers feel that the time spent on the students goes beyond their own development, both in terms of their own careers and their own professional development, e.g., time spent learning new knowledge about technology. In addition to practice, supervisors are responsible for written work requirements and for being available to serve as substitutes when colleagues fall ill.

When it comes to human-technology interaction training programs, one must inevitably consider the context and the stakeholder. Consistent with the (hu)Man-Technology-Organization (MTO) model, needs, priorities, and strategies must be aligned in a systemic manner. For educational purposes, this means that people (M) with various inclinations towards technology must be able to safely interact with it. For the technology aspect (T), this means that we need to tackle the challenges of rapid development and massively diverse HMI designs across car manufacturers, by focusing on the main features that have empirically shown to enhance safe driving. A training course can focus on giving theoretical and practical space to learn about those main features and to develop a good mental model based on knowledge and trial and error (Forster et al. 2019; Muslim and Itoh, 2021). Another key challenge for education programs is that HMIs are being used by drivers with different driving skill levels. Most HMIs are designed for more experienced drivers. This means that training programs must be flexible to accomodate individual differences. This requires time, resources, and a trustworthy training program. The school alone cannot meet all these needs. Partnership with regulatory bodies and with car suppliers --either the designers or the technical support departments -- is needed (O).

5. Conclusion

Our research shows that the education of traffic teachers poses challenges. The topic of technological development in driver education is starting to be addressed to a greater extent but still depends on individual measures. There is a lack of a clear future strategy, both in terms of employees and tools. Subject group leaders, study program managers, and subject managers see a need for change. The practice teachers require new knowledge and skills to improve the quality of their teaching. They recognize that their own knowledge and skills will affect the quality of education their students give to student drivers. The practice teachers feel responsible for providing the best possible education. As Nord University is the largest supplier of teachers to the traffic teaching industry, they want to appear with good academic weight, which in turn gives a stamp of quality. A future strategy must contain concrete plans for how to update knowledge, acquire available technology, and prioritize measures in terms of time.

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