

E-learning and driver training –a stepchild in transportation research

Thomas Troglauer^a

^aDanish Transport Research Institute, Knuth-Winterfeldts Alle, 116 West, DK-2800 Lyngby, Denmark, tt@dtf.dk

Abstract

This paper explores the current and potential utilisation of e-learning applications as training and learning tools within the spheres of driver training. Compared to existing theoretical driver training, which traditionally are based on text books and classroom teachings, e-learning offer new possibilities such as a higher level of interactivity, individual control of learning pace, design and instructional methods.

Based on an internal survey conducted within the HUMANIST network and the European project TRAINER, it was found that the majority of applications in use operate on existing driver training curriculum. Within the domain of the GDE-matrix most applications are aimed at control or manoeuvring tasks though a few applications also attempt to address higher order skills such as hazard perception and situation awareness.

In general only little research have been done on the effect of e-learning compared to traditional learning methods both with respect to understanding of training curriculum and actual driving performance. It is suggested that future research should concentrate on specification of training needs of different target groups (e.g. elderly drivers, novice drivers, disabled drivers), exploration of suitable didactical content and learning processes in the utilisation of e-learning applications and the assessment of the transfer processes of skills acquired through e-learning into real world driving. Finally it is proposed that the utilisation of e-learning should be adapted to existing practises of driver training rules within different European countries.

1. INTRODUCTION

E-learning or multimedia¹ learning can be defined as the combination of text, graphics, animations, pictures, video or sound to present information (Najjar, 1995). Since these media can readily be integrated by means of computers, e-learning is becoming a more and more widespread tool for training and education within many spheres of society. It has been stated that the future of e-learning is not whether it should be deployed or not but rather how, when and to what end (Littig, 2003 from Littig et al, 2003).

Within driver training similar tendencies have been found and it has been proposed that the traditional schemes and content of drivers training is likely to change with the

¹ In this paper e-learning and multimedia will be used inter-changeably. Though it could be stipulated that e-learning denotes the use of electronic means whereas multimedia denotes the use of several media. For instance this would mean that e-learning occurs when a book text is presented through a computer screen (the text is simply presented in a different media. However in order to qualify as multimedia the text would have to be supplemented by other media (e.g. graphics or videos etc.).

implementation of e-learning applications and driving simulators within the forthcoming years. It should be noted however that the change does not solely come from e-learning in itself but also because e-learning applications have the potentials to overcome some of the weaknesses and flaws inherited within the present state of driver training. Thus, in order to fully comprehend the implications and potentials of e-learning applications in driver training it is necessary to understand the context in which is applied.

Firstly, e-learning applications are not being implemented in a vacuum but in long existing driver training schemes which concurrently undergo revisions. Traditionally, driver training have been divided into theoretical learning or curriculum based training (the abstract understanding of the vehicle, the traffic systems and the rules which applies) and the practical application of these into real world driving (vehicle control, navigation and interaction with the traffic environment). Secondly, most countries have driver licensing systems, which have operated for a vast number of years, where e-learning applications presently are being used as supplements or replacements. Thirdly, existing driver training schemes have received a substantial amount of criticism for not sufficiently encompassing all aspects required to master the driving task to a full extent. It has been proposed that the both the content and didactical approaches to driver training needs to be reconsidered (Hattaka, et al., 1999).

In this respect implementation of e-learning applications should be analysed at two levels; a content related level and didactical/pedagogical level. At the first level e-learning could be used to replace, supplement or even introduce new levels of content of the driver training. The second level however, also considers how e-learning can most appropriate facilitate and enhance the learning process for the learning driver both within existing schemes and the proposed changes.

1.2 Purpose

This paper explores the potentials of e-learning as tools for driver training on the premises of the above mentioned considerations. The paper attempts to draw conclusions from theoretical suggestions and empirical findings from both general theories of driver training/learning processes and from studies, which have specifically examined the applications of these aspects within the domain of driver training. Finally, the paper attempts to relate some of the issues raised to the fact that countries within the European Union apply different driver licensing schemes, which could call for different actions within the spheres of e-learning.

The theoretical considerations are based on the European projects TRAINER and GADGET, whereas the empirical findings are based on internal surveys conducted within HUMANIST and from the TRAINER project.

2. THE TRAINING PROCESS AND DRIVER TRAINING SCHEMES

The European project GADGET addressed issues relevant for driver training and in particular training of novice drivers. From this project the GDE-framework (Goals for Driver Education) was developed as an analytical tool to address the areas of competences driver training and education ideally should attend to (Hattaka et al, 1999). A premise is that driver behaviour is organised into four different hierarchical vertical levels (the highest levels rank first):

- *Goals for life* (personal motives and beliefs): this level is based the assumption that lifestyle, social background, gender, age, income etc., has an influence on driving behaviour and attitudes towards driving
- *Goals and context of driving*: This level focuses on the context in which driving is performed particularly on choice and planning of trip, travel-mode, time of day, road situations or driving under influence of driving deteriorating conditions or substances.
- *Mastering of traffic situations*: The conditions applied to level refers to the mastering of adaptation to specific (though continual changing) traffic situations, such as overtaking, speed choice, perception of hazards.
- *Vehicle manoeuvring*. The lowest level refers to vehicle control such as shifting gears or steering manoeuvres. On this level is also included evasive manoeuvres, control in different weather conditions and use of passive safety measures such as seatbelts and airbags.

In addition it was proposed that a competent driver is also aware of risks as well as own abilities and preconditions in the driving task. Thus on a horizontal level for each of the four vertical levels the GDE-framework proposed that driver training curriculum should address safety relevant issues according to three different levels of risk-awareness:

- *Knowledge and skills*: this level refers to the skills a driver needs for driving under different circumstances.
- *Risk-increasing factors*: this level deals with aspects of driving or traffic that can increase the risk, such as worn out tyres, perception of the traffic situation, speed adjustment, risk acceptance.
- *Self-evaluation*: this level emphasises how the driver is capable of assessing his/her performance on the four levels. It really points to critical self-adjustments of everything from skills in vehicle handling to reflection of individual risk attitudes.

(For a more elaborate description, please consult Hattaka et al., 1999).

Ideally, the driving curriculum should cover all areas in the framework and address the appropriate driving behaviour associated. However, it was concluded that existing driver training typically only addresses the first two levels, vehicle manoeuvring and mastery of traffic situations, whereas the other two areas typically is not included or simply omitted from the driver training. Similarly, on the horizontal level usually only knowledge and skills and to a lesser extent risk-increasing factors are included in the driver training schemes (Hattaka et al, 1999).

The GADGET and TRAINER projects concluded that existing driver training schemes to a large extent are insufficient and do not provide the learning driver with sufficient strategies for safe driving in particularly in the area of the higher order skills. Similarly, it was found that the traditional training methods of theoretical training of knowledge and skills have been learned in a declarative manner and to a large extent is geared towards obtaining the driver license as quickly as possible, while ignoring much of the safety relevant knowledge and behaviour (Hoeschen & Bekiaris, 2001). Typically the learning approach to learning a content was through reading a book (and in some countries additionally receiving class room teaching of the content) and then being

tested in issues of the content of the curriculum. However, it was proposed that several alternatives to these approaches exist which have shown higher prospects both facilitating the learning process and the transfer of this knowledge into subsequent real world driving. These approaches include a higher degree of active involvement of the trainees and more extensive feed-back mechanisms. A major task in the implementation process of e-learning will have to go through content related as well as didactical and pedagogical considerations.

3. E-LEARNING APPLICATIONS FOR DRIVER TRAINING

Within the domain of driver training e-learning denotes all kinds of techniques using electronic means or multimedia to enhance traffic safety through improvement of drivers' skills and knowledge. As such e-learning techniques can employ strategies, which range from theoretical knowledge of traffic rules and regulation to training of certain skills or techniques or improvements in awareness of special subjects. Similarly, it has been stated that new communication technologies can be applied to the field of driver training to enhance and improve the effectiveness of training and education and offer cost-effective alternatives to existing driver training schemes.

In essence e-learning has the potential to move the learning process from the classroom or traditional written curricula into the learners' world, providing access to learning anytime or anywhere without geographical or time barriers. In addition it is technically possible, e.g. through the internet, to provide immediate access to learning materials and interaction with experts or/and fellow learners. Finally, the advancement of computers' capacities makes it possible to illustrate real life driving situations and animated scenarios thus making the experience quite realistic.

It has been suggested that e-learning compared to traditional class room teaching or instructions from text-books, offers learning advantages on several levels of the learning process (Najjar, 1995):

- **Instructional methods:** Multimedia instruction may force the instructional designer to organise and structure the learning material at least compared to traditional class room teachings. This is particularly the case when using complex and large amounts of learning material and when a large degree of freedom in information gathering is possible for the learner.
- **Interactivity:** Can be thought of as mutual action between the learner, the learning system and the learning material. Compared to traditional learning forms multimedia offers a high degree of interactivity due to the integration of written and illustrated contents. There is a tendency for e-learning material to be more interactive than traditional textbooks and classroom teachings.
- **Control of learning pace:** Multimedia to a large extent allows the learner to set the pace of learning thus offering the possibility of adjustment of content to individual needs and preferences.
- **Novelty:** Information presented through various sources (audio-visual and illustrative examples) may be more stimulating than material presented through traditional means. It has been suggested that initial positive findings from multimedia learning compared to traditional classroom learning stems from the fact that multimedia was a novel experience.

Though the above mentioned aspects of learning processes advocate strongly for the use of multimedia as learning tools in general and within driver training in particularly, it

has to be emphasised that these are aspects of the learning process, which can be better utilised and integrated in multimedia environment than in traditional learning environments. Thus it is not stated that these aspects (e.g. interactivity) are not possible to integrate in traditional classroom training. Similarly, it does not imply that multimedia per se has a superior effect over traditional teaching methods. As such it has not been consistently proved that use of several media in instructions (redundant information) is superior to one media instruction (monomedia information) though research evaluations of multimedia instructions suggest that if utilised efficiently and appropriately certain advantages will persist. Thus, it can be stipulated that it is doubtful whether use of traditional instructions methods or content in a multimedia setting has any superior effect in itself. Simply transferring text book material into a multimedia program is unlikely to have any persistent effect and does not utilise the potentials inherited within the multimedia. Thus, in essence it might be stated that the use of multimedia in driver training should include a thorough understanding of the subject of driver and training in relation to the task of driving.

3.1 E-learning applications in the driver training process

A substantial part of the TRAINER-project was devoted to the exploration of the potentials of different applications in driver training. One of the main conclusions regarding e-learning in the training process was that e-learning should primarily be regarded as a theoretical prerequisite for the applications of driving skills and knowledge in real driving. Thus, multimedia applications are not supposed to replace the existing practical driving training. In contrast to driving simulation and real world driving multimedia scenarios are not able to recreate the same level of dynamic interaction between the driver and traffic environment. It is best regarded as a supplement in the process of the application of safe strategies in the driving task as well as to create a theoretical understanding of certain manoeuvres and risk increasing/decreasing actions (Pirenne et al, 2002). In particular multimedia was recommended as suitable for awareness of risk increasing factors at the manoeuvring level and to a lesser extent at the strategic level e.g. reacting to other road users, lane changing and effects of alcohol. (For a more comprehensive list of scenarios please refer to Hoeschen & Bekiaris, 2001, table 45). Concerning higher order skills, the sequencing for the adaptation is important and it was stated that these should be implemented after the acquisition of skills on the skill-and- knowledge based levels. This in essence underlines that higher order skills are primarily integrated through experience and not stem solely from the education or training. Following this approach e-learning applications, should be considered a supplement to the practical driver training following the path of theoretical understanding of higher order skills into corresponding multimedia-based training sessions finally followed by practical driving lessons where the acquired skills can be put into practice (Pirenne et al., 2002). For multimedia tools to be useful and effective in driver training TRAINER proposed that a good and simple user interface was required, as well as use of realistic audio and images. The latter was particularly relevant for groups of drivers who could not be expected to be familiar with the use of multimedia e.g. elderly drivers. With regards to the didactical approach of the driver training process it seems that e-learning in particular holds advantages compared to traditional driver training materials with regards to the combination of interactivity, level of individual feedback and self-paced learning if utilised properly. Practically anything can be illustrated from

simple illustrations to dynamic scenarios e.g. through the combined use of text, audio or video sequences. In essence this should provide ample possibilities for learning aspects or principles of driving at the proposed levels of the GDE-matrix. Similarly, within the domain of abstract learning of concepts, rules or traffic situations, multimedia hold promises for extensive feed-back mechanisms. E.g. in traditional choice test it is of course possible to only give correct/wrong scores but due to its interactive possibilities it will also be possible to illustrate or animate outcomes of choices or answers in e-learning applications.

Measuring of performance in e-learning can take different approaches. When using computers or multimedia in assessment of performance it is only possible to register the interaction between the learner and media of registration. As such thorough understanding of the learner's comprehension of the instructional content is still only possible to register according to the limitations or possibilities in the multimedia thus it was recommended that e-learning applications in general should only be used under the supervision of professional driving instructor.

3.2 E-learning and driver training- experiences from e-learning applications

From the above mentioned considerations an interesting question arises as to how e-learning applications are utilised in driver training? To answer this question an internal survey was conducted within the HUMANIST network (Troglauer, 2005). Only five institutions within HUMANIST had been involved in either development or use of e-learning applications. As this can hardly be said to reflect the amount of number of e-learning applications it was decided to include an analysis of e-learning applications conducted in the project TRAINER (Hoesechen & Bekiaris, 2001).

It should be noted that these surveys do not cover the all e-learning applications available for driver training. As e-learning applications can be considered a cost effective training tool to use as driver training tool, it is highly likely that a substantial amount of applications already exists on topics related to driver training or safety related issues e.g. defensive driving, hazard perception or driving fuel efficiently. It is relative inexpensive to construct DVD/cd-roms or interactive training programs on specific training issues and distribute them either as part of a training scheme or through the Internet. However it is beyond the scope of this paper to investigate to what extent these applications exist.

The majority of e-learning applications in both the TRAINER and HUMANIST surveys were targeting novice drivers and to a lesser extent professional drivers. Most of the applications in the HUMANIST-survey were developed and used as supplements to existing training courses. For the majority of applications the purpose was to give the driver additional possibilities of learning existing curriculum and were based on existing training programmes (though not interactive programs). The applications had an emphasis on training the learning driver in traffic rules and regulations. A few of the applications stated to include a test section, which were based on the existing curriculum and developed as supplement e.g. through focus on traffic situations at intersections. In relation to the GDE-framework the applications were operating on the control and manoeuvring level though one of the applications for the professional drivers was targeted toward hazard detection strategy.

From the TRAINER survey it was found that only five out of sixteen multimedia tools provided content on both the control, manoeuvring and strategic level of driving, whereas the rest covered various aspects of the three levels but not comprehensively. In

general however it was found that these three levels were covered unevenly with an emphasis on the manoeuvring level: Particularly circumstances (e.g. night driving, having an accident, driving in narrow streets), non-moving traffic (parking, towing), observing traffic (when starting, stopping overtaking), keeping safe distances, driving at appropriate speeds. In contrast risks related to specific driver groups, human characteristics or personal conditions were only sparsely covered, reflecting that most of the applications primarily covered the manoeuvring level whereas the strategic level was only explored to a lesser degree.

From the TRAINER survey it was found that most multimedia applications measured performance from the trainee in relation to giving the right answer or showing the right choice on different scenarios. It was found that aspects covering hazard detection was often used but not sufficiently related to the tasks the trainee had to carry out, thus leaving the trainee in a rather passive role. Similarly, it was found that even fewer scenarios actually illustrated the consequences of a given action the trainee had chosen. This was emphasised as a potential way of strengthening the applications as this could be an improvement towards risk awareness and hazard detection (Hoeschen et al., 2001).

In the TRAINER-project a multimedia training tool was developed on the premises of the TRAINER concept. In this training tool scenarios were grouped into blocks dealing with specific themes. The performance was typically measured as multiple choice scenarios with a corresponding right or wrong answer. The scenarios were weighted according to importance in relation to the driving task in order to obtain a mean weight for each scenario. This gave the opportunity to integrate or supplement the multimedia theme with corresponding theoretical lessons. Feed-back was given immediately after each block or scenario with a possibility to repeat immediately.

4. EVALUATION AND VALIDATION OF EXISTING SCHEMES AND E-LEARNING APPLICATIONS

In general little scientific validated knowledge exists on the retention or transfer effects of e-learning applications examined in the HUMANIST and TRAINER survey. A few of the applications conduct evaluations by the users which are then incorporated into the application. This lack of evaluation makes it difficult to establish whether these applications provide a useful base as learning tools for driver training either isolated or in combination with traditional training methods.

Though it might be suggested that evaluation of e-learning should be further explored it should also be emphasised that limited knowledge exists on effect of traditional driving schemes. On a negative note it has been stated that driver training has no effect as long as it is purely aimed at obtaining a drivers license as fast as possible. Similarly it has been stated that the effect of traditional instruction (both theoretical and real driving) are limited as long as the content is purely directed at the control and manoeuvring level. On a more positive note it seems that an improved retention rate might be obtained through improvement of didactical approaches e.g. a higher degree of involvement of the trainees as well as extensive feed-back mechanisms. It does however remain unresolved whether these learning effects are better learned through e-learning or more traditional approaches.

4.1 Implementation of e-learning in existing driver training schemes

When evaluating the implementation of e-learning it is also of relevance to consider

what driver training schemes are supposed to be replaced or supplemented by e-learning applications. Firstly, it needs consideration that presently large differences exist between European countries to the extent that they require supervision of professional driving instructors in the training process. On a general level the training process of novice driver revolves around six different training models in Europe. The countries which applies the models are mentioned in brackets (Groot et al., 1999).:

1. Compulsory theory and practical training at a driving school (A, BUL, CRO, DK, EST, SF, D, HUN, LAT, L, N, P, CH)
2. Theory and practical training at driving schools but not compulsory (UK, M, NL, RUS, E, S)
3. Theory and practical training must begin at a driving school, followed by a non-professional supervisor (A, ISR, L, N, CH)
4. Theory and practical training must begin at a driving school, followed by training with a non-professional supervisor; obligation to report regularly to a driving school (A, EST, F)
5. Training with a non-professional supervisor, without the involvement of a driving school (B, SF, UK, LAT, RUS, E, S)
6. Training at a driving school or with a non-professional supervisor, followed by a non-accompanied internship (B)

As can be seen the learning models imply different approaches to the responsibilities of theoretical and practical learning. Though several countries offer several models for the learning driver it is obvious that to large extent it is possible for students to acquire their initial driving skills (in particularly the theoretical aspects) without the instruction or supervision of a professional driving teacher.

To complicate matters even more differences also exist between countries which require involvement of driving instructors in the training process. Though the supervision of a professional driver instructor should guarantee a minimum of qualified instructions several countries do not require a professional diploma for the theory teacher, whereas all countries require a diploma of professional qualification for the practical driving instructor (Groot et al., 1999). Thus besides the obvious influence of the didactical quality of the e-learning applications on the learning process, it is also likely that the effect of e-learning applications might differ substantially between countries according to the present standard of theoretical driver training. This aspects need discussion when considering adjustments between countries in order to obtain a common standard of the training process as it is likely to have influence on the extent of adjustments required.

5. RESEARCH NEEDS

E-learning applications can be considered as a cost effective training tool to use, both for development and running, for any purpose such as increase specific knowledge, raise awareness or simply illustrate certain traffic situations thus making it an attractive product for commercial developers of driver training. It is often proposed that certain areas of driver training are better learned through use of e-learning applications or that the format of e-learning is sufficient for certain skills or knowledge.

However, most of these questions still remain open and unanswered and to a large extend the potential learning benefit from e-learning has not been conducted scientifically, especially in comparison to traditional theoretical driver training.

As a general notion it can be stated the process of identifying training areas where e-

learning applications could possibly contribute to driver training, have been provided in particular through the TRAINER-project and the GDE-framework. However, a suitable scientific validation process has not been established. In general little scientifically validated knowledge exists on the transfer effects of e-learning in regards to driving behaviour, situation awareness or anticipatory behaviour.

In order to answer some of the questions/proposals raised in this paper it would be recommended that future research is conducted on the following research areas:

- Effects of different didactical approaches on transfer (e.g. interactivity, learning pace, feed-back mechanisms) to the content of driver training. This should ideally both be conducted as studies between e-learning applications as well as e-learning compared to traditional learning measures. The parameters should be covering a wide range of performance indicators measures such as driver performance outcomes as well as attitude, knowledge and accident involvement.
- More research is needed on the potential of e-learning applications targeting special driver groups in particularly elderly drivers, impaired drivers or drivers with special needs. Many of these driver groups could potentially benefit from certain elements of these applications. It could be stated that e-learning applications potentially could have good chances of reaching these drivers as use of e-learning does not require physical presence of a driving instructor or that the drivers have to participate in traditional class-room teachings. On the other hand it could be argued that many of these groups are not familiar with these types of training tools meaning they would not necessarily be interested in this form of training.
- The time span of evaluation. Though e-learning seems to offer advantages with regard to facilitating learning processes it still remains an open question whether these effects will also transfer into the real world driving. It might be suggested that a short-term effect can be achieved but it remains unknown how long this effect will last.

Before these and related questions have been addressed more systematically it remains an open question whether any of the e-learning applications used within driver training have accomplished an increasing learning effect or moved beyond the spheres of existing driver training.

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