

Computer Based Training in Driving Education and Current Developments on Computer Assisted Driving Tests in Europe and in the World

Karen Kammler
TÜV | DEKRA Arbeitsgemeinschaft arge tp 21
Wintergartenstraße 4
01307 Dresden
Germany
or
Institute for Applied Research on Childhood,
Youth, and the Family (IFK)
at the University of Potsdam
Burgwall 15
D-16727 Oberkrämer
Germany
kammler@uni-potsdam.de

Kathrin Schlemmer
TÜV | DEKRA Arbeitsgemeinschaft arge tp 21
Wintergartenstraße 4
01307 Dresden
Germany
or
Institute for Applied Research on Childhood,
Youth, and the Family (IFK)
at the University of Potsdam
Burgwall 15
D-16727 Oberkrämer
Germany
k.schlemmer@ifk-vehlefananz.de

This paper summarizes the results of a recently completed study on driving tests in 30 European countries and follow-up research in selected other countries, concentrating on the use of computers in theoretical driving tests. Besides presenting an overview of *where* computers are used in theoretical examination we discuss different ways of using them, ranging from the mere transposition of questionnaires on a computer screen to the development of new question formats. Those question formats using multimedia techniques were analyzed in more detail in the follow-up study which included question formats from theoretical driving tests as well as from selected learner driver training CD-ROMs of different countries. The starting point for this analysis was a model of information processing in traffic situations, derived from a social information-processing model. The model was used to classify the different types of learning items by the level of information processing necessary to solve them. It was found that many items focus on the assessment of processes related to the perception of and memory for situational cues showed in a film (e.g. “eye scanning” items). Other – typically more complex items – focus on the assessment of anticipation processes, in particular on response planning and response decision in hazardous situations. Examples of typical items used to assess the different levels of information processing in traffic situations are described and discussed.

1. THEORETICAL DRIVING TESTS IN EUROPE

1.1 Outline of the Research Study on Driving Tests in Europe

In the years 2004 to 2005 a study of the theoretical and practical driving tests in 30 European countries (named below), commissioned by the TÜV | DEKRA Association for Technical Inspection of Motor Vehicle Traffic in the 21st Century (arge tp 21), was conducted by the Centre for Research on Education and Socialisation of the University of Potsdam (Bönninger, Kammler, Sturzbecher, & Wagner, 2005). The aim of the study was to obtain an up-to-date comparative inventory of the test implementation in the considered countries. Germany is currently heading for new potentials in licence testing: At present the German theoretical driving test is commonly administered as a paper-and-pencil version; for the future it is considered to conduct it on a computer assisted basis as a standard. The aim of the presented study was to get some new ideas from other European countries on how driving tests can be improved; the results of the study intend to be a source for international exchange of experience and to offer suggestions for an optimisation of the German driving test system. In addition, the results can offer a basis for progress in European harmonisation and for further development of the driving test systems.

The countries investigated included (in alphabetical order): Austria, Belgium, Bulgaria, Croatia, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Great Britain and Northern Ireland, Greece, Hungary, Ireland, Latvia, Lithuania, Luxembourg, Monaco, the Netherlands, Norway, Poland, Portugal, Russia, Sweden, Switzerland, Slovakia, Slovenia, Spain, and Turkey. In order to obtain as much up-to-date and practical information as possible from the considered countries, Internet searches were

made and telephone interviews as well as written surveys were conducted with experts in the field of driving tests.

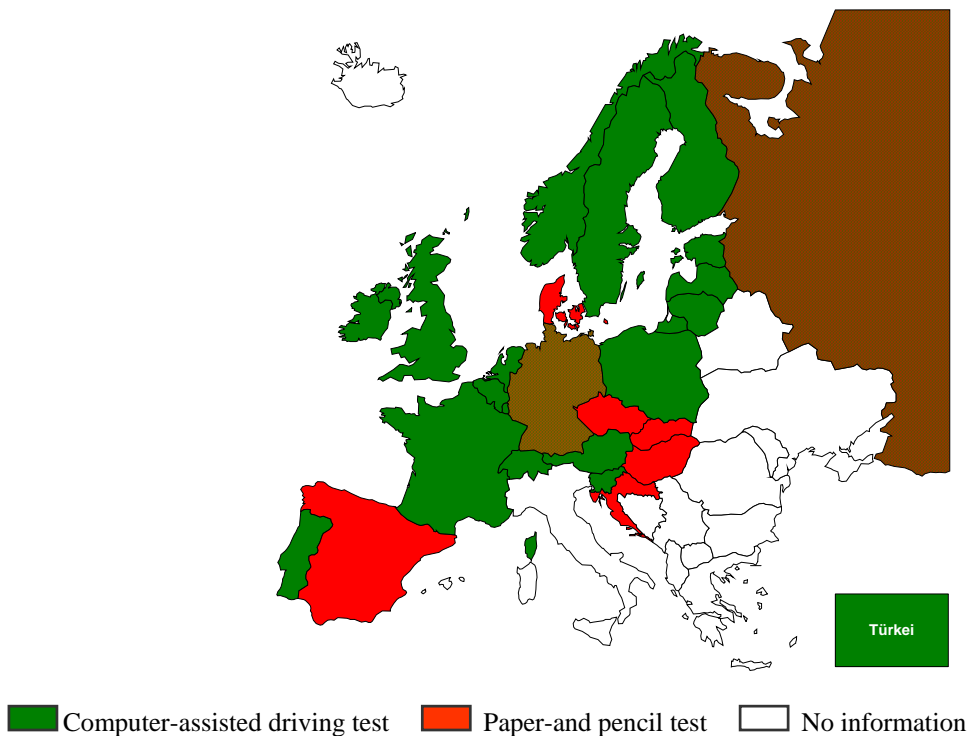
In this paper we want to present the results of the study concerning issues of media usage in theory driving tests: Besides presenting an overview of *where* computers are used in theoretical examination we discuss different ways of using them, ranging from the mere transposition of questionnaires on a computer screen to the development of new question formats.

1.2 Media Usage in European Theory Driving Tests

Where Computers are Used

In the countries involved in our study, the theoretical driving licence examination is regularly carried out either in form of a written examination or a computer based examination. Some countries apply both types of examination. Figure 1 summarises the results of computer usage in theoretical driving licence tests in different European countries.

Fig. 1: Computer assisted and paper-and-pencil theoretical driving examination in Europe



The theoretical driving licence examination is already computer assisted in 20 of the 28 countries included in our study; Greece is currently introducing a computer assisted examination.

In Germany today it is possible to sit a computer assisted examination in the regions of Hamburg, Bremen and Berlin; for non-German speakers it is obligatory to take the computer assisted test in these regions. Within the framework of a current pilot project for the implementation of a mandatory computer assisted theory driving test in Germany, another 25 cities now offer a computer assisted driving licence examination. Apart from these exceptions, the theoretical driving licence examination in Germany is currently administered in a paper-and-pencil mode.

In Russia, both a computer-based and a written examination are offered with the mode of examination depending on the equipment of the respective testing agency.

How Computers are Used

In most countries computer assisted driving licence tests are a mere transposition of the paper-and-pencil format to computer. This already leads to some advantages like an improved objectivity of the test since the presentation of the items as well as the scoring of the test is carried out automatically.

Yet a few countries have expanded the conventional formats and made greater use of the advantages of the computer medium choosing a different item format: For example, audio elements are utilised in the theory examination in Finland, Ireland and Belgium. In Portugal, it is also possible (under certain circumstances) to listen to examination questions.

Five of the countries included in the study – Belgium, Estonia, France, Finland, and the Netherlands – use a time limit for individual items; usually the same time limit applies to all items. However, in Finland time restrictions vary according to the content of an item: the maximum processing time for general theoretical items is 30 seconds, whereas items with depictions of traffic situations have to be answered within 10 seconds. The latter items have been introduced to assess the ability of driving licence applicants to recognise dangerous traffic situations.

In the theory driving test in France and in Monaco blinking indicators, warning lights and traffic lights with changing signals have been integrated into still pictures. Nevertheless, all these items have a similar design: questions are presented in multiple-choice format with some of the items being supplemented with illustrations or photos; in rare cases supplementary items are used as well.

The only European countries with substantially different item formats compared to the common schemes of test items are Great Britain and Austria. The Austrian theory driving test contains examination items demanding a justification for previously correctly answered questions in subsequent items. In Great Britain a *Hazard Perception Test* was introduced in November 2002; the aim of this test is to measure the applicant's ability to perceive hazards and to react to dangerous situations in time. Every applicant is shown 14 one-minute clips of a drive in road traffic on a computer screen. These 14 clips feature situations with a total of 15 developing hazards (i.e. one clip has two such hazards). What the applicants are required to do is click the mouse as soon as they have spotted a potential hazard. The faster the hazard is recognized, the more points are awarded with five being the maximum score per hazardous situation.

In conclusion we can state that computer assisted theory driving tests are used in many European countries. Yet only in very few countries new item formats have been introduced that exceed a mere transposition of the paper-and-pencil theory test to the computer screen. In order to receive more ideas on the development of innovative item formats and especially on those using multimedia techniques, we extended our research to the international field of both driving tests and selected learner driver training programs. The results of this follow-up study will be presented in the next section.

2. COMPUTER ASSISTED DRIVER TRAINING AND DRIVING LICENCE TESTS IN THE WORLD

2.1 A Model of Information Processing in Traffic Situations

Items using multimedia techniques as part of a theoretical driving examination were found in two countries only: Besides the Hazard Perception Test in Great Britain which we mentioned before, in some states of Australia a Hazard Perception Test is included in the theory driving test. Computer assisted training programs for learner drivers seem to be more common. Those to be presented in this paper are "Drive Smart" from Victoria, Australia, "Shift Second Gear" from New South Wales, Australia, and "CD Drives" from New Zealand. These driver training programs usually include different types of items. Not all of these will be presented here. Rather, we want to give an overview of the possibilities and prospects of multimedia items by structuring the presentation according to the item format and the item's cognitive requirements on the learner driver, i.e. the level of information processing necessary to solve the item.

The model of information processing in traffic situations presented in figure 2 (Sturzbecher, Kammler, & Bönninger, 2005) defines different levels of information processing. It is derived from a social information-processing model by Crick and Dodge (1994) and shows the social-cognitive processes a

person has to engage in when participating in traffic. A driver needs to master these processes and accomplish them more and more automatically. So a learner driver should be taught about the importance of his information processing skills and improve them by training. Driving examination then can contribute to assess the degree of cognitive competence the learner driver has reached so far.

Fig. 2: Model of information processing in traffic situations (Sturzbecher, Kammler, & Bönninger, 2005)

1. Encoding of the traffic situation and internal cues
- Perception of (social) information - Focusing of attention - Selective scanning for information referring to available schemes
2. Interpretation and mental representation of the situation
- Analysis of the current situation - Conclusions from already experienced situations
3. Clarification of goals
- Decision to continue with a pre-existing goal or - Selection of a new goal
4. Response access or construction
- Accessing possible responses from memory or - Construction of new responses
5. Response decision
- Evaluation of possible responses in respect to the outcome expectations, the degree of confidence in the ability to enact each response, and the evaluation of the appropriateness of each response - Selection of the most positively evaluated response
6. Behavioural Enactment

The model describes six cognitive steps that are necessary when determining the optimal response to a given situation. Consider this example of a driver approaching an intersection with the goal to turn left: First of all he needs to perceive the situation and scan it for relevant stimuli like a road sign, oncoming cars, or a child standing close to the road on the pavement. In the second step, he will interpret what he saw by drawing on his memory, e.g. his knowledge of regulations, of the meaning of road signs, or his anticipation of a possible misbehaviour of other road users. He can also access so called schemata and scripts gained in former situations and adapt them to the current situation. This helps him to structure the cues he perceives and to interpret them both correctly and in appropriate timing. According to the results of the interpretation process, in the third step the driver will decide whether he can continue pursuing his original goal. If this is the case, he will now – in step 4 – search for his behavioural options in the given situation, e.g. turning in front of an oncoming car or yielding to it. In step 5 the driver evaluates the appropriateness and the consequences of the possible actions and selects the optimal behavioural response, which he acts out on the final step.

In case of a sudden change of situation, e.g. if the child stepped out on the road, the driver needs to adapt his goal to the new situation: His primary aim now will be to avoid hitting the child. So he rapidly has to work through the information processes again: He looks for relevant cues, e.g. whether the opposite lane is vacant so that he could move there, he evaluates his chances of coming to a stop in time, and finally he determines the optimal behaviour and acts it out.

This example illustrates the importance of correct and quick information processing when driving. Moreover, it exemplifies that the steps of information processing described in the model above actually have to be considered as occurring simultaneously: When driving in traffic a person is continually engaged in all of the six information processes since new stimuli keep coming up and need to be dealt with. Nevertheless, for a single stimulus the cognitive process from perceiving it to finding the optimal behavioural response follows the sequence of six steps as they are described in the model.

2.2 An International Comparison of Innovative Item Concepts

Applying the presented model to the innovative test and training items for learner drivers and driving licence applicants respectively that we found in our international study, it shows that many items focus on the assessment of the information processing steps 1 and 2. So these items relate to the perception and interpretation of situational cues showed in a film as well as to the memory for such cues. In the following we will refer to these items as item format 1. Other – typically more complex items – focus on response planning and response decisions in hazardous situations and on anticipation processes needed to evaluate the possible behavioural responses in the given situation. So these items function as operationalisations of steps 4 and 5 of the above model. They will be referred to as item format 2.

Item Format 1: Items Relating to the Perception and Interpretation of Traffic Situations

Taking a closer look at the single items of item format 1 we can distinguish three different sub-groups. The first group contains scanning items, a second group contains items relating to the anticipation of dangerous situations, and a third group comprises hazard detection items.

Scanning. To solve the scanning items the learner driver is required to observe the situation attentively and to remember what he saw. There are two different methods of asking the person about his observations. One option is to present a multiple choice question on the content of the situation while the final picture of the film is still presented and might contain some information on the correct answer to the given question. The other one is to present the question without showing the final picture of the film.

Anticipation. The second item group comprises items relating to the anticipation of dangers and hazardous situations. To master these items the learner driver has to watch attentively and evaluate the given situation in reference to his knowledge of other situations as well as of facts and regulations. Afterwards, he is asked to express an anticipation of what is most likely to happen next. Having answered the question the learner driver can watch the continuation of the film and see how the situation actually proceeded.

Hazard detection. The third group of items relating to the perception and interpretation of traffic situations could be entitled hazard detection. To solve these items the learner driver and the driving license applicant respectively has to observe the situation and scan it for potential hazards. For this he needs to see the relevant cues and interpret them correctly concerning their risk potential. The user then has to point out the spotted hazards by clicking on them. In some cases he is required to do this while the final picture of the film is still presented. In other cases, as in the British Hazard Perception Test or in the dynamic hazard detection items on CD Drives from New Zealand, he has to spot and mark the developing hazards “on the move”, i.e. while the film is playing.

What are the advantages and the disadvantages of item format 1? As we said before, the items of item format 1 focus on the early information processes, i.e. on the perception and interpretation of traffic situations. This results in a simplification of the complex information processing needed in real traffic situations which seems appropriate for learner drivers. Not having to think of possible behavioural responses the learner driver can completely focus on the perception of the situation and thus improve his perception skills.

In the first group of items presented – the scanning items – the emphasis is put on the retentiveness of the user by not only asking for potential dangers but also for less relevant elements and characteristics of the situation displayed. This might help to sensitise novice drivers to the relevance of attentive driving. The items of the second group, relating to anticipation of how a given situation will continue, seem to be effective learning items; with the help of these exercises the learner driver can develop his skills to evaluate the risk potential of situations. These items seem to be less appropriate as examination questions, though, since the probability of different continuations of the same situation is hard to define and that makes it difficult to establish an objective scoring for these items. The hazard detection items require the highest level of information processing as the user has to interpret the meaning of the perceived situation and the spotted objects and evaluate their hazardous potential in relation to himself as a driver. Grading the authenticity of the different items we can say that the scanning items and the dynamic hazard

detection items make the most realistic demands by showing the hazards only in passing. This fact proves to be a great improvement in comparison with the use of still pictures or illustrations.

Item Format 2: Items Relating to Response Planning and Response Decision

Concerning the items of item format 2 we can also distinguish three sub-groups that differ in the demands they pose on the learner driver, even though all of them require a decision for the optimal behavioural response. These three item types can be described as items with a focus on choosing the correct time, the correct behaviour, or both.

With the first item type the learner driver is asked to choose the right moment for a certain behavioural response which has been predetermined as part of the question. In the second group of items the right moment for the action is a given whilst the learner driver has to choose the optimal behavioural response from a list of possible reactions. And in the last group of items the learner driver first has to stop the film *when* he feels the need to act in one way or the other and afterwards he is asked *what* reaction he would show in the given situation.

Compared with the requirements on someone driving in real traffic, the items of item format 2 – as well as of format 1 – are based on a simplification which is appropriate to the competence level of a learner driver. In contrast to driving in real traffic the user of these training programs has to accomplish fewer tasks: Either he has to decide on the right moment, not having to think about the appropriateness of the given behaviour. Or he has to decide on the right behavioural response, yet the time when an action is needed is predetermined. Even in the last item group where the user needs to find the optimal response *and* the right moment to act it out, the requirements are still simplified in comparison with real traffic situations: The moment that requires action has to be determined in real time while the film is playing, but after this the film stops and the user can choose the correct behavioural response to the situation without any time pressure.

In comparison with item format 1 we can observe a far greater complexity of the items relating to response planning and decision. To choose the right response and/or the right moment to act it out requires higher levels of information processing. Given the model mentioned above it becomes evident that for a correct response planning and response decision the learner driver first has to perceive and interpret the situation correctly and has to clarify whether the original goal can be kept up or needs to be changed. Only after having accomplished these cognitive processes (steps 1 to 3 of the information processing model) he can evaluate possible reactions and make a decision concerning the required behaviour in the given situation.

3. CONCLUSION

The presented overview of item concepts using multimedia techniques has shown that the potential of computer assistance is very great, both in the field of trainings for learner drivers and in the field of driving license examination. However, so far this potential is only rarely used – especially in the context of driving tests. Although in 20 out of 28 European countries paper-and-pencil driving tests have been replaced by computer assisted theory driving tests, only in Great Britain innovative items have been introduced that utilise the actual potential of computers as a test medium.

Since multimedia presentations of traffic situations – as compared to still pictures or verbal descriptions of the same – prove to be more realistic, they provide an opportunity to design items that require the same cognitive skills as driving in real traffic. Moreover, in contrast to a practical training, multimedia items provide the opportunity to adapt the requirements of the item to the learner drivers' competence level. For example, when using computer animation techniques the presentation of the situation can be simplified both by accentuating certain elements and extinguishing distracting objects. Besides, the question can be reduced to a specific content, e.g. asking solely for perceived objects or for the right moment to act out a given behaviour. In order to be able to assimilate the cognitive requirements of driving in real traffic to the cognitive requirements of answering the examination questions in the theory driving test, the use of a theoretical model of information processing in traffic situations proves to be helpful. In general, multimedia techniques make it possible to design items that operationalise any step of the information processing model.

Multimedia items like the ones described in this paper allow the training as well as the testing of fundamental elements of driving competence that novice drivers need to acquire. When items of this type are used in driving tests and driver trainings, relevant competence elements like perception, interpretation, and response decision can be acquired at an early stage of driver training. To achieve these cognitive elements of driving competence through theoretical training is obviously associated with the least danger. In the subsequent practical driver training the acquired cognitive skills and knowledge are further differentiated and combined with the motor skills of navigating a vehicle.

The possibility that the learner driver can already acquire important cognitive skills in the course of his theoretical training increases road safety during practical training for the learner driver himself and for other road users. Moreover, the higher level of competence achieved through the visualization of many different traffic situations – e.g. including all possible weather conditions – can reduce the risk of novice drivers when driving in similar situations by themselves in real traffic after having finished their driver training. In conclusion the introduction of innovative item formats using multimedia techniques in driver training programs and driving tests can make an important contribution to road safety in Europe and in the world.

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