Computer Assisted Instruction in Traffic Theory

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Overview

Practical driving lessons and instruction in traffic theory are separated parts of driver education in the Netherlands. The public driving schools concentrate principally on providing guided practice, and students acquire knowledge of traffic theory primarily through self study. The prevailing view in public driving schools is that driving skill can only be acquired by doing, and that the role of traffic theory is merely to provide the necessary background knowledge of the meaning of signs and right-of-way rules. This notion is likely to be the result of the fact that the content and presentation of traffic theory in the current tradition does not lead to the acquisition of knowledge that the student-driver needs when he is actually driving a car. It is our belief however, that instruction in traffic theory càn pay an important contribution to making students good drivers, providing that the theoretical knowledge is relevant and applicable in every day traffic situations.

A new instructional method using Computer Assisted Instruction (CAI) for teaching traffic theory is proposed. An important objective of this new approach is to optimize the effects of practice lessons by providing a sound theoretical basis. The instructional material is organized according to prototypical road categories rather than general principles and traffic rules. This type of structuring makes it easier for students to make a direct link between theory and actual behavior.

A central conception of this program is that instructional material should be presented in the context of traffic situations that students are likely to encounter in real life. This demand is realized by using instructive video fragments. Because the video fragments are digitally stored, students can control the presentation of this information.

Unlike existing methods that separate instruction from testing, this program employs a mastery model, in which instruction and evaluation is integrated.

The development of the proposed program is currently underway. The materials (video, photo's, animations) that are now being collected will be implemented in a preliminary program, covering four of eight themes. The evaluation of this prototype is planned to be carried out in the winter and spring of '94.

Introduction

A driving test normally consists of a theoretical and a practical exam. In the Netherlands, one needs to pass for the theory exam before a practical exam can be taken. This illustrates the fact that the ministry of transportation considers it very important that driver-students have acquired sufficient background knowledge of traffic behavior before they can be tested on their ability to apply this knowledge in practice. Public driving schools do not seem to share this view, as they concentrate principally on providing guided practice in driving a car in everyday traffic situations. "Instruction" in traffic theory is usually limited to handing over the standard text-and-exercise book. Sometimes the book is explained by an instructor is small classroom settings, but learning traffic theory is primarily a matter of self study. If, during practice lessons, it becomes clear that a student-driver lacks prerequisite knowledge to handle certain situations

correctly, the instructor communicates the necessary information on the spot. This is obviously a very undesirable situation. It is therefore not surprising that the contribution of instruction in traffic theory to driving performance is low or non-existent (Brown, Groeger, & Biehl, 1987).

There are probably many reasons for the fact that instruction in traffic theory plays a minor role in driver training, but one important factor is that the content of contemporary method of instruction in traffic theory, as well as the manner in which it presents the information, does not lead to the acquisition of knowledge that the student-driver needs when he is actually driving a car. Cognitive psychology has learned us that people acquire knowledge of concepts, rules and ideas in the context of specific situations and tasks rather than in an abstract form (e.g. Norman, 1983, 1993). The implication is that instruction should present the material to be learned in the context of traffic situations that students are likely to encounter in real life. Furthermore, in order to optimize transfer from theory to practice, instruction should learn students how to recognize traffic situations, to identify their potential problems and conflicts, and how to act appropriately when in such situations. However, the method adopted in almost all traffic theory text books, as we shall point out, does not satisfy these instructional demands. The method can be criticized with respect to the educational approach, its too limited content, and its method of testing.

It is clear from the strictly formal approach of current schooling in traffic theory that it has been derived directly from statutatory traffic rules. Instruction focuses on learning definitions, rules, and the meaning of signs. It is up to the student to acknowledge the implications of the newly acquired knowledge for driving behavior in actual task situations. Thus, the relation between theory and practice is very formal and indirect. For example, students learn to identify the sign indicating a motor-way, learn that a car belongs to the category motor-vehicles, and learn that the speed-limit for motor-vehicles on motor-ways is 55 miles/hour. Because this information is of an abstract nature and presented in a context that has no correspondence at all with the setting in which it has to be used, it is doubtful whether this knowledge will be triggered at the right moment. In order to optimize the transfer from theory to practice it would be better to instruct students how to recognize motorways (on formal, but also on informal characteristics, like dual carriageways) and link this directly to desired driving behavior rather than teaching general principles.

A second criticism concerns the limited content of current traffic theory. Driving tasks can only be performed adequately if the driver is capable of appreciating all relevant factors. In other words, the (student) driver must have a fully specified 'mental model' of the task (Gentner, 1982). Traffic theory education fails to provide students with sufficient information to build up adequate mental models of driving tasks because instruction is limited to statutory regulations. Regulations are certainly important, but they are not sufficient. Instruction should include information as to how task performance is affected by various factors, such as characteristics of the driver, road, (other) vehicle(s), and whether. Thus, a primary goal of education in traffic theory is to achieve adequate driving performance through knowledge and understanding of the factors related to the actual task.

The third criticism concerns the method of testing. Knowledge of traffic theory is tested by presenting a series of slides of traffic situations. Each slide is accompanied by a question that can be answered by either yes or no. The student indicates his response by pushing one of two buttons on a device. Our objections to this testing procedure pertain to the presented situations and the amount of cuing in the phrasing of the questions.

Often the questions to test whether students have acquired certain knowledge provide contexts that do not fit in with problems encountered in reality (e.g. "Should the white car (driving on an unpaved road) give right of way to the horse and cart (riding on a paved road)?"). The selected situations reveal the implicit conception that it is considered more important that students can apply formal abstract traffic rules to rather exotic situations, than that they prove to be capable of handling problematic traffic situations in an appropriate manner.
Another objection concerns the phrasing of questions. As stated earlier, an important objective of traffic education should be that students actively recognize traffic situations as belonging to a certain category. This should immediately and automatically trigger category-associated knowledge. However, in the current testing method, questions explicitly refer to the relevant problem (e.g. "should the car give right of way to the bike?"). In other words, the student is 'cued' by the way the question in phrased. This is very unlike real-life situations, in which drivers have to recognize the kind of traffic situation, identify the problem, and retrieve the required associated knowledge. It would be better if questions are formulated in a more open and non-directive form, like "should you stop or continue?" or even better: "what should you do next?".

To summarize, the formal approach of teaching and testing knowledge of traffic theory and its opaque relation to real-life situations are probably the cause that the potential contribution of traffic theory to driving performance is not yet being realized.

The present project

In collaboration with the driving schools of the Royal Netherlands Army, we are currently developing a new instructional method using Computer Assisted Instruction (CAI) for teaching traffic theory. The primary goal of this approach is to optimize the effects of practice lessons by providing a sound theoretical basis. Transfer of knowledge from theory to practice is of central importance. We will give a concise outline of the program in the following sections.

BACKGROUND AND HISTORY

Traditional classroom teaching with the instructor explaining and students listening is still the prevailing method of instruction in the Netherlands Army. The problems associated with this type of instruction have been recognized. Possibilities to introduce more advanced instructional techniques are now being investigated. The development of the present program is part of that policy.
The goals of the computer assisted instruction program are twofold: It should lead to better performance of students and it should bring down costs by reducing the number of instructors.

TARGET POPULATION

The program is being developed by appointment of, and in collaboration with, the Royal Netherlands Army. The target population consist of 18 year old conscripts. The planned abolishment of the compulsory military service system will have its effect on the composition of the target population. The anticipated target group will probably more homogenous in terms of sex, age, and schooling.

INSTRUCTIONAL MATERIAL

The instructional material is arranged in eight themes. Themes correspond to prototypical road categories, arranged by their functionality and their setting (Janssen, 1991). Three functionalities have been distinguished: roads serving local traffic, roads designed to serve large quantities of traffic with long-distance destinations, and roads designed to connect local with interlocal roads. Two settings are distinguished: within and outside the city limits. Examples of themes are: residential areas and 30 km/h areas, right-of-way roads within the city limits, motorways. Task analyses have been conducted for all themes. First, relevant clusters of behavior have been identified. Subsequently, prerequisite knowledge and skills for performing this behavior have been determined. For example, the behavioral clusters for "motorways" are: 'turning onto the approach road and joining the traffic, driving and following, passing, and exiting. Prerequisite knowledge and skills for correctly driving into a motorway, for instance, requires that the driver can recognize approach roads both on their formal and informal characteristics, that he is familiar with the appropriate driving procedures, and that he is aware of potential complications and knows the proper actions when such situations arise. It is the objective of this program to provide the necessary background for adequate traffic behavior.

INSTRUCTIONAL PHILOSOPHY

An important question in the design of an computer assisted instructional program is how much guidance should be provided. An often recommended approach is exploratory learning, in which students are completely free to delve into the material to acquire the knowledge and learn the relations between the elements (Mager, 1961). Because the instructional elements in traffic theory are interrelated and some elements are prerequisite for the mastery of others, constraints in the student's freedom is necessary (Gagné, 1985). We therefor adopted an approach with both directive and explorative characteristics. A directive approach is used for learning arbitrary information (for instance, the design of a traffic signs is often arbitrary, as is the rule to keep the right side of the road. It is rather senseless to let students 'discover' this knowledge). Explorative approach is used for learning material in which clear relations can be distinguished (For example, the design of road types is logically related to their function, and we think that it is instructive to let student discover these relations).

We have selected a mastery learning model (Bloom, 1971), which postulates that on-line performance testing is necessary to continually adjust the type and amount of instruction to the individual's need in order to achieve that all students eventually pass on all learning objectives. To realize this goal, the instructional material is divided into modules and submodule, in this case corresponding to respectively themes and main behavior clusters. After each (sub)module, students receive a series of questions. The sub(module) can only be concluded if the students achieves at criterium. If the student fails, the program assesses problematic sections and provides additional instruction, followed by a new test.

DELIVERY SYSTEMS

Earlier we argued that students can make the link between theoretical knowledge and practice more easily if the information is presented in real-life like contexts. Perhaps the most salient characteristic of real-life traffic is that it is dynamic. In the present instruction program we have chosen to represent the dynamic aspect of traffic situations by digitized video. Video is very well suited to demonstrate the characteristics and function of a certain road design, to show

(potential) problems and conflicts in traffic situations, to show the outcomes of different reactions to a certain problematic situation, to show the antecedents that produced the problematic situation in the first place. In short, because video has the possibility to illustrate the dynamic aspects of traffic situations, it has the potential to facilitate the acquisition of knowledge and understanding of the relation between traffic situations and appropriate behavior.

INTERACTIVITY

One of the advantages of CAI is that students can be made more active than is possible in traditional classroom settings. The present program utilizes video to involve the students in activities like: recognizing and classifying traffic situations, specifying potential hazards, and indicating appropriate actions. Video fragments are digitally stored, and can be started very easily from the program. This allows students to control the type and amount of information. Earlier research has shown that student-control increases the medium's educational effectivity (Baggett, 1988; Fletcher, 1989).

INDIVIDUALIZATION

An important advantage of the present program is that students can go through the program in their own pace. Furthermore, they are free to repeat an instructional fragment, jump back to earlier sections in the program or they can consult the on-line help facility. A more extensive form of individualization through adjusting instruction to students' starting level was considered not necessary because the anticipated target group is quite homogeneous in terms of schooling.

Current state of affairs

The development of the program is currently (october '93) underway along the lines presented above. In order to test whether the proposed program satisfy the objectives, we developed a test program covering two behavioral clusters of the theme 'motorway'. An informal evaluation was subsequently carried out by trying out the program in a single case study. The result was encouraging. All learning objectives were achieved. The video fragments turned out to be very instructive and motivating. Because we felt that more interaction in the program would be desirable, we are currently working on ways to achieve this goal.

Scenario's for stills and video have been completed for half of the themes. The material will be implemented in a preliminary program, covering four themes. This will allow the evaluation of the program in a more profound and systematic manner. Evaluation and adjustments will be carried out in the winter and spring of '94.

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