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From control of the vehicle to personal self-control; broadening the perspectives to driver education

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Abstract

The objective is to formulate guidelines and goals for future development in the area of driver training and education. The content of this paper is not empirical, but merely an analytical summary or review. A four-level descriptive model is presented in which driver behaviour is conceptualised as a hierarchy, in which the goals and motives of the driver play an essential role. The recent constructivist ideas in mainstream pedagogy and psychology of learning are combined with a hierarchical approach to driver behaviour. A comprehensive framework for goals and contents of driver education (GDE framework) is presented. Two main conclusions can be drawn. Firstly, the conceptual analysis points towards a need to emphasise the motivational aspects in driver education more than it is done at present. Secondly, in order to reach the goals, pedagogical methods should be re-evaluated. For example, active learning methods and use of self-reflection should be promoted in driver education.

Keywords: Driver training; Driver education; Educational methods; Theory in traffic psychology; Driver behaviour

1. Introduction

The objective is to formulate a conceptual model of driver training and education. The idea is to be prospective, with clear emphasis on finding new goals and methods. A solid theoretical framework is needed to cover a driver's task as broadly as possible. Issues that are addressed

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include, for example, what the driver has to master; which factors affect the learning process and, in particular, which educational methods are needed.

2. Theory of traffic behaviour and driver education

2.1. Hierarchical approach to drivers' task and skills: defining the complexity of the problem

An analysis of the driver's task and accidents has shown that adequate psychomotor skills and physiological functions are not sufficient for good and safe performance as a driver. This conclusion is in line with the notion that driving is a self-paced task (Näätänen & Summala, 1974). Recently, for example, Rothengatter (1997) has pointed out, that research in traffic psychology shows not only the importance of performance factors, but also the importance of motivational and attitudinal factors. This observation concurs with the distinction between the concepts "errors" and "violations" in driver behaviour (Parker, Reason, Manstead, & Stradling, 1995; Reason, Manstead, Stradling, Baxter, & Campbell, 1990). Since Miller, Galanter, and Pribram (1960), hierarchical approaches have been typical in more recent psychological attempts to explain human behaviour. The importance of hierarchical approaches is realised also in the more general debate in traffic psychology (Janssen, 1979; Michon, 1985, 1989; Ranney, 1994; Summala, 1985).

Although in the past hierarchical approaches have been used mainly for describing the performance aspects of driving behaviour (Mikkonen & Keskinen, 1980; Rasmussen, 1980; Van der Molen & Bötticher, 1988) a hierarchical approach can also be used to combine the motivational and attitudinal aspects of driving behaviour with performance, or operations in certain traffic situations. The interplay between the elements of driving skill as well as the conceptualisation of driving as a task that includes all components from motor coordination to higher motivational levels becomes evident, when driver behaviour is schematised in a hierarchical approach (Keskinen, 1996) (see Fig. 1).

Skills for vehicle manoeuvring and mastery of traffic situations are the basis for successful operation in traffic and these aspects should be learned well during driver training. Psychomotor and physiological aspects are important as basic requirements for operations at the lowest levels of the hierarchy of driver behaviour. However, these skills are applied under guidance of higher

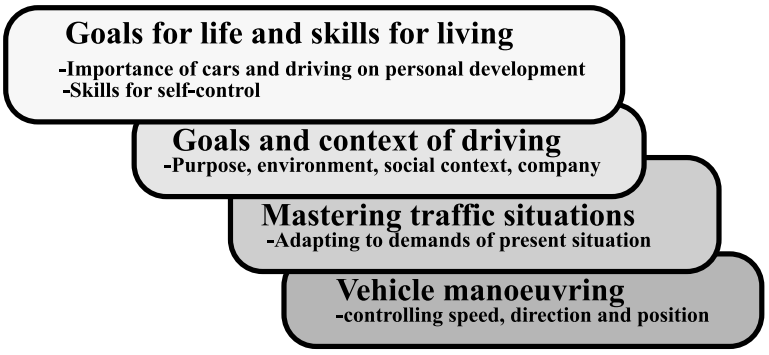

Fig. 1. Illustration of hierarchical levels of driver behaviour (adapted from Keskinen, 1996).

level goals and motives. This means, that in addition to the training of basic skills, driver training should also be able to deal with these higher levels in the hierarchy and take into consideration the driver's goals related to driving and, for example, skills for dealing with social pressures during a trip. Driver's goals may have an effect on both, increase or decrease of risks. The general idea of control of higher levels on lower levels is found also in Janssen's (1979) and Michon's (1985) thinking, but they were not focussing on the question how different motivational aspects were increasing or decreasing risks.

The idea in a hierarchical approach is, that failure as well as success at higher levels affect the demands on skills at lower levels. A person's general goals for life and the means for satisfying these (e.g. developing one's identity with car, and driving-related activities) (Gregersen & Berg, 1994; Jessor, 1987), as well as a person's general skills for life (e.g. self-control) (Kokkonen & Pulkkinen, 1999; Pulkkinen, 1998) can be considered as the highest level in the hierarchy.

When viewed from this perspective, it is easy to understand why several attempts to improve safety by improving skills at the lower levels of the hierarchy only (vehicle handling skills on slippery road) have actually failed to decrease accidents (Christensen & Glad, 1996; Glad, 1988), exclusive vehicle handling skills of race drivers are connected with high number of accidents (Williams & O'Neill, 1974) or that some groups benefit from training to master slippery road conditions and other groups obtain a negative effect from it (Katila, Keskinen, & Hatakka, 1996; Keskinen, Hatakka, & Laapotti, 1992).

The control in the hierarchy is not a simple top-down process. Changes in lower levels also have effects on the whole system. If increased skills, or even worse, imagined increase in skills (Gregersen, 1996a) are used to satisfy needs for maintaining as high a speed as possible, the results are very likely to be negative. If the motivational level fails to produce a safe strategy for driving, no level of skills in mastering traffic situations or vehicle handling is high enough to compensate for this lack of safety orientation and to result in greater safety. This is also the message of the risk motivation theories of driver behaviour (Fuller, 1984; Näätänen & Summala, 1974).

Thus the view presented here considers all levels in the hierarchy to be essential for successful operation in traffic. Even though cognitive theories of psychology allow the theoretical possibility to use the same constructs from the bottom to the top of the hierarchy, it is obvious, that several theories are needed to specifically understand the problems encountered at each level of the hierarchy. We do not expect, that there would be a general traffic psychological theory that covers all these levels, but there are for each level several theories (theories specific to traffic psychology or theories of general psychology). Examples of those will be presented in order to illuminate the specific problems connected with each level in the hierarchy, and to explain how each level is present in traffic behaviour. The function of the hierarchical approach here is to make the goals of driver training more clear. What are the aspects that driver education should include and how these aspects can be influenced. This theoretical description of driving task should be considered as a starting point for evaluation of specific driver education methods.

2.2. Description of hierarchical levels

2.2.1. Goals for life and skills for living

The highest level in the hierarchy refers to the motives and goals of the person in a rather broad sense (Keskinen, 1996). Personal skills for handling different situations in life in general are also

included at this level. Traffic psychological research has indicated that general motives as well as the developmental stage of the person are influential factors in determining traffic behaviour. Youngsters, for example, are frequently involved in risky behaviour (Evans, 1991), but this is not for risk in itself, but because such behaviour serves youngsters' developmental needs. Risky behaviour can thus be considered functional (Jessor, 1982, 1987). The effects of the motivational aspects were emphasised by Näätänen and Summala (1974) when they presented their concept of "extra motives".

Gregersen (1996b) has emphasised the importance of lifestyle factors and values that affect driver behaviour. Lifestyle studies (Gregersen & Berg, 1994; Schulze, 1990) show that lifestyle is related to driving behaviour. A highly car-oriented lifestyle seems to be particularly problematic. It can be hypothesised, that when motives for self-enhancement are realised in the traffic context, this may increase risk. This type of information should be included in driver training in order to make youngsters more aware of their personal processes and the possible motivational pressures they encounter while driving.

The differences between males and females in traffic risk are aspects that can be traced back to motivational factors. These differences are both qualitative and quantitative (Bruhning & Kuhnen, 1993; Farrow, 1987; Keskinen et al., 1992; Laapotti & Keskinen, 1998; Twisk, 1994b). Most investigations of young drivers have, however, either focused on males or have failed to distinguish between the behaviour of males and females (Jonah, 1990; Laapotti & Keskinen, 1998; Renge, 1983). This is why our image of a typical young driver's accident usually resembles the features of male rather than female accidents. A typical image of a young driver's accident would be a severe single (loss of control) accident that happens when the driver is driving at high speed during a weekend night while on a leisure trip with drinking friends.

Young female drivers' accidents have quite different characteristics. The mechanisms behind their accidents also seem to be different. They are so different that it may not be possible at all to speak about typical young drivers' accidents. For example speeding and driving while impaired are typical for male drivers but rare for female drivers. Such differences are the result of differences in motives (Laapotti & Keskinen, 1998). The causes of accidents seem to vary considerably, and since the training has to be adapted to the causes, this calls for a variety of methods in training.

Effects of gender on accident involvement are probably related to the highest levels in the hierarchy, as no suggestion has been made that females possess better technical skills for dealing with various traffic situations or for vehicle manoeuvring than male drivers. Studies also show that older novice drivers seem to have fewer accidents compared to young novice drivers when mileage is controlled for (Keskinen et al., 1992, 1994). Thus, the differences have to be associated with maturation. In addition to the effect of age, experience also has an independent effect on accident involvement (Maycock, Lockwood, & Lester, 1991).

When a hierarchical approach is applied to driver training it points towards an emphasis on methods that are capable of dealing with the highest levels of the hierarchy, i.e. motivational and other factors connected more generally with driver's strategy, motives and life skills. Modification of behaviour is not possible without modification, or at least, awareness of personal goals.

When these aspects are considered as important targets for driver education, a need for a change in driver training methods arises. Measures for accident prevention at the highest level of the hierarchy focus partly on arranging support for young persons in their developmental tasks so that they could mature in a more safe way. Even though it cannot be expected that driver edu-

cation can change a person's life goals, education should make a person conscious of his or her personal tendencies, that affect driving behaviour. A recent example of safety-positive trend, which is obviously connected with the highest level of values and life goals is the radical decrease in the licensing of youngsters in Sweden. Young people choose public transportation and are driving less, and this has decreased accidents (Swedish Road Administration, 1998). Such trends as choosing not to drive when other methods of transportation are available should be supported by driver education. Perhaps, driver training should broadened into transport education.

Anticipation of risks connected with goals for life and skills for living is related to knowledge about the relations between risk-increasing tendencies, risky motives or lifestyle and driving. The drivers should also be aware of their own personal characteristics at this level.

There is evidence that it is possible to have at least some effects on alcohol-related violations and other traffic violations with appropriate educational methods. In Germany, driver improvement methods have been widely used and evaluation studies have shown reduction of recidivism after course participation (Bartl & Stummvoll, 2000; Utzelmann & Jacobshagen, 1997). The educational methods used in driver improvement courses are largely based on self-reflective and self-evaluative processes and even therapeutic elements are included (Hatakka & Keskinen, 1999). The methods used in driver improvement programs are, however, not widely in use in basic training of novice drivers (GADGET, 1999).

2.2.2. Goals and context of driving

The second highest level is related to goals and context of driving. At this level drivers decide for what purpose, where, with whom, with what and at what time to drive. These decisions have important consequences for traffic safety and are functions of many factors in a person's life situation, e.g. economical situation and in his/her personality.

This level refers partly to the navigational and planning tasks of the driver that are described in earlier hierarchical conceptualisations (Janssen, 1979; Michon, 1985; Mikkonen & Keskinen, 1980; Van der Molen & Bötticher, 1988), However, the view is somewhat broadened to include also trip-related goals and driving contexts. The idea is that trip goals and driving contexts are affected by higher level goals. While middle-aged drivers are typically involved in driving connected with work or transportation of family members, youngsters are more often engaged in driving for leisure purposes and in the company of friends (Laapotti, Keskinen, Hatakka, & Katila, 1996).

Good planning of the trip may make the driving easy, while bad planning or lack of planning can cause troubles. Proper estimation of travel time, selection of the easiest route or the most suitable time for the trip, will help the driver to encounter less demanding traffic situations and lessen the burden on vehicle manoeuvring skills when actually making the trip. A central aspect of planning is, of course, the major decision to drive. These kinds of evaluations should be included in driver training because of their direct effect on both quality and quantity of exposure and thus, on personal risks.

Other factors that are relevant at this level are related to the social context of the driving. Social pressure has a strong impact on driver behaviour. General social–psychological theories and social psychological theories about traffic (Jessor, 1982, 1993; Jonah, 1986, 1990) should also be used in the design of driver education. Passenger-related risks are emphasised in some studies (e.g. Marthiens & Schulze, 1989). Social context in the form of peer group represents the most

important influence on the behaviour of young male drivers (Lewis, 1985). Farrow's (1987) and Laapotti's (1994) results support this statement. In accidents where the cause was loss of control, young male drivers had more passengers than females and their passengers were more likely to be friends. Females had more often family members in their car. As Twisk (1994a) summarises: "The young driver is not an isolated individual, but is part of a closely knit social structure. His or her position in this social structure influences his or her current behaviour, attitudes and beliefs".

Again, we must point out that young drivers may be realising their personal motives through their driving. In Vogel and Rothengatter's (1984) study, the "pleasure in driving" had the highest relative contribution to driver's attitude towards speeding. Motivational factors, e.g. driving for pleasure can also be seen in the selection of cars. Those male drivers who are interested in driving fast tend to choose fast cars (Hatakka, Keskinen, Katila, & Laapotti, 1994). Those drivers who had the highest level of "extra motives for car choice" (important factors in car choice were high acceleration, powerful engine, good looking, sporty) also had the highest annual mileage and highest number of violations even when mileage was controlled from.

Decisions made at this level of the hierarchy can be considered partly as skills in a rather traditional sense, e.g. planning of the route and it is possible to find training methods for improving these skills. However, such factors as risks connected with the goals of the trip and with social pressure while driving are somewhat different aspects, and require educational methods that help to increase subjective awareness.

Anticipation of risks at this level of the hierarchy is related to knowledge about the necessity of planning and the problems that arise, when the driver is not able to plan driving properly. Furthermore, the driver should be aware of the risks connected with specific goals of the trip or driving context. If the driver is aware of typical personal goals for driving or habits when encountering problematic situations, he or she could prepare himself or herself for dealing with the problems.

2.2.3. Mastery of traffic situations

Mastery of traffic situations has traditionally been the central component of driver education. The driver has to adapt his or hers individual behaviour to other road-users' behaviour and to the traffic environment. The driver also has to perceive and predict other road-users' behaviour and make his or her own behaviour predictable to others. Knowing traffic rules and behaving according to them is one important part of these skills. In a hierarchical view, it is emphasized that behaviour in specific traffic situations is related to the driver's general tendencies and goals of the trip.

Earlier hierarchical approaches (Janssen, 1979; Michon, 1985; Mikkonen & Keskinen, 1980; Van der Molen & Bötticher, 1988) have considered this level as a tactical level, or level of specific traffic situations. This level is related to the negotiation of traffic situation and road designs. An essential problem at this level for novice drivers is that insufficient skills and insufficient automatism result in information overload and mistakes or less appropriate strategies, for example in observation or allocation of visual attention (Mourant & Rockwell, 1972; Wikman, Nieminen, & Summala, 1998), and longer reaction times (Quimby & Watts, 1981). Novice drivers are involved in accidents more often as a guilty party than experienced drivers (e.g. Keskinen, 1982). There is also a strong effect of experience on the accident liability (Maycock et al., 1991). Fuller (1984, 1988) conceptualises mastery of traffic situations as increased ability for threat avoidance and he

suggests that experience has a strong effect on this ability. Good skills for mastery of traffic situations include, in addition to skills needed in normal situations, skills for risk-recognition in problematic situations. Gregersen et al. (2000) results showed that increase in amount of practising before licensing reduced novice drivers' accident involvement. This refers to the importance of mastery of traffic situations.

Excellent skills for mastery of traffic situations are necessarily not enough for safe driving. The high interest in cars and driving traditionally exhibited by males does not lead to lower crash rates even though it may lead to higher levels of skill and knowledge (Evans, 1991, p. 136). Training courses focusing on technical mastery of traffic situations, and on producing relaxed and confident drivers, may desensitise the driver to fear in more risky situations (Job, 1990). The increased technical skills are likely to lead to an increase in the level of task difficulty, such as caused by driving faster, overtaking in heavier traffic, or accepting additional secondary tasks, e.g. listening to the radio, rather than simply to an increase in safety (Evans, 1991).

In Japan, an interesting relationship was found between the success in a driving test, the number of hours in driving school before the driving test and accidents and violations. The less hours of training male students had (i.e., the easier they had achieved the required level of skill) the more often they were involved in accidents and violations. The better the males were in the driving test the more they were involved later in accidents and violations. Both these effects remained even when the age of males was controlled for. However, no such effect was found in female drivers' groups (Renge, 1983). Passing the driving test also is easier for young males in Finland, but after licensing males have more accidents than older drivers or female drivers (Keskinen et al., 1992). The results suggest that measurement of mastery of traffic situations that emphasises maximal performance—which is the major topic in driving tests—is not sufficient. Driving tests should also include elements of driving style factors. The distinction of drivers' mistakes in traffic situations into violations, where the problem is not in basic skills but in the intention of the driver, and slips and lapses (Reason et al., 1990) must be taken into account in driver education design.

As a general conclusion, it can be stated that skills for mastery of traffic situations are essential for success in traffic. It is necessary, that licensing systems should guarantee a good level of mastery of traffic situations. However, a general problem in driver education and testing is that training and evaluation of skills for mastering traffic situations is not enough. Driving is essentially a self-paced task, the driver chooses the demands that are put on his or her skills. Improvement of skills should be gained in such a way, that misuse and overestimation of personal skills is avoided. This requires that the goals of training and the design of training methods take into consideration both drivers' aptitude and also drivers' typical motivational and driving style factors. Furthermore, awareness of personal skills and their limits should be included in training.

2.2.4. Vehicle manoeuvring

Vehicle manoeuvring is a challenge for driver education in much the same way as skills for coping with traffic situations. To operate a vehicle efficiently the basic manoeuvres have to be automatized. If not, the manoeuvring will demand conscious attention and strain the limited capacity for information processing. This leaves little capacity to observe and predict the behaviour of other road users. This idea is well described in earlier hierarchical approaches to driver

skills (Michon, 1985; Mikkonen & Keskinen, 1980; Van der Molen & Bötticher, 1988) and in the literature about learning of skills (e.g. Fitts & Posner, 1967). The problems at this level are partly related to problems of information overflow in novice drivers. During training a sufficient number of repetition of basic manoeuvres is needed in order to achieve automaticity. In addition to the skills needed in normal driving situations, the driver should be aware of the typical mistakes with speed control and steering, that lead to loss of control of the vehicle. Without this knowledge avoidance of these mistakes is not possible.

It should be noted that as for the training of skills needed in traffic situations, there are problems connected with training of vehicle manoeuvring skills. As described above, vehicle-manoeuvring skills are used according to the driver's motives. Improvement of basic vehicle handling skills will probably have positive effects on the driver's possibilities for safe driving. However, training of skills that are intended for use in hazardous situations seems to bear a possibility for misuse or development of overconfidence in technical driving skills. It is important that driver training does not create the impression that the driver's task is mainly a manoeuvring task. Such an impression would be an incorrect basis for the development of the driver's behaviour. Studies indicate that such impressions may easily be mediated by the driver training (Gregersen, 1996a; Katila et al., 1996).

3. Combination of driver's task and goals for learning, GDE framework

Table 1 presents a framework relating the hierarchical approach to driving with contents and goals of driver education. Later on the framework will be referred to as "Goals for Driver Education" framework, in short GDE framework. The GDE framework can be used as a basis for evaluation of specific driving education methods and also as basis for developing new ideas. The four hierarchical levels and their interplay was described above, but in Table 1 several examples of specific contents of knowledge and skills at each level are presented. The second dimension of the framework is formed by three goals for training: basic skills and knowledge, knowledge and skills concerning risk increasing factors and skills for self-evaluation.

The first column is familiar from the traditional goals of driver training. *Basic knowledge and skills* for vehicle manoeuvring and mastery of traffic situations are typical contents of driver training. However, some of the contents on the highest two levels of the hierarchy are not typically included in driver training curricula (GADGET, 1999). The contents of this column are related to knowledge and skills needed in order to manage in normal traffic. On the lowest level this means basic vehicle manoeuvring skills like control of speed and position, sufficient automation of gear shifting etc. Knowledge about effects of vehicle properties (front wheel drive/rear wheel drive/four wheel drive) and cargo are also included. Basic skills and knowledge required for mastery of traffic situations are based on knowledge of rules, but also on skills for communication, speed adjustment, observation etc. Basic skills on the second highest level, goals and context of driving are connected with planning the trip, and with knowledge about the effects of time pressure and goals of the trip on driving. In driver training the idea of the highest level, (and also of the second highest level) would be to give the driver an idea of driving as a form of behaviour, in which success or failure are closely related to a person's motivational characteristics and the strategy he or she chooses.

Table 1
GDE framework (GADGET, 1999)

Hierarchical level of behaviour	Essential contents (examples)		
	Knowledge and skills	Risk-increasing factors	Self-evaluation
Goals for life and skills for living (general)	Knowledge about/control over how life goals and personal tendencies affect driving behaviour • lifestyle/life situation • group norms • motives • self-control, other characteristics • personal values etc.	Risky tendencies • acceptance of risks • self-enhancement through driving • high level of sensation seeking • complying to social pressure • use of alcohol/drugs • values, attitudes towards society etc.	Self-evaluation/awareness of • personal skills for impulse control • risky tendencies • safety-negative motives • personal risky habits etc.
Goals and context of driving (trip related)	Knowledge and skills concerning • effects of trip goals on driving • planning and choosing routes • evaluation of requested driving time • effects of social pressure in car • evaluation of necessity of trip etc.	Risks connected with • driver's condition (mood, BAC etc.) • purpose of driving • driving environment (rural/urban) • social context and company • extra motives (competing etc.) etc.	Self-evaluation/awareness of • personal planning skills • typical goals of driving • typical risky driving motives etc.
Mastery of traffic situations	Knowledge and skills concerning • traffic rules • observation/selection of signals • anticipation of course of situations • speed adjustment • communication • driving path • driving order	Risks caused by • wrong expectations • risk-increasing driving style (e.g. aggressive) • unsuitable speed adjustment • vulnerable road-users • not obeying rules/ unpredictable behaviour • Information overload • difficult conditions (darkness etc.)	Self-evaluation/awareness of • strong and weak points of basic traffic skills • personal driving style • personal safety margins • strong and weak points for hazard situations • realistic self-evaluation

(*continued on next page*)

Table 1 (*continued*)

Hierarchical level of behaviour	Essential contents (examples)		
	Knowledge and skills	Risk-increasing factors	Self-evaluation
	• distance to others/ safety margins etc.	• insufficient automatism/skills etc.	 etc.
Vehicle manoeuvring	Knowledge and skills concerning • control of direction and position • tyre grip and friction • vehicle properties • physical phenomena etc.	Risks connected with • insufficient automatism/skills • unsuitable speed adjustment • difficult conditions (low friction etc.) etc.	Awareness of • strong and weak points of basic manoeuvring skills • strong and weak points of skills for hazard situations • realistic self-evaluation etc.

The second column, *risk-increasing factors*, consists of knowledge and skills related to risks. The contents of risk increasing factors are actually a part of knowledge and skills but they are separated from other content because of their importance. The risks are different on different levels of the hierarchy. The frequently-used concept "hazard perception" is a good example to be analysed. By using the GDE framework it is easy to see that the traditional idea of hazard perception as "road-craft" appears rather limited. There are potential hazards at all levels of the hierarchy the driver needs to be able to recognize, such as risks related to type of the trip or personal motives or behavioural tendencies.

This column contains topics, that are essential in the so-called "insight" learning courses (see Gregersen, 1996b) as well as defensive driving courses. Defensive driving courses may emphasise mainly skills based on vehicle manoeuvring when involved in a risky situation, and avoidance of risks and risky situations is secondary (DAN, 2000). As for the first column, driver-training programs probably do not contain as many topics connected with the highest two levels as with the two lowest ones. It is evident, that insufficient knowledge of or skills related to all the aspects of driving that are presented in the first column bear a possibility for increased risk and mastery of skills and knowledge improves safety. However, the function of this column is to emphasise the typical risk factors and describe these more in detail.

The content of the third column, *self-evaluation*, is an important tool in driver training and also in development of driving skill after training. Research on development of expertise has shown, that metacognitive skills and reflective thinking are essential characteristics of an expert (Kolb, 1984; Mezirov, 1981; Mezirov & Associates, 1990). Furthermore, reflective thinking is also an essential part of development of an expert. Thus, training of self-evaluative skills should also be included in the training, they do not develop automatically. Abilities for self-evaluation are also expected to have relevance in driving behaviour. A driver, who is, for example, aware of his tendency to fall asleep or his tendency to be unable to resist peer pressure, or a driver who knows the limitations of his or her personal skills on slippery road conditions, may be able to take these factors into consideration and adapt his or her driving accordingly. Educational methods, that

might be appropriate to increasing driver's skills for self-evaluation are improved feedback during training, self-assessment tools like questionnaires and scales, discussions with other youngsters about personal experiences and evaluations made by instructors or examiners.

Skills for self-assessment as well as driver attitudes and individual needs, which can be considered as part of the highest levels in the hierarchy that are presented in the GDE framework, have been referred to by Lynam and Twisk (1995) as the most promising aspects for finding improvement in driver training. In this paper these are intertwined and seen in a wider perspective and as a hierarchy. The GDE framework also gives a comprehensive tool for evaluating of driver education methods along two dimensions at the same time.

It is hypothesised that driver education (at least pre-licensing) is still too concentrated around the boxes in low-left corner of the GDE framework, while those in upper right corner tend to be ignored and miss effective methods. Perhaps these methods are found in some areas of driver education, e.g. driver improvement programs, or are developed for experimental purposes, but they are not widely implemented in driver training. There is only a limited number of practical educational methods, that are aimed specifically at the two highest levels in the hierarchy (GADGET, 1999). Driving methods improving drivers' metacognitive skills are equally scarce.

4. Conclusions

The evaluation of existing driver education methods, as well as defining new goals and new methods should not only be based on empirical results but also on a conceptual analysis. Empirical evidence is essential when developed or already implemented methods are tested, whereas conceptual analysis helps in making new questions and finding the "white areas in the map". A traditional criterion for a well-functioning driver training or driver improvement has been the number of violations and the number of accidents after training. Driver training, especially formal training has been criticised because of rather limited effects on accidents. This criticism is justified, but not enough to prove the activity in itself useless. A fact is that there is no single technical, legislational or behavioural means for reducing the number of accidents radically. Improvement of safety is based on a wide net of countermeasures. It should be pointed out also, that if there is no clear signs of good results with a certain driver training method it cannot be concluded, that training in general is ineffective. In many studies concerning the effects of driver training, the focus has been in the differences between formal and informal training, but the specific goals, contents and methods of the formal training have not been analysed. The goals and the pedagogical methods should be carefully analysed when an safety effects of training are evaluated.

The conclusions are presented as questions that arise from the GDE framework. The first question concerns the framework itself. There are now four levels in the framework, but is that sufficient? Should there also be a fifth level dealing with the phenomena and effects of society on driver's lifestyle, and with the possibilities for learning self-reflection or self-control? The driver is not isolated but operating in certain circumstances and under certain conditions. Some researchers have tried to integrate societal factors into their driver behaviour models (Michon, 1976) or tried to get a grip on the latent, system errors in accident causation (Reason, 1990). The question can be raised whether society is doing everything that it can and what it should do to help the driver to drive safely?

The second group of questions concentrates on the goals and contents of training. Are all levels of driver behaviour hierarchy emphasised enough in professional and layman instruction? Is training still concentrating too much on the two lowest levels and too much limited to basic knowledge and skills? Or should it concentrate on those two lowest levels and should training not touch the highest levels but consider these as a person's private areas. In particular trying to change or affect the highest level can be seen as an intrusion to the persons private life and values. However, in driver improvement courses the highest levels are in the main focus of work (DAN, 2000).

The third group of questions concerns the methods of driver education. What are the consequences if learning of basic knowledge and skills, and concentration on vehicle manoeuvring and mastery of traffic situations are not considered as a sufficient target of driver education? What are the best methods to support learning when instruction aims at learning and understanding risks? What are the pedagogical implications of trying to cover also the two highest levels in the GDE framework? Is lecturing enough?

Self-evaluative or reflective skills were presented in the third column of the GDE framework. What could be their role in the implementation of the idea of "life-long learning" in traffic? What kind of measures are effective in teaching those skills or is it possible to teach them at all. Do we have to support the learning process and how can we do it in an effective way?

It is also possible to discuss about the probable effects of different kind of training methods. There is a possibility that a novice driver gets feedback concerning only about basic manoeuvring skills and skills needed in mastery of traffic situations. What happens if the driver does not get feedback or consider the role of the less concrete highest hierarchical levels before getting the license? We already know what the problems are if training to drive on slippery roads is concentrating on manoeuvring skills. We may also have other questions concerning driver training, and systematic and conceptually well based tools help us to formulate the right questions and help us to answer those in the future.

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