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John Wagner
Clemson University, jwagner@clemson.edu

M Jensen
Clemson University

F Switzer
Clemson University

K Alexander
Clemson University

P Pidgeon
Clemson

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M. Jensen, J. Wagner, Ph.D., P.E., F. Switzer, Ph. D., K. Alexander, Ed.D., and P. Pidgeon, Ed. D., D. Min. - Department of Mechanical Engineering, Psychology Department, and Automotive Safety Research Institute, College of Engineering and Science, and College of Business and Behavioral Science, Clemson University, K. Rogich, Richard Petty Driving Experience

ABSTRACT: Novice drivers are overrepresented in traffic crashes and fatalities. Traffic crashes are the leading cause of death for 16 to 20 year olds and account for one in three deaths in this age group (NHTSA, 2008; CDC, 2010). Significant research has been conducted developing and analyzing driver education and training and education programs. Effective programs identify their target audiences and tailor the program paradigm and methods to their developmental needs. This paper develops a second-stage safe driver program for novice drivers focusing on classroom and behind-the-wheel instruction for four common driving skills and situations: braking, avoiding obstacles, losing control, and tailgating. Based on a review of the available research, four modules are outlined which integrate best practices and training tools aimed to improve not only driver knowledge but behavior, awareness, and driving skills as well.

1. INTRODUCTION

Driver education and training is a necessary and important aspect of vehicle operation and general mobility. During 2006, the 12.7 million 16-20 year old drivers represented 6 percent of the nation's licensed drivers; about 2 million new drivers, mostly teens begin driving each year (NHTSA, 2008a). While nearly all eligible US students received driver education coursework during the 1970s, by 2008 driver education was offered in only 30 states and the District of Columbia as a requirement of the Graduated Licensing program (NHTSA, 2008b). All 50 states and the District of Columbia implement some form of a GDL program; all have a minimum age to start licensure and most include night and passenger restrictions, along with specified supervised driving documentation and learner permit holding periods. Requirements vary state by state, but generally a minimum of thirty (30) classroom hours and six (6) behind-the-wheel hours of instruction are required before a beginner driver is eligible to attempt licensure for vehicle operation (Bishop *et al.*, 2005). More recently, many states have removed mandatory driver education for young drivers. States that have eliminated these local and/or state government-funded driver education programs rely more heavily on parental involvement and graduated driver licensing (GDL) programs for driver development. Further, they use driving examinations for driver competency testing (Senserrick, 2007). As of 2005, all 50 states and the District of Columbia have implemented some form of a GDL program (Williams & Mayhew, 2008). GDL programs focus on restricting young drivers (under 18 years of age) from certain high-risk situations for a specified amount of time, providing young drivers with real-world driving experience, and allowing them to practice under safer conditions. For instance, GDL-imposed driving restrictions include nighttime driving, driving with multiple passengers, and unsupervised driving during certain hours (Insurance Institute for Highway Safety, 2010). Over time, and assuming violation free status, the GDL restrictions are reduced and/or eliminated.

Recent developments in driver education and training have focused on a multistage instructional design (Mayhew, 2007). In 1994, the National Highway Traffic Safety Administration (NHTSA) suggested the merits of a multistage novice driver education and training to take advantage of the time delay for driving privileges in GDL. The proposed multistage education and training should offer classroom and behind-the-wheel training progressively at different points during licensure. The first stage of driver education and training should occur early in the driver licensing program when students have obtained the learner's permit. During this stage the novice driver education and training would involve formal driver education with instruction in general knowledge, rules of road, and basic vehicle handling conducted during learner phase of GDL. The second-stage of education and training should

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ideally occur after the students have had at least 6 months of driving experience with an intermediate/provisional license. Thus, second-stage driver education and training is designed to complement the supervised driving with parents in order to provide instruction in safe driving procedures including risk perception and decision-making skills.

The theoretical basis for a multistage driver education and training program is consistent with research in adolescent development which has demonstrated that the learning goals for the driving task should be spread out over time due to both the student's inadequate cognitive abilities as well as their lack of readiness to learn (Mynttinen, 2010; Gregersen et al. 2000; Gregersen, 1994; McKnight, 1985). According to Mayhew and Simpson (2002), it is important for novice drivers to have experience in real world driving in order for instruction in safe driving to be more meaningful. The authors further suggest that a second-stage of driver training should address the following key areas: (a) psychomotor, cognitive, and perceptual skills; (b) safe driving practices; (c) personal limitations and skill deficiencies; (d) overconfidence in training skills; and (e) lifestyle and psychosocial factors.

Beyond formal driver education, supplemental or second -stage training programs ranging from brief internet courses to intensive multi-day in-vehicle programs have been developed (Mayhew, 2007). According to Foss (2007), programs focused on increasing students' driving safety level should address human behaviors equally or to a greater extent than driving skills and knowledge. These courses should moreover include targeted content appropriate for the given demographic. For novice or inexperienced drivers, content related to visual searching, attention errors, and overall vehicle speed should be included (McKnight, 2006). Additionally, training in both risk assessment and risk management should be considered necessary components of any second-stage training program (Mynttinen, 2010; Rosenbloom et al., 2008; Fisher et. al., 2006).

It should be noted that some studies have suggested that programs attempting to increase driver safety by means of increasing driver skill levels may at best be ineffective and can increase the student's crash risk (Senserrick, 2007). This higher crash risk is thought to be due to the fact that advanced driving skills courses may unintentionally encourage overconfidence and increased risk taking on the part of participants (Katila *et al.,* 1996). However, more recent studies have offered a favorable view of designing a driver skills education and training program which avoids increasing overconfidence in its participants (Rosenbloom *et al.,* 2008). Such a course should give priority to instruction in anticipatory driving strategies while at the same time teaching maneuvering skills (Katila *et al.,* 2004).

This paper discusses the development of a second-stage safe driving program that includes both classroom and behind-the-wheel curriculum. First, we present a brief review of the literature on curriculum development in driver skills and education training programs. Second, we discuss the development of the novice driver education and training program curriculum. And, finally, we present conclusions.

2. LITERATURE REVIEW

Historically, driver education was considered to be the best method for teaching basic driving skills to novice drivers (Warner, 1972). In the United States, driver education has traditionally been administered through the public school system and taught by instructors with varying qualifications. The driver education programs in the 1940s and 50s were designed to teach basic driving skills and knowledge required to pass the state-regulated driver examinations (written and behind-the-wheel). Driver education and training programs increasingly began to address other critical objectives as a more systematic examination of the driving task occurred in the early 1960s. Curricular areas focusing on motivation, hazard perception, risk evaluation, and risk acceptance were added in the 60s and became normative by the 1970s. The total amount of instructional time scheduled in driver education programs has not varied much since the first national conference on Safety Education recommended 30 (classroom) and 6 (behind the wheel). (Palmer, 1981). An expectation that students were practicing driving

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skills with their parents/guardians outside of formal training environment has been common among driver education instructors and many driver education instructors have made guided practice and assignment between behind the wheel driving lessons. Current estimates for the total amount of supervised teen driving needed to prepare a novice driver range from 40 to 75 hours (Simons -Morton & Ouimet, 2006).

Recently, many countries have seen an increased demand for programs offering specialized instruction and improved driving skills training for novice drivers. This increase has led the European Commission to publish the "Summary and Publication of Best Practices in Road Safety" in the EU Member States (SUPREME, 2007). The SUPREME report found that then current formal pre-license driving schools had a limited safety benefit while advanced post-license skills training trended to have a negative safety impact.

The DeKalb County (Georgia, USA) driver education study (NHTSA, 1983) found no statistically significant positive safety impacts for driver education. Several evaluations of the original DeKalb dataset have been conducted since the early 1980's (Lund *et al.,* 1986; Smith & Blatt, 1987; de Wolf and Smith, 1988; and Davis, 1990) and each concluded that formal driver education was not associated with any reduction of crash involvement by young drivers within two (2) years of training. Jones and McCormac (1989) examined crash rates in Oregon for trained and untrained drivers, finding no significant difference in crash involvement within one (1) year after licensure. Gregersen (1994) evaluated a Swedish driver training program and found that crash rates were higher for trained drivers in the first year post-licensure, but were slightly reduced in the second year. The net effect of the program after two years was negligible. Mayhew *et al.* (1998) note that other similar studies have reached the same conclusion.

One study conducted in Denmark by Carstensen (1994) analyzed a newly adopted mandatory driver education program for young drivers. Unlike previous studies, Carstensen concluded the program yielded a positive reduction in crash rates. However, the study was completed under less than ideal conditions utilizing a quasi-experimental design that examined before and after groups. Regardless of the research design, the Denmark study has remained the best evidence of a positive effect on novice driver safety by a driver education and training program. A follow up study (Carstensen, 2002) used a different subject group and longer driving history to confirm the earlier results of the Denmark training program.

The American Driver and Traffic Safety Education Association (ADTSEA) has developed a formal driver education program used by many USA school districts. The program provides suggestions for in-class and behind-the-wheel programming using a best-practices approach to novice driver training. Williams *et al.* (NHTSA, 2009a) examined the feasibility of evaluating the ADTSEA program using a complete and randomly assigned study (similar to the DeKalb project). The paper concluded that such a study would be prohibitive due to cost, necessary group size, and difficulty of obtaining participating schools and students. Moreover, ADTSEA through the National Driver Education Standards Project released *Novice Teen Driver Education and Training Standards* in 2009. This effort has resulted in a tool which is intended to assist driver education and training professionals in advancing best practices (NHTSA, 2009b).

New research on development of driver education and training has focused on motivation, or insight training, where a driver's knowledge of their limitations and behaviors allow them to change their driving style to suit a given scenario (MacNeil, 2007). Insight training seeks to impart in participants a greater appreciation for personal driving skill sets or lack thereof. For young drivers especially, this self-awareness is underdeveloped and should be incorporated into any driver education and training program, most notably second-stage driver education programs aimed at improving driver safety during the intermediate stage of the licensing process.

Similarly, recent research in teen driving safety from the perspective of adolescent development has suggested promising avenues for enhancing the acquisition of safe driving skills. While it remains true that expertise in safely maneuvering a motor vehicle is developed over time,

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research also indicates that initial training in correctly acquiring these skills is extremely important to embedding the desired patterns of behavior (Keating, 2007). Furthermore, it is clear that instruction in maneuvering skills for novice drivers must be secondary to stronger emphasis on the acquisition of anticipatory safe driving strategies (Rosenbloom *et al.,* 2008). Additionally, pedagogy must be aimed at helping participants avoid overconfidence and risk-taking behaviors in the driving task (Hatakka *et al.,* 2002).

Recent studies have only begun to show a renewed interest in evaluating the effectiveness of novice driver education and training programs (Lonero & Mayhew, 2010). The questions as to what skills and knowledge should be taught, how best to teach those skills and knowledge, and how much practice is necessary in driver education and training have yet to be definitively answered. In order to increase driver/occupant safety, a successful education and training program will have to be developed using a research- and theory-based approach that utilizes previous research, best-practices, and new (or new to the field) technologies and emphasizes content and teaching methods, with possible inclusion of student assessment (both short-term and long-term) (Lonero & Mayhew, 2010).

3. SAFE DRIVING PROGRAM (SDP)

During development of the Petty Safe Driving Program (SDP), a second-stage novice driver education and training program, teen drivers were targeted due to their driving inexperience and underdeveloped skill set. This pilot program was designed to improve driver safety through improved classroom and behind-the-wheel training with emphasis on program delivery and content. One of the underlying assumptions was that students learned fundamental vehicle operation skills and safety guidelines prior to enrollment in the SDP. The SDP course offered supplemental education and training in anticipatory safe driving strategies regarding the leading causes of automotive crashes through classroom and in-vehicle training. In addition, meaningful feedback was provided to students through written and performance evaluation. Section 3.1 of this paper discusses the paradigm used for the program delivery while section 3.2 introduces the content for the driving and classroom modules.

3.1 Paradigm

Effective delivery was critical for the program to be successful, while efficient use of time and space was equally important. The developed SDP totals six (6) hours and consists of a 30 minute opening, four (4) 75 minute long modules, and a 30 minute conclusion. Equal time was given to classroom and behind-the-wheel curriculum with the presented materials reinforcing each other. The 50/50 ratio of classroom and behind-the-wheel time departed from a formal driver education course; however, the SDP was designed to provide supplemental instruction/practice rather than fundamental instruction. The classroom time was used to emphasize important knowledge and behaviors for safe driving while the behind-the-wheel instruction focused on skill development.

Each of the four modules included goals and objectives, introduction, demonstration, driving instruction and guided-practice, classroom activities, and assessment. During the driving portion, students practiced skills with in-vehicle instructors who provided one-on-one instruction to each student. In order to promote best practices (Lonero & Mayhew, 2010; NHTSA, 2009b; SUPREME, 2007; Williams *et al.,* 2009), instructors acted as coaches, providing verbal feedback and corrections throughout the training rather than basic instructions. The skills training and classroom curriculum reinforced each other without being dependent on one another. A single classroom instructor was used to focus discussions and introduce driving strategies and methodologies normally undertaken by more experienced drivers. A more detailed discussion of the materials is presented in section 3.2.

All classroom and in-vehicle instructors had completed a training course directly related to novice driver training. This course included methodologies for educating teenagers, an overview of all SDP materials, and step-by-step discussion of each driving module.

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In order to provide a safe and controlled environment for the driving portions of the program, a closed course of at least 450 meters (m) (1500 ft) by 610 m (2000 ft) was suggested. Ideally the location should be relatively flat without any obstacles such as concrete barriers or light poles present. Typically large open parking lots were considered suitable.

3.2 Modules

Four modules were developed for the SDP including: braking skills, reaction time / obstacle avoidance, loss of control, and tailgating. These modules were identified in order to address major contributing factors for teen crashes both in the southeastern states (primary locations for the program) and nationwide. The contributing factors for teen crashes were determined using the Fatality Analysis Reporting System (FARS) which contained data on all fatal crashes within the 50 states, District of Columbia, and Puerto Rico. Each module was designed as a 75 minute stand-alone course with a 10 minute introduction/ demonstration, 30 minutes of behind-the-wheel activities, 30 minutes of classroom material, and a 5 minute conclusion.

Braking Skills: The primary driving skill for safe driving was the use of proper braking techniques. The inclusion of anti-lock braking systems (ABS) in modern vehicles has reduced the difficulty associated with repeatable, maximum (emergency) stopping; however, not all vehicles (including brand new vehicles) are equipped with ABS. Additionally, vehicles equipped with ABS do not stop in as short a distance as possible (Alleyne, 1997). These conditions, along with novice drivers' lack of experience with emergency braking, had lead to the inclusion of a braking skills module in the SDP.

Rationale: The braking skills module addressed several contributing fatal crash factors for teen drivers including: driving too fast for conditions, running off the road, and following improperly.

The purpose of this module was to help novice drivers gain insight into factors that affect braking performance and provide experience and skill development in maximum or threshold braking (i.e., stopping without skidding). In addition, instruction was provided to help participants better understand the limitations of their vehicle's brakes and motivate them to avoid situations in which they were unable to stop their vehicle in time to avoid a crash. Both ABS and non-ABS equipped vehicles were utilized in wet and dry pavement conditions. Participants began by accelerating to a constant speed. At a set point on the track, a stop light was triggered by the vehicle signaling the participant to bring the vehicle to a sudden and complete stop using the vehicle's maximum stopping ability.

Classroom instruction included exercises focused on safe driving judgment and decision making and an overview of vehicle maintenance as a safe driving strategy. Three role-play situations were used to teach awareness of risky driving situations and promote driving strategies for anticipating hazards. Vehicle maintenance was reinforced through presentation displays about vehicle fluids and brake pad wear along with demonstrations on how to check tire pressure and tire tread depth.

Reaction Time / Obstacle Avoidance: The ability to react quickly in an emergency driving situation can often mean the difference between a near miss or a crash and sometimes even life and death. Personal perception or reaction time can be defined as the time it takes a person to visually recognize a stimulus and respond properly (e.g., see the red light, lift foot off gas pedal, and depress the brake pedal). During an obstacle avoidance situation, reaction time and situation awareness (the ability to perceive and think ahead) were the most critical elements for safe maneuvering.

Rationale: The module addressed several contributing crash factors including: driving too fast for conditions, inattentive, failure to obey traffic signals and following improperly.

The driving portion of the module utilized a similar layout to the braking skills module. Wet and dry roadway conditions were used for practicing vehicle maneuvering and braking for the purpose of obstacle avoidance. Three (3) lanes are simulated using traffic cones with the participants beginning the module in the center lane. Participants were instructed to bring the vehicle to a constant speed until a traffic light above each lane illuminated at a

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pre-defined location. The signal light was used to convey the safety level of each lane with green/unlit signifying safe and red identifying potential danger. The participants were asked to maneuver the vehicle as quickly as possible into the correct (safe) lane while either maintaining the vehicle's speed or bringing the vehicle to a complete stop. Exploration of each driver's personal reaction and decision-making skills allowed for participants to better identify the limitations of the vehicle and their own limited driving abilities.

In the classroom, participants applied a four component safe driving strategy - *scan, anticipate, decide, move-countermove* - to several case studies. These case studies used typical traffic conditions and driver behaviors to initiate discussions about the importance of reaction time and situation awareness and how to avoid overconfidence. The importance for all vehicle occupants to use seat belts correctly was also emphasized.

Loss of Control: This module focused on improving participants' skills in loss of control situations, including recognition of loss of traction and use of countermeasures for loss of control in cornering and braking situations.

Rationale: The module addressed contributing crash factors including driving too fast for conditions and inattention, while also focusing on failure to keep in proper lane, over-correction and improper turn.

This module was designed to improve participants' chances of avoiding loss of control situations by providing anticipatory driving strategies such as recognizing advisory curve speed (ACS) signs, scanning farther down the road for obstructions and blind curves, and looking in the direction they want to travel. The module included both a circular skid pad and simulated roadway environment. During the skid pad exercise, participants experienced both front and rear-wheel skids. The roadway portion included three (3) turns (two right-hand, one left-hand) of various radii and traction levels. Several runs performed at different speeds were suggested, providing participants with different simulated scenarios.

In addition to the driving instruction, classroom activities included the hands-on demonstration of how to jump-start a vehicle with a dead battery and a discussion about supplies needed in a vehicle emergency kit. A review of vehicle maintenance tasks and safe driving strategies was conducted in a game format. These activities were all used to reinforce situational awareness in the driving task and underscore drivers' responsibilities.

Tailgating: The tailgating module was designed to complement the braking module, as tailgating may lead to necessary emergency braking and was one of the more common driving errors made by drivers. Additionally, tailgating was a common situation where drivers typically experience no repercussions from dangerous behavior. The lack of consequences can very easily create overconfidence and foster inattention.

Rationale: The module was a more specialized driving module; however, several contributing crash factors were addressed including driving too fast for conditions, inattention, and following improperly.

A custom training tool was developed in conjunction with the driving curriculum in order to better simulate a tailgating scenario (Jensen *et. al.,* 2011). During the in-vehicle instruction, two participant-driven vehicles followed the tailgating apparatus at various distances while maintaining a constant speed. The instructor in the lead vehicle (to which the apparatus is attached) performed sudden emergency braking maneuvers triggering the participants to react and attempt to bring their vehicle to a stop prior to colliding with the apparatus (refer to Figure 1).

Figure 1: Demonstration of the tailgate apparatus during the tailgating module.

In the event of a collision, the apparatus had been designed to absorb low speed impacts without causing damage to either vehicle or the apparatus itself. By allowing

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collisions, participants were able to experience the consequence of poor following techniques without personal injury or vehicle damage. This training experience was designed to directly address overconfidence with respect to actual skills in crash avoidance.

Classroom instruction reinforced the driving materials through a hands-on activity about the blind areas surrounding large vehicles. With a participant seated in the cab of a semi-truck providing direction, other participants used chalk and traffic cones to outline the "No-Zone" in order to gain an appreciation of correct following distances when sharing the road with trucks and busses. In a second exercise, participants referred to vehicle manuals as a tool for discussion regarding safe vehicle operation and maintenance.

4. CONCLUSION

Traffic crashes kill a large number of Americans every year and is the leading cause of death for adolescents. Significant research has been conducted on the impact of driver education and training courses, but few positive results have been found to date. Other studies have been conducted to identify possible best practices for safety focused driver training programs.

This paper has outlined four training modules that constitute the Petty SDP, a second-stage safe driving program focused on improving novice driver safety. Future research efforts should include a pilot test of the new curriculum in order to determine its effectiveness. Assessment of the program's impact should examine the change in participants' knowledge, attitude, and driving behaviors, as well as provide an evaluation of driving performance, perceptual strategies and decision making.

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