A New GDL Framework:
Evidence Base to Integrate
Novice Driver Strategies

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November 2014
Traffic Injury Research Foundation

ISBN: 978-1-926857-57-2

A NEW GDL FRAMEWORK: EVIDENCE BASE TO INTEGRATE NOVICE DRIVER STRATEGIES

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ACKNOWLEDGEMENTS

This project would not have been possible without the support of many key people. First, the authors would like to thank the project sponsors for their support and assistance with various tasks associated with this work, as well as for the organization and logistics of the International Expert Panel Discussion.

We also gratefully acknowledge the input and knowledge gained from the many individuals, internationally, who informed the development of the GDL framework through their responses to the environmental scan. As well, we would like to thank the Moderators, Expert Panel Members, and other participants of the International Expert Panel Discussion. Their knowledge, insight, perspectives, and suggestions allowed us to develop a comprehensive and well informed product.

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Purpose

This report describes a comprehensive Graduated Driver Licensing (GDL) framework that has been developed to better address the elevated crash risk of young and new drivers. This new GDL framework is unique in that it proposes that driver education, licensing and testing requirements, as well as in-vehicle monitoring technology be integrated into an enhanced GDL program.

The discussion is focused on the U.S. situation, but this GDL framework is intended to be applicable and adaptable to GDL programs worldwide. The goal of the present project is to identify internationally, current approaches and research on GDL, driver education, license testing/assessment, and in-vehicle monitoring technologies that have the potential to increase the safety outcomes of young and novice drivers. These best practices are consolidated into a new comprehensive framework in which all of these safety initiatives are better integrated to reinforce an optimal GDL program. As well, this GDL framework is presented as a formalized representation of best practices that have the potential to be efficiently and effectively incorporated into existing GDL programs worldwide.

Method

The major tasks of this project include:

- a literature review of academic journals and published materials from various traffic safety organizations and resources of research related to the effectiveness and implementation of GDL, driver education, license testing/assessment, and, in-vehicle monitoring technology for young and novice drivers across the globe;
- an environmental scan of contacts in relevant agencies in North America and internationally to identify the most recent advancements in young and novice driver programs throughout the world that may not have otherwise been captured through a literature review alone;
- a 1½ day international expert panel discussion to describe, discuss, and augment a proposed GDL framework; and,
- the application of the information obtained from these sources to develop and refine the final comprehensive GDL framework contained in this report.

GDL framework

The review of the scientific evidence, the environmental scan of current and best practices, and the international expert panel discussion provided guidance regarding ways to enhance GDL and better integrate safety measures for young and novice drivers, including driver education and training, license testing, and in-vehicle monitoring technologies, within a comprehensive GDL framework. The GDL framework described below comprises evidence-based initiatives along with those that are largely unproven but make sense on logical grounds and are supported by expert opinion. This is similar to the situation several decades ago when the concept of GDL was initially developed and promoted. At that time, there was limited or no research on the safety effects of GDL and most of its components, with the exception of a night driving restriction which early studies had shown to have safety benefits. However, the concept of a GDL system that introduced beginners into the traffic environment while protecting them as they gained experience made sense on logical grounds. As jurisdictions implemented GDL and evaluated it, GDL emerged as a popular and successful policy with proven safety benefits.

The description of the GDL framework is followed by an illustration of it. Since the strength of the evidence in support of a specific component being recommended varies from strong to lesser or insufficient evidence, the illustration uses a gold star to denote components with a strong empirical base. Other components are based on expert opinion having a solid logical basis for consideration. Although these lack strong empirical evidence they are recommended as part of the GDL framework since they may reinforce GDL principles and operation but further research is needed to determine their safety effectiveness and/or the extent to which they contribute to the overall benefits of GDL.

In the framework, young and novice drivers move through two restricted phases of licensing, including a learner and intermediate stage, before progressing to full licensure. The specific components of each of these license stages are detailed below.

Learner Stage

Eligibility age. GDL should apply to all beginners, regardless of age, although some rules could be relaxed for adult learners and novices.

Minimum entry age. The minimum entry age should be no younger than 16.

Minimum length in learner stage. The minimum length required to remain in the learner stage should be no less than 12 months.

Entry requirements. To obtain a learner license, applicants must pass knowledge and vision tests, which should include items relating to GDL requirements.

Supervised driving. The minimum number of supervised driving hours that should be a requirement to progress through GDL should be greater than 50 hours, optimally 80-120, and should span all seasons of driving. Log books should be required to increase knowledge and promote compliance with the required number of supervised hours. Also, log books could provide evidence of requirement fulfillment. In-vehicle monitoring could be used as a method to more accurately monitor practice driving hours.

Restrictions. Seatbelt use should be required for drivers and passengers. Supervisors should be restricted to a low or zero BAC. Phone/electronic device use by learners should be prohibited. Vehicle decals, designed to help police enforce GDL and encourage compliance with GDL restrictions, should be required for all drivers in this stage. Although not shown in the framework illustration, if GDL is extended to older novice drivers, a zero alcohol limit should be applied.

Driver education. Jurisdictions should regulate driver education to meet Novice Teen Driver Education and Training Administrative Standards (NTDETAS) in a multi-phased approach, including an initial phase of driver education (Phase 1), which would include in-vehicle and theoretical instruction that teaches basic vehicle handling skills and rules of the road to learners. Phase 1 driver education for young learners should: be teen-oriented; include a mandatory parent orientation course and encourage parental involvement throughout the GDL process; include GDL rationale and requirements in the curriculum; provide end of course reports/debriefings to parents that include recommendations for areas that need improvement; and, provide information about available in-vehicle technologies that can enhance the safety of young and novice drivers. The completion of driver education should not result in a reduced length of time spent in the learner stage. Driver education in-vehicle hours could be applied to reduce the mandatory minimum supervised driving hours if they are set at 120 hours or more.

Intermediate Stage

Minimum entry age. The minimum entry age should be no younger than 17, and should not include exemptions for drivers who have completed driver education courses.

Minimum length in intermediate stage. The minimum length required to remain in the intermediate stage should be no less than 12 months, regardless of age at the time of entry. This ultimately means that the minimum possible age to progress to full licensure should be 18 years old.

Entry requirements. Requirements for obtaining an intermediate license should include passing an on-road, standardized entry-test. This test should include hazard perception skills. In-vehicle monitoring technology is encouraged as a means of objectively assessing driving skills and abilities. The completion of a second phase of driver education (Phase 2) which would involve advanced instruction to teach safe driving procedures including perceptual and decision-making skills (could include hazard perception training and incorporation of driving in high-risk situations, such as highway driving) should be jurisdiction-regulated and encouraged. Phase 2 driver education should be delivered just prior to the on-road test, or alternatively or in addition, in the first few months after the road test when teens are driving independently for the first time and experiencing their highest crash risk.

Restrictions. Unsupervised nighttime driving restrictions beginning at 9-10 pm and ending no earlier than 5 am should be required for all intermediate drivers. With the exception of a supervising driver and family members, intermediate license holders should be restricted to have no more than one teenage passenger in the vehicle at all times. Seatbelt use should be required for drivers and passengers. Phone/electronic device use by intermediate drivers should be prohibited. Vehicle decals, designed to help police enforce GDL laws and encourage compliance with GDL restrictions, should be required for all intermediate license holders. Although not shown in the framework illustration, if GDL is extended to older novice drivers, a zero alcohol limit should be applied.

Exit requirements. In order to progress to a full, unrestricted license, intermediate license holders should be required to pass an advanced on-road or computer-based exit test that includes measures of higher-order driving skills such as hazard perception, situational awareness, and decision-making. This test provides incentive for novice drivers to obtain additional driving instruction (in the form of Phase 3 driver education) and practice during the intermediate stage, in order to attempt the exit test and obtain a full license. In addition, or as an alternative to testing, graduating from this stage to a full license could be contingent on having a clean driver record.

Additional features. Technology, such as Smart Keys, in-vehicle feedback systems and other resources and tools, including on-line safety-oriented programs, should be promoted by licensing and insurance agencies, as well as driver education programs to help: enforce seat belt use; limit speeding; provide warnings of dangerous driving behaviors (e.g., lane deviation); and, reduce distractions (e.g., vehicle stereo volume) to novice drivers. As well, this stage should encourage continued parental involvement through in-vehicle monitoring technologies that automatically alert parents of risky driving behaviors. This could include a ‘two-strike system’, where teens are given the opportunity to correct an unsafe behavior before their parents are alerted.

GDL FRAMEWORK

★ Apply to all beginner drivers

Learner Stage
Supervised driving

Stage Components

Entry Requirements
- ★ Minimum 16 years old
- Pass vision test
- Pass knowledge test (includes GDL items)

Restrictions
- Seatbelt requirement
- Phone/electronic devices prohibited
- Decal required
- Zero BAC for supervising driver

Length
- ★ 12 months (no reduction in length for DE completion)

Supervised Hours
- ★ >50 mandatory supervised driving hours, optimally 80 to 120 hours

Reinforcing Components
- Phase 1 driver education with parental involvement; includes basic skills
- Paper log books and in-vehicle monitoring technology to monitor accumulated hours and requirement fulfillment

Intermediate Stage
Solo driving

Stage Components

Entry Requirements
- ★ Minimum 17 years old
- Pass enhanced on-road test

Restrictions
- ★ Nighttime restriction (9 or 10 pm-5 am)
- ★ Teenage passengers limited
- Seatbelt requirement
- Phone/electronic devices prohibited
- Decal required

Length
- ★ 12 months

Exit Requirements
- ★ Minimum 18 years old
- Pass advanced on-road exit test(s) and/or maintain clean driving record

Reinforcing Components
- Phase 2 driver education with parental involvement; includes higher-order skills, delivered just prior to, and/or just after, the on-road test
- In-vehicle technology to monitor compliance and to assess skills
- Phase 3 driver education encouraged as a means to pass exit test

Full Stage
Unrestricted driving

★ A gold star denotes a stage component with a "strong evidence base".

INTRODUCTION

Novice drivers, especially young ones, have a heightened risk of collision compared to older, experienced drivers. In the United States, young and novice drivers aged 16-19 had a fatal crash risk that was approximately three times that of drivers aged 20 and older in 2012. Furthermore, this risk was found to be the highest among drivers aged 16-17, the age at which many teenagers are driving independently for the first time (Insurance Institute for Highway Safety 2014c).

While these facts are a significant cause for concern, progress has been made in recent decades in reducing the number of young driver fatalities and crashes. One of the most important contributors to this decrease can be attributed to the implementation of Graduated Driver Licensing (GDL) programs. GDL involves a tiered system of licensing in which novice drivers are gradually exposed to driving situations over an extended period of time spent in low-risk environments. As well, other programs with varying levels of evidence-based effectiveness, such as driver education, enhanced driver license testing, and new in-vehicle monitoring technologies, have been increasingly implemented in the hopes of reducing the risk to teen and novice drivers. However, such programs, including GDL programs, have little uniformity in content and delivery across jurisdictions and are generally operated separately, as opposed to in conjunction with each other.

With this in mind, the Traffic Injury Research Foundation (TIRF) has been sponsored by the National Safety Council (NSC), with cooperation from the National Highway Traffic Safety Administration (NHTSA) and the Allstate Foundation to carry out a project that involves the development of a comprehensive GDL framework. This new GDL framework is unique in that it proposes that driver education, licensing and testing requirements, as well as in-vehicle monitoring technology be integrated into an enhanced GDL program.

The discussion is focused on the U.S. situation, but this GDL framework is intended to be applicable and adaptable to frameworks worldwide. The goal of the present project is to identify internationally, current approaches and research on GDL, driver education, license testing/assessment, and in-vehicle monitoring technologies that have the potential to increase the safety outcomes of young and novice drivers. These best practices are consolidated into a new comprehensive framework in which all of these safety initiatives are better integrated within an optimal GDL program. As well, this GDL framework is presented as a formalized representation of best practices that has the potential to be efficiently and effectively incorporated into existing GDL programs worldwide.

The major tasks of this project included a literature review, an environmental scan of contacts in relevant agencies in North America and abroad, an international expert panel discussion, and the application of the information obtained from these sources to develop and refine the final comprehensive GDL framework.

Literature review

The first major task was to conduct a literature review of academic journals and published materials from various traffic safety organizations and resources. The review covered any pertinent information and research related to the effectiveness and implementation of GDL, driver education, license testing/assessment, and in-vehicle monitoring technology for young and novice drivers across the globe. This information was used as a starting point from which a draft report was constructed.

Environmental scan

The second task of this project aimed to gather additional information from subject matter experts in the field of traffic safety by means of an environmental scan (see Appendix A). The purpose of the environmental scan was to identify the most recent advancements to young and novice driver programs across jurisdictions that may not have otherwise been captured by conducting a literature review alone. The scan, which consisted of 7 items related to participant knowledge of completed or on-going enhancements to young and novice driver programs, was sent electronically to a total of 28 experts in 11 countries. Furthermore, participants were asked to provide any references to individuals who might have additional information to add to the project. These references were subsequently contacted to request that they also complete the environmental scan. A total of 21 experts from 11 countries responded to the environmental scan. Their responses were systematically compiled into a single source which was then used to further develop the GDL framework and inform the content of this report.

Expert panel discussion

A panel of international experts was convened in June 2014 to discuss and augment a proposed GDL framework. The list of expert panel members and other participants at this meeting are provided in Appendix B. The two-day expert panel discussion included a presentation of the proposed framework, in-depth guided discussions of the rationale and best practices for various components related to young and novice driver programs, as well as how they could be best integrated into current GDL systems. The outcomes of this panel discussion served to further develop and refine the GDL framework, as well as this final report.

Development of a GDL framework

A novel GDL framework was progressively developed throughout the course of this project. It recommends the integration of GDL, driver education, license testing/assessment, and in-vehicle technology into a system which represents best practices in young and novice driver programs. Development of the framework includes recommendations for best practices based on the following two criteria:

- Strong empirical evidence from credible sources demonstrating that the feature, which is central to GDL, has influenced safety performance measured in terms of improved driving behaviors and/or fewer collisions and convictions.
- Expert opinion from the literature review, environmental scan, and expert panel discussion that the feature has a logical basis for consideration. These practices lack strong empirical evidence because available research, although promising, has been limited or the practice has not been evaluated even though it may have been in place in one or more jurisdiction(s) for some time or it has only recently

emerged for consideration. These practices are recommended as part of the GDL framework since they may reinforce GDL principles and operation but further research is needed to determine their safety effectiveness and/or the extent to which they contribute to the overall benefits of GDL.

This framework is supported by years of evidence-based research and evaluations, as well as knowledge and insight from experts with several decades of combined experience in young and novice driver programs. Ultimately, this GDL framework provides the basis for standardization and enhancement to current GDL programs worldwide.

Licensing policies and the introduction of GDL

Worldwide, young drivers have an elevated crash risk resulting primarily from inexperience and characteristics associated with youthful age. Older beginner drivers also have high crash rates primarily due to inexperience. This has led to an emphasis on ways to introduce beginners into the traffic environment while protecting them as they gain experience and, for young beginners, maturity. One way to do this is through licensing policies which apply to all beginners. These policies set the age at which licenses can be obtained and the requirements to obtain a license that allows independent driving.

There is substantial variation in licensing policies around the world. Licensing ages have generally ranged from 15 to 18 years old. Requirements that must be met to obtain a license also differ and have changed over the years. The most dramatic shift has been in countries with younger licensing ages of 15 or 16 (e.g., Canada, New Zealand, United States) with the adoption of graduated driver licensing (GDL). GDL in its basic form involves an extended learner stage of supervised driving, moving to an intermediate stage prior to full licensure in which there are restrictions on unsupervised driving in high risk situations. It is this second stage which is the unique feature of GDL. Late-night driving and driving with young passengers have been the high-risk situations primarily targeted. New Zealand adopted its initial version of GDL in 1987, including night and passenger restrictions, and Canadian provinces and U.S. states began adopting GDL policies in the mid-1990s. Australian states, most licensing at age 17 except for Victoria (18), have had a long history of GDL policies focused primarily on the learner phase, and some states have now added night and/or passenger restrictions. In 2013 Israel began a GDL program involving 50 hours of supervised driving and a three-month restriction on driving between 9 pm and 6 am. Other countries also have shown interest in GDL, for example, the UK Parliament has urged the government to introduce licensing programs such as those that exist in Australia and the United States (House of Commons 2013).

GDL has been a popular and successful policy. Studies in North America have indicated that GDL is associated with substantial decreases in crashes among 16-year olds and positive but lesser effects among 17-year olds (Williams et al. 2012a). Effects at ages 18 and 19 are not resolved (Masten et al. 2014). Positive, negative, and neutral effects at these ages have all been reported in the literature (Masten et al. 2011; McCartt et al. 2010b; Morrisey and Grabowski 2010; Vanlaar et al. 2009; Zhu et al. 2013). However, although all 50 states and the District of Columbia have some form of GDL in place, there is substantial variation in the strength and completeness of the systems and it is well-established that stronger programs have more positive effects (McCartt et al. 2010b; Fell et al. 2011a; Steadman et al. 2014). All but a handful of U.S. jurisdictions have minimum required supervised driving hours and night and passenger restrictions.

In terms of core elements, the age of entry into the learner stage of GDL in the U.S. varies from 14 to 16 and the required holding period is generally 6 to 12 months. Required supervised practice hours generally range from 30 to 60 hours. Intermediate (often referred to as provisional or probationary) license ages range from 14½ to 17 with night restriction starting times ranging from 8 pm to 1 am. Passenger restrictions allow from zero to three passengers and the age of graduation to a full license varies from 16 to 18. The Insurance Institute for Highway Safety (2014a) provides a GDL “calculator” that allows states to estimate potential reductions in 15-17-year old driver fatal crash rates if they had the most stringent provisions found in the U.S. Based on these calculations state reductions ranging from 17% to 63% would be possible, yielding an annual savings of more than 500 lives.

One goal of the present project is to identify GDL components that optimize safety outcomes, updating prior guidelines using the latest evidence from scientific research studies. The second goal, to recommend a framework for augmenting GDL by integrating it with driver education, license testing requirements, in-vehicle technology, and other young driver program features in place worldwide, has been discussed previously but not formalized in a systematic way. This framework can be adapted to any existing GDL program. However, since GDL programs alone have been shown to be effective in reducing crashes and there is much room to improve their crash-reduction potential, optimizing basic GDL features is by itself an important step.

Throughout the report GDL recommendations based upon strong supporting evidence are presented first, followed by recommendations where there is lesser, or insufficient evidence presently. Some candidates for inclusion were considered but are not discussed in the report because the supporting evidence indicated minimal effectiveness, or was inconclusive for making appropriate recommendations, or was outside the scope of the report. These include vehicle power restrictions; contingent advancement (violations delay progress through the GDL system); driver improvement programs and penalty systems; limiting the roads on which GDL drivers can drive; and parent programs that are outside of driver education.

Alcohol policies for GDL drivers also are not included. These are an integral feature of GDL in other countries, but in the United States all persons younger than 21 are subject to minimum drinking age and zero tolerance laws which have been put in place and are unrelated to licensing programs.

GDL should apply to novices older than 17
(Strong evidence)

The focus of this report is on GDL programs in the United States, although in most cases the information is also relevant to other GDL countries. GDL practices in other countries also provide information relevant to improving GDL programs in the United States. However, before discussing GDL components of the learner and intermediate stages, it is important to address the question of which drivers should be included in GDL programs. One unique characteristic of GDL programs in the United States is that in almost all jurisdictions they apply only to those younger than 18. Consequently in these instances, individuals who start driving at age 18 or later may bypass having to comply with the restrictions of GDL entirely. Those in the GDL system are automatically graduated to full license status when they turn 18 even if they have not completed the requirements. GDL is designed to manage driver inexperience, not age per se, and in Australia, Canada, and New Zealand, it applies to older novices, and time, not age, determines graduation to a full license. In Canada, full GDL policies apply to all novices. In New Zealand and in some Australian states, policies are modified for older novices, generally around age 25.

In the United States, only New Jersey applies full GDL rules to novices through age 20 (6 month learner stage plus night and passenger restrictions for one year), and lesser requirements (3 month learner stage) for older novices. An evaluation of New Jersey's GDL system found positive effects for 18 year olds for all crashes and for driving during restricted hours and with passengers (Williams et al. 2010). Studies in Australia and Canada indicate that GDL reduces crashes among older novices (Mayhew et al. 2005; Healy et al. 2012). Application of New Jersey's policy also deals with the possibility that some teens may delay licensure until 18 or later to avoid participation in GDL.

It is also clear from research studies that many beginners in the U.S. bypass some or all of GDL requirements. Older novices in the U.S. are not a small group. Nationally representative surveys have indicated that about 25% of those 18 and older have not yet begun the licensing process (Williams 2011; Tefft et al. 2012). It has been estimated that as many as 36% of beginners in the U.S. will be licensed after their 18th birthday and thus be exempt from most or all GDL requirements beyond the learner stage (Tefft et al. 2014).

The New Jersey requirements are preferred, and a survey of 17-19-year olds in New Jersey indicated that 77% approved of the policy (Williams and McCartt 2014). There are other options available to extend GDL to older novices, for example, by applying only the learner period requirement to those ages 18 or older, as is done in Maryland and Maine. Connecticut recently adopted a 3 month learner requirement for beginners ages 18 or older. The effects of these lesser requirements have not been established. There is also the possibility of not allowing graduation to full licensure for those who are in the system but have not completed the requirements before reaching age 18. The size of this "premature graduation" group is unknown.

It should be noted that if GDL is applied to beginners age 21 and older, consideration should be given to extending zero alcohol tolerance laws to this group.

Recommended GDL components
(Strong evidence)

There have been several previous efforts to identify recommended evidence-based GDL components. When states and provinces first debated licensing policies and were seeking guidance, the Insurance Institute for Highway Safety (IIHS) of the U.S. and the Traffic Injury Research Foundation (TIRF) of Canada partnered to produce *Graduated Licensing: A Blueprint for North America* (Williams and Mayhew 2004). The Blueprint was evidence-based where possible. For example, since some states had night driving restrictions before GDL began to be widely introduced, there was existing evidence about their effectiveness, and some indication that earlier nighttime restrictions covering more of this high-risk period were preferable (Williams and Preusser 1997). However, for other components such as duration of the learner period, there were no research studies and recommendations were made that were consistent with the principles of GDL. The Blueprint was modified as more evidence became available and was subsequently superseded by separate "best practice" recommendations for Canada (Mayhew et al. 2005) and the United States (McCartt et al. 2010b).

The present recommendations for learner and intermediate license components of GDL are based largely on a recent review of the literature on the research evidence for their effectiveness (Senserrick and Williams 2014), using evidence primarily from Australia, Canada, New Zealand, and the United States. Since GDL began to be introduced in the mid-1990s a vast amount of research has been conducted, but there is still a lack of information about ways to calibrate the various components. Useful information is available from several studies, especially four from the United States that systematically address the calibration issue. Two are national studies based on fatal crashes (McCartt et al. 2010b; Masten et al. 2013). One is a meta-analysis based on 14 qualifying studies that include some national data plus information on 13 different states (Masten et al. 2014). This study is limited because there were too few effect sizes for many of the GDL components. The fourth study is based on insurance claims per vehicle year for licensed drivers (Trempel 2009). The results of these four studies are not always consistent but provide useful information for consideration. For shorthand purposes, the studies are referred to as the McCartt study, the Masten 2013 study, the Masten 2014 study, and the Trempel study.

For GDL core elements, the recommendations for optimal safety outcomes are outlined below. They are presented with recognition that in a highly diverse country such as the United States, economic, geographical, cultural, political, and other considerations come into play when setting policies. As such, in many states the "ideal" from a safety perspective may not be realistically achievable and could involve some safety/mobility trade-offs. However, setting the bar high indicates to states the areas where improvements toward that level are needed and may be feasible.

- Minimum learner entry age: 16 years
- Minimum duration of learner stage: 12 months
- Minimum learner supervised hours requirement: more than 50; 80-120 likely optimal
- Minimum intermediate (provisional) licensing age: 17 years

- Starting time for night restriction: 9 or 10 pm
- Number of young passengers allowed: 0 or 1
- Minimum age for graduation to full driving privileges: 18 years

Notably, all of these provisions exist in one or more states (Insurance Institute for Highway Safety 2014b). Only New Jersey licenses at a minimum age of 17, but 9 of the 51 U.S. jurisdictions have learner entry ages of 16, 8 have a minimum learner duration of 12 months, 5 require more than 50 supervised hours, 14 start the night restriction at 10 or earlier, 44 allow one or zero passengers (16 allow zero), and 15 have a minimum exit age of 18.

Minimum learner entry age. A learner starting age of 16 is in place in New Zealand, and in most Australian states and Canadian provinces. New Zealand increased the age from 15 to 16 in 2011 after years of efforts by safety groups to do so (Begg and Langley 2009). The McCartt study reported that a one-year delay, from 15 to 16 reduced the fatal crash rate by 13% and the Masten 2013 study provided support for an age 16 start. Age 16 rather than earlier is consistent with the general finding that beginning to drive at older ages has safety advantages (Williams et al. 2013), and is also consistent with the view that because of neurobiological development driving at age 15 or younger may be too early.

Minimum duration of learner stage. Most states require six months in the learner stage, but the Masten 2013 study found evidence in favor of 9-12 months (26% reduction at age 16; 17% at 17), and Masten 2014 reported that 12 months had the most safety benefits. In addition, a recent New Zealand study reported that increased time spent in the learner stage was associated with a reduced risk of collision involvement during the unsupervised restricted license stage (Gulliver et al. 2013). Neither the McCartt nor the Trempel study found independent safety benefits for longer learner periods, but it is notable that increasing the learner period to 12 months would raise the intermediate licensing age in 23 states, and older intermediate age starts are associated with safety benefits. Requiring twelve months is also consistent with the principles of GDL in providing more time for supervised driving practice in the low-risk learner period. A 12-month learner period also allows beginners to practice driving under supervision in all seasons of the year which may be especially important in those jurisdictions experiencing severe seasonal weather conditions.

Supervised hours requirement. There was evidence from the Trempel study that higher numbers of required supervised hours were associated with decreases in insurance claims. In addition, a study by Chen et al. (2006) reported a reduction of 18% in deaths among 16-year olds when 30 or more hours were required compared with fewer or none. The McCartt and Masten (2013 and 2014) calibration studies found no relationship between supervised hours requirements and crash rate changes. Part of the issue may be that in almost all states 50 hours is the most that is required. Some Australian states require 100 or 120 hours. After an extensive review of Australian and European as well as U.S. literature, Senserrick and Williams (2014) concluded that more hours are better than less, and that 80-120 hours may be optimal. It is notable that requiring too few hours may discourage learners and their supervisors from obtaining more practice than the minimum (Bates et al. 2010).

The majority of states require that some number of practice hours (usually 10) take place at night. This makes sense in that it provides opportunity for supervised practice under more challenging conditions, although the effects of this policy are unknown.

Minimum intermediate licensing age. There is strong evidence that, in general, higher licensing ages are associated with increased safety outcomes, and that in the U.S. a minimum intermediate licensure at age 17 is warranted. Only New Jersey licenses at this age currently, although several states have increased the age beyond 16 through learner policies (e.g., a minimum learner age of 15 years, 9 months and a six-month minimum holding period increases the intermediate licensing age to 16 years, 3 months). Studies of New Jersey's policy have shown the extra safety benefits that accrue (Ferguson et al. 1996), and the McCartt, Masten 2013, and Trempel studies all support higher licensing ages. McCartt reported that delaying licensure for 6 months, from 16 to 16 ½ lowered the fatal crash rate by 7%, and delaying for one year (16 to 17) by 13%. Masten 2013 reported that a licensing age of 16 ½ or 17 lowered the fatal crash incidence for 16-year olds by 23%, although there was no effect at age 17. Trempel reported a one-year delay reduced insurance claims at age 16 by 9%. There is evidence that age 17 has greater benefits than 16 ½, 16 ½ better than 16, and 16 better than 15. Furthermore, the benefit continues beyond 17; that is Australian research has indicated that licensing at 18 is more beneficial than 17 (Drummond 1986).

Starting time for night restriction in the intermediate stage. Driving at night is more challenging because of lesser visibility when it is dark and because recreational driving, alcohol use, and fatigue are more common during this time. Late-night driving increases teen risk for fatal crashes although not for less serious crashes (Williams 2004; McCartt and Teoh 2014).

The majority of U.S. states do not restrict nighttime driving until midnight or 1 am, but the evidence supporting earlier starts is strong. The McCartt and Trempel studies reported maximum benefits for 9 pm, the Masten 2013 study for 10 pm or earlier (19% lower incidence for 16-year olds), and the Masten 2014 study supported earlier than midnight. The largest proportion of nighttime 9 pm-6 am fatalities of 16-17 year olds take place prior to midnight, and state studies have shown that differential percentage reductions in restricted vs. unrestricted hours are similar in states whether the restriction starts at 9 pm or midnight. For example, in North Carolina, with a 9 pm start crashes of 16-year olds were reduced by 47% in restricted vs. 22% in unrestricted hours, and in Michigan with a midnight restriction, there was a 59% reduction in restricted hours vs. 32% in unrestricted hours. Although there may be additional benefits to having a night restriction start even earlier at 8:00 pm or even 7:00 pm, these earlier starting times have generally not been investigated so the strength of the evidence supports a restriction that starts at 9 pm. The ending time for night restrictions in the United States varies generally from 4 am to 6 am (sunrise in one case), but there is no evidence of any differences in safety benefits.

Number of young passengers allowed in the intermediate stage. The literature on adolescent development indicates that peer influences are capable of encouraging helpful as well as harmful behavior, but there is evidence that teens take more risks in groups of teens than when alone in a variety of contexts (Allen and Brown 2008; Brown et al. 2008; Gardner and Steinberg 2005; Steinberg 2011). The profusion of recent studies in this area has shown the complexity of the relationships. For example, one naturalistic study found that teen drivers with multiple teens in the car were more likely to speed, tailgate and show off (Goodwin et al. 2012). Another naturalistic study found that teen passengers had a protective effect on teen drivers (Simons-Morton et al. 2011). There do seem to be combinations of teens that increase the likelihood of risk taking (e.g., risky drivers, who tend to have risky friends; male teenage passengers), or decrease it (e.g., female teen passengers with male teen drivers). Overall, however, there is clear evidence that having young passengers in cars driven by teenagers increases fatal crash risk. Multiple passengers increase crash risk the most, but even one passenger substantially increases risk. In the most recent study, the fatal crash risk per mile traveled quadrupled for 16-17-year old drivers when there were three or more passengers younger than age 21 and no older passengers in the vehicle, compared with the time when driving alone. However, with one young passenger there was a 44% greater risk of driver death in a crash per mile traveled compared with having no passengers. For all crashes, risks of involvement followed this same pattern but were smaller and not statistically significant (Tefft et al. 2013).

Both state and national studies have reported positive effects of passenger restrictions, and crash reductions have been reported for both fatal and nonfatal crashes (e.g., Masten and Hagge 2004; Chaudhary et al. 2007; Fell et al. 2011b; Vanlaar et al. 2009). However, where to set the passenger limit to yield the most positive effect has not been settled. There has been debate as to whether no passenger limits would be complied with less than if one passenger was allowed, and the question is unresolved. The McCartt and Masten 2013 studies came to opposite conclusions about crash effects. The McCartt study indicated a 21% reduction for zero passengers and 7% for one passenger. Masten 2013 found a 9% reduction for zero passengers at age 16 and 20% for one passenger; Masten 2014 also indicated positive effects for one-passenger limits. Thus, while both passenger restrictions allowing zero or one person appear to have positive effects, it is not clear which is most beneficial from a safety standpoint. Thus the question as to how strictly to set passenger limits is presently unresolved.

Minimum exit age. Eighteen is the highest minimum exit age in U.S. states although in many states graduation is possible at earlier ages. In other countries exit ages can be higher. For example, in Victoria the earliest age for graduation from the GDL program is 21. If GDL were applied to older novices exit ages would increase.

Other recommended GDL components
(Expert opinion-based, further research needed)

Seat belt use in learner and intermediate stages. Seat belt use among teenage drivers has typically been lower than among adults and many teenage passengers are not belted (McCartt and Northrup 2004). In some states, seat belt use requirements are part of GDL legislation as a violation that can lead to delayed advancement through the system, although seat belt violations may not be specifically mentioned. North Carolina does call out seat belt use specifically and requires everyone in the vehicle to be properly restrained. If anyone is not wearing a seat belt, drivers can be cited. This provision should be adopted in all states as primary enforcement legislation which would allow a police officer to stop and sanction a novice driver for non-compliance. It should be noted that publicity/enforcement campaigns in North Carolina designed to increase compliance with GDL restrictions have had little effect on seat belt use (Goodwin et al. 2006; Goodwin and Foss 2008). However, it has been reported that teen passenger seat belt use was higher in secondary enforcement states that had a primary enforcement provision for youth compared with secondary states without this provision, providing some support for this policy (R. Shults, personal communication 2014).

Log book requirement. Parents are a key target to help ensure compliance with supervised driving hours requirements both in terms of the number of hours and the conditions under which these hours should be driven. In that regard, it is notable that surveys in five U.S. states indicated that some parents did not know of their state's requirement for supervised hours, and the majority did not know the number of hours required. Knowledge was much greater in Maryland, where parents are given a log book when their teen obtains a permit and are required to hand it in when their teen appears for the road test (O'Brien et al. 2013). Log books are required in Australia and the use of a log book in U.S. states would be an easy way to improve knowledge; a first step in promoting compliance with supervised hours rules. North Carolina has recently introduced a log book requirement but without much publicity. If laws are unknown to many to whom they apply their impact will be limited. Thus the recommendation is in reality a well-publicized log book requirement. Note also that a log could consist of a print version, or hours could be compiled electronically (see in-vehicle monitoring technology section) which would provide an accurate count of the number of practice hours as well as help to inform parents of the supervised hours rules.

Cell phone use in learner and intermediate stages. The risks of cell phone calling and texting while driving have drawn considerable attention in recent years. Teenagers are more susceptible than adults to cell phone use risks in vehicles (Klauer et al. 2014; Durbin et al. 2014), and in many states laws have been enacted that apply specifically to teenagers. As of March 2014, 37 states and DC had restrictions on teenagers' use of mobile communication devices in vehicles. Presently, only the North Carolina law has been evaluated to determine its effects on cell phone use, and it has not decreased use any more than in states where such laws do not exist (Foss et al. 2009; Goodwin et al. 2012). Thus, although the risk is there, the effects of laws on use rates among teenage drivers are undetermined but questionable based on the experience of one state. Moreover, in some cases where the laws apply to drivers of all ages, observational studies have reported drops in use, but the results in regard to crash reductions are mixed and inconclusive (Trempel et al. 2011; McCartt et al. 2014). Thus there is uncertainty about the effects on use rates, on crash outcomes, and on ways in which laws might be made more effective. Many of the laws have secondary enforcement provisions, which impede enforcement, but there is no evidence on the extent to which primary enforcement laws make a difference.

Cell phone use and texting while driving are risk factors but given the above results modification of GDL programs might better concentrate on the core elements of GDL where the recommend changes have more certain crash-reduction outcomes. Alcohol-impaired driving among 16-17-year olds has been reduced greatly since the 1980s, but has been a persistent contributor in about 15% of fatal crashes in this age group during the last decade. Zero tolerance and minimum alcohol purchase age laws have contributed to the reduction that has taken place, and there is evidence that strengthening night and passenger restrictions would extend these reductions (Fell et al. 2011b; Williams et al. 2012b).

License plate identifiers. New Jersey is the only state that requires drivers in the GDL system to indicate their licensing status and mandate learners and intermediate license holders to affix red reflective decals to front and rear license plates. This policy, intended to facilitate police enforcement of GDL requirements, has been in place for many years in Australia and Canada. It has been highly controversial in New Jersey due to concerns about the identification and potential targeting of teenage drivers (McCartt et al. 2013). The policy is unpopular among both teens and parents of teens, and use rates appear limited. However, a survey of police departments in New Jersey indicated that predator incidents were not an issue (New Jersey Division of Criminal Justice 2012) and it has been reported that the decal requirement was associated with crash reductions among New Jersey teens in its first year (Curry et al. 2013) and these reductions continued during the second year of the law (Curry et al. in press). Despite the fact that there is some evidence base for New Jersey's decal policy further evidence is needed regarding its long term effects, effects for intermediate vs. learner license holders, current use rates, citation rates, and the extent to which non-users may drive more carefully due to concern about the $100 fine for non-use. Studies are underway to investigate these issues. For states that decide to consider this policy, it is recommended that they examine the experience of other countries, particularly Australia, where license plate identifiers for learners and initial license holders have long been in place and are well-accepted.

Alcohol use by supervising drivers. In the Canadian province of Ontario and in several Australian states the supervising driver in the learner stage is subject to a low BAC requirement. Although this policy makes sense on logical grounds given the important role of the supervisor in guiding practice driving, compliance with the restriction and its safety effects have not been established.

Introduction

Driver education is designed to teach new drivers the rules of the road and the driving skills to prepare for the road test and obtain a driver's license. It is recognized and promoted as a safety measure that dates back to the early 1930s in the United States and Canada. Today and for many years, most jurisdictions in the United States, Canada, and elsewhere have delivered driver education in high schools and/or commercial driving schools. And, a recent U.S. National Young Driver survey administered in public schools revealed that almost 80% of students with a driver's license reported participating in formal driver education (Curry et al. 2012). These programs typically consist of both "theoretical" instruction in the classroom and "practical" training in the vehicle (Chaudhary et al. 2011). Although there are similarities in traditional driver education programs, there is considerable variation in their content and delivery across jurisdictions as well as within some jurisdictions. In some cases, driver education is a mandatory requirement of the licensing process and in others it is not compulsory, although provisions may be in place that encourage teens to take driver education (e.g., obtain a learner or provisional/intermediate license at an earlier age, fewer hours of supervised driving practice required).

Safety effectiveness

Although driver education provides an efficient means to learn how to drive evaluations have failed to show that such formal programs produce safer drivers (Christie 2011; Engstrom et al. 2003; Lonero and Mayhew 2010; Mayhew and Simpson 2002; Mayhew and Simpson 1998; Roberts et al. 2002; Simpson 2003; Thomas et al. 2012a; Vernick et al. 1999; Williams et al. 2009; Woolley 2000). This is the case in evaluations of the safety effects of driver education that have been conducted internationally, and not just in the United States. Poor evaluation methods may be part of the reason for this, but even well-designed evaluations have produced findings that raise questions about the safety benefits of driver education. To illustrate, the DeKalb County, Georgia randomized control trial (RCT) involved the development and evaluation of a specialized curriculum with over 70 hours of classroom, simulation, closed-course, and on-road training (Stock et al. 1983). Despite having a very large sample of teen drivers randomly assigned to the new program, a more traditional program or to a control group, this investigation along with several subsequent re-analyses of the datasets failed to show a consistent favorable effect of driver education on collisions. Although one of the analyses in the original study reported that the new program was associated with fewer crashes in the first six months of driving this positive result has been hotly contested in the literature on methodological grounds (Mayhew and Simpson 1996, 1998; Peck 2010; Stock et al. 1983). The safety benefits of driver education have also been questioned because some driver education programs may inadvertently encourage earlier licensure, and consequently, result in crashes at an earlier age than would have been the case in the absence of training (Robertson 1980; Mayhew and Simpson 1996).

As an outcome of the investigations conducted by DeKalb and others, support and funding for driver education dramatically decreased at state and federal levels in the United States. For several decades, driver education was no longer viewed as a priority safety measure (Nichols 2003; Simpson 2003).

These evaluations have focused primarily on whether driver education reduces crashes and not whether it achieves other important program objectives such as improving safe driving knowledge, attitudes, motivations, skills, and behaviors. A major investigation that has recently been completed has taken a more comprehensive approach to evaluating driver education programs in Manitoba and Oregon and has found modest but important improvements in such intermediate measures among course graduates relative to control groups who have not taken these programs (Mayhew et al. 2014). In Manitoba, for example, driver education graduates were found to be associated with slightly greater safe driving knowledge, greater self-reported driving skills, fewer self-reported risk-taking behaviors, better performance on a simulated drive test, and stronger hazard anticipation skills. This investigation also reported results suggesting that driver education in Oregon is associated with statistically significant reductions in collisions and convictions although other factors not accounted for in the analyses might explain part or all of, these positive findings, and not driver education itself. These positive findings on safety effectiveness are consistent with those of an earlier evaluation of GDL in Oregon (Raymond et al. 2007), although the better crash outcomes for driver education in this investigation could have been due to self-selection bias. Further potentially promising findings for driver education also emerged from an evaluation of graduated driver licensing programs in Canada and the United States which found that the relative fatality risk of 18-year old drivers in jurisdictions where driver education is mandatory in the learner phase decreased compared to those jurisdictions where driver education is not mandatory in the learner phase (Vanlaar et al. 2009). This, however, was not the case for 16- and 17-year old drivers. These findings from a few recent studies are promising but given their design limitations there is the need for further investigation to establish the safety effects of driver education within GDL programs.

Recent developments in driver education

In recognition of the research on driver education, and in an effort to promote more uniformity in programs, there has emerged a concerted effort at the federal level and within the driver education leadership in the United States to improve traditional programs. This resurgence of interest is perhaps best exemplified by the recently published Novice Teen Driver Education and Training Administrative Standards (NTDETAS) developed by representatives from the driver education professional community with assistance from NHTSA. The Standards document states that: “The goal of driver education and training is to transfer knowledge, develop skills, and enhance the disposition of the teen, so he/she can perform as a safe and competent driver, thereby contributing to the reduction of crashes, fatalities, and injuries.” These National Administrative standards also provide guidance as to how traditional driver education programs should be substantially restructured to better achieve their safety goals (NHTSA 2011). As states adopt the new standards, research is needed to determine if safety goals have actually been achieved.

Following the development of these administrative standards, a new, voluntary national association was formed called the Association of National Stakeholders in Traffic Safety Education (ANSTSE) with representation from the driver education community, both from the public and private sectors, and key national traffic safety agencies. ANSTSE members have been actively promoting the administrative standards, and they have designed an information-sharing website database that identifies the extent to which states meet the administrative standards. As well, ANSTSE has developed a strategic plan to promote the administrative standards and they are conducting several projects to develop delivery standards for driver education and online driver education, as well as standards to improve teacher training.

NHTSA has also introduced and supports a Driver Education Review program which allows relevant state authorities to have their state-approved driver education program assessed by a panel of experts against the administrative standards. This program is relatively new and only a few states have undergone this NHTSA-facilitated review, including Oregon, Maryland, Vermont, Delaware, Idaho, and Michigan. Priority recommendations identified for the Oregon program were, for example: increasing classroom hours from 30 to 45 hours; increasing behind-the-wheel instruction from six hours to ten hours; increasing in-car observation from six hours to 10 hours; and, requiring second stage education of at least 10 hours (Lewis et al., 2010). Until states adopt and evaluate these recommended changes, the safety effects remain unknown.

In recent years, there have also been efforts to supplement traditional driver education programs as well as to develop and implement alternative programs (ADTSEA, 2010; Thomas et al., 2012b). Several of these initiatives are described below.

On-line driver education. On-line programs are increasingly prevalent in today's educational delivery system and driver education is no exception. More jurisdictions are moving to accept on-line programs as a means to deliver the classroom segment of driver education. With many students living in rural areas and many public school systems moving to a digital environment, it is easy to estimate that in the coming years well over 50% of teens will receive their driver education classroom segment via some type of on-line delivery method. Platforms such as Moodle and Blackboard have integrated student-teacher interaction while others are simply visually-oriented, with reading and click-to-advance procedures. Whether on-line is a more effective method to deliver driver education than in-class and which type of on-line platform works best are currently unknown and require research (Thomas et al. 2012b).

Parent-taught driver education. Another development in the United States has been the growth in parent-taught driver education and home-study programs. For example, in Texas parents can teach their teen driver using a state-approved curriculum if they have met certain qualifications and submitted an application to the DMV. An analysis of parent-taught DE in Texas (Pezoltd et al. 2007) concluded that parent-taught teen drivers performed more poorly on state-administered tests and had more traffic violations and crashes during provisional and full licensure than young drivers who received DE through commercial or public school courses. California DMV also evaluated the effectiveness of home study driver education programs but arrived at different conclusions, although unlike the Texas study they did not examine collisions and convictions. They found no compelling evidence that home-study courses are less effective than classroom courses for teaching driver education (Masten and Chapman 2003). Given that these two studies have produced mixed results the evidence base for parent-taught driver education remains unclear.

Simulation and driver education. Simulator training has been a teaching technique applied in-class during driver education for many years. Typically, a certain number of hours of simulator training would be treated as equivalent to a certain number of instructional hours driving in-vehicle. As computers and software have become more sophisticated, driving simulators today are much more interactive, for example, allowing the teen to alter travel within the simulated driving environment using a brake, accelerator and steering wheel. Driving simulators have considerable face validity and allow for training under hazardous conditions and circumstances that are infrequent and/or could not be allowed on-road. The Netherlands is currently considered a world leader in the use of simulators for driver training and simulators are used initially to teach driving skills which are then further refined and practiced with an instructor on the road.

Driving simulators offer control over the driving experience but may lack some important similarities to driving, which would more likely be the case with low fidelity than high fidelity simulators. High fidelity simulators may present a more realistic real world driving environment but would be cost-prohibitive for a driver education program and still have issues related to simulator sickness. There is some research evidence, however, that low fidelity simulators could be effective in training a specific skill such as hazard perception (e.g., the ability to perceive and react to hazards in the driving environment; see Fisher 2008). In this context, hazard perception training programs have been recently developed using computer-based driving simulation. This has been an improvement over commentary hazard perception training in which a video of driving situations is used along with commentary of hazards identified and how to deal with them (Crundall et al. 2010; Isler et al. 2009).

Hazard perception training. The need for training in hazard perception emerged from two related developments. First, there has been growing recognition that poor hazard perception skills contribute to teen driver crashes and these critical skills need to be improved through training (Crundall and Chapman 2012; Deery 1999; Wang et al. 2010 a, b). Second, with the advent of hazard perception testing as a component of the GDL process, for example, in several Australian states, hazard perception training courses were needed so that teen drivers could pass these higher-order cognitive skill tests (Hull 1991; Hull and Christie 1993; Congdon 1999; Wetton et al. 2011).

On balance, the available research suggests that part-task computer-based and/or commentary hazard perception training improves hazard detection and response, at least in a simulated driving environment (see, for example, Romoser et al. 2014; Cantwell et al. 2013). This has been the case, for instance, of the New Zealand based eDrive program which aims to teach the cognitive skills of situational awareness, hazard perception and risk management in learner drivers. Similarly, in the United States the computer-based program, RAPT, on risk awareness and perception training for learner or novice drivers has been shown to improve hazard detection on a driving simulator and, more importantly, on-road (Garay-Vega et al. 2007; Fisher 2008; Pradhan et al. 2006). The same research team that developed RAPT has also recently developed an attention maintenance training program called FOCAL (Focused Concentration and Attention Learning) to teach teen drivers how to reduce their glance durations to under two seconds while still performing secondary in-vehicle tasks accurately. Initial research suggests that FOCAL training effectively reduces glance times (Chan et al. 2010; Pradhan et al. 2011; Thomas et al. 2011).

Advanced skills training. Early investigations principally in Scandinavian countries of skid control and emergency maneuvers training reported that these types of programs actually increase crash risk (Bartl et al. 2000; Bartl et al. 2002; Beanland et al. 2011; Jones 1993; Katila et al. 1995; Mayhew and Simpson 1996). The authors of these studies concluded that training in procedural skills may actually generate overconfidence or an optimism bias in the graduates' perceptions of their skill level (i.e., having completed training in higher-order vehicle-maneuvering skills graduates think they are more skilled than they actually are). Such advanced skills training are not recommended for the GDL framework.

Other driver training initiatives. To counter concerns that driver education, especially advanced skills training, generates overconfidence in driving ability, training programs have been developed to provide "insight" to novices regarding their own limitations by demonstrating that they can fail in driving tasks. Insight training is designed to increase with the objective of understanding in young people regarding the dangers they face while driving reducing overconfidence in young drivers (Gregersen 1996). The limited research that is available suggests that such programs can produce positive safety attitudes and driving behaviors (Senserrick and Swinburne 2001)

Alternative educational programs for teen drivers have also been developed to overcome the shortcomings of traditional driver education programs. In the United States, for example, Adept Driver's teenSMART program is a computer-based training program consisting of three core elements: computer-based driving tutorials (CBTs); parent-teen materials and activities; and, a certification test to pass the program. This was developed as a post-licensing crash reduction program for teen drivers with input from an expert advisory group. Insurance companies offering discounts for the program have reported safety benefits. Lower collision rates for teenSMART graduates, however, could be the result of teenSMART training or self-selection bias. In Los Angeles, California, the Mercedes-Benz Driving Academy (MBDA) is a DMV-certified driving school for teens that offers teenSMART as well as on-line driver education, behind the wheel training, a distracted driving range, a vehicle safety workshop, and a parent-teen workshop. The MBDA uses a coaching approach with an emphasis on parental involvement, including having parents join their teen on a lesson so they can observe the coaching approach and learn how to incorporate these techniques into their teen's supervised practice. The MBDA is also currently located in Vancouver (Canada), Utrecht (Netherlands), London (UK) and Beijing (China). This unique program is relatively new and has not yet been evaluated to determine its safety effectiveness.

In Australia, one recent study found that a non-traditional driver education program that is more community-oriented and resilience-focused was associated with a reduced relative risk of crash but a more conventional program had no significant effect (Senserrick et al. 2009). However, the authors caution that because this was a voluntary study albeit based on a large sample size, there is still an important need for further research to confirm the road safety benefits of this resilience-based program. In Victoria, Australia and in New South

Wales there is an ongoing research effort called the "P Drivers Project" which aims to evaluate a behavior change program for young newly licensed drivers (R. Seymour, personal communication 2014). The program involves two facilitated peer group discussion sessions and an in-car coaching session. Through sharing of experiences, self-reflection and evaluation the program aims to raise awareness among young drivers surrounding the risks associated with driving, and of their capabilities and limitations as drivers. To gauge the effectiveness of the program data on infringements, self-reported crashes and driving behavior are being collected at several time points from over 6,000 young drivers in their first year of licensure.

Integrating GDL and driver education

GDL and driver education co-exist but they are seldom integrated. In fact, the advent of graduated licensing in the United States and Canada in the 1990's had relatively little influence on existing driver education programs and in most cases both GDL and driver education operated independently, with the requirements for driver education being carried over from the previous pre-GDL period. A major challenge is to identify ways to integrate GDL and driver education to enhance the benefits of both. This challenge has certainly received some attention, but not much action in graduated licensing programs in North America and elsewhere. In this regard, a recent NHTSA-funded report taking a fresh look at driver education called for an expanded and integrated driver education and graduated licensing system with improved content, delivery mechanisms, and legal/administrative framework (Thomas et al. 2012a) This report, however, did not provide much guidance as to ways to accomplish this goal.

The need to better integrate driver education and GDL is supported by the fact that it is estimated that almost 80% of public school students with drivers licenses have participated in formal driver education (Curry et al. 2012). Previous efforts to, and opportunities for, integrating driver education within a GDL framework are discussed below.

Recommended components for GDL framework
(Expert opinion-based, further research needed)

The driver education initiatives and practices that are recommended below for the GDL framework are largely based on expert opinion because they have lesser or insufficient evidence compared to those GDL components rated in the previous section as having strong empirical evidence. These practices make sense on logical grounds and may reinforce GDL principles and operation but require further research to determine their safety and cost effectiveness and/or the extent to which they contribute to the overall benefits of GDL.

Multi-phase approach. NHTSA recommended a two-phase driver education program as part of graduated licensing over a decade ago (NHTSA 2004). Such a program would involve an initial phase to teach basic vehicle handling skills and rules of the road and a second phase to teach safe driving procedures, including perceptual and decision-making skills. This notion of multi-phase driver education had actually been raised several years earlier by McKnight, who observed that it may be advisable to introduce more safety-oriented driver training following initial licensing and after some driving experience has been gained (McKnight 1985). Consistent with the multi-phase structure of graduated licensing, phase one would occur during the learner stage and phase two during the intermediate stage of this licensing process.

GDL does not exist in most European countries but a few have multi-phased driver education programs. For example, in Finland, the compulsory second phase of driver training focuses on avoidance of risky situations rather than the mastery of technical skills. In the DAN report (Description and Analysis of post-licensing measures for Novice drivers), Bartl et al. (2000), recommends multi-phase driver education similar to the Finnish model. The Finnish experience was one of the factors that contributed to the design of the P-driver project in Australia, which was described previously (Barry Watson, personal communication 2014).

Although a multi-phase approach is appealing on logical grounds, Michigan is the only jurisdiction in North

America to adopt such a two-phase driver education program but both phases are in the learner period. The independent contribution of the program to the success of the overall graduated licensing effort has not yet been investigated.

Governments responsible for graduated driver licensing in Canada and the United States have not embraced the notion of multi-phase driver education. Although the reasons for this governmental reluctance are not clear, the multi-phase approach needs further consideration, particularly if serious efforts are made to improve driver education. If governmental reluctance arises from concern about increasing the time and cost of the licensing process, evaluation can provide a means to consider the cost of this approach relative to its benefits.

Multi-phased driver education is recommended for the GDL framework but regulatory government agencies will have to decide, based on their current practices and other political and economic considerations, whether they adopt this as a mandatory requirement or encourage it on a voluntary basis. If multi-phased driver education is introduced, and available as a voluntary option, incentives will need to be put in place to encourage new GDL drivers to enroll in and complete each of the phases.

GDL enhancements and driver education. The move to enhance GDL in several Australian states by increasing the mandatory minimum driving practice hours in the learner stage and adopting a more demanding drive test has also resulted in optional driver education programs to help learners meet these requirements. For example, driver education courses are available for learners who have already completed 50 hours of a 120 hour supervised driving requirement. Participation in the course, comprising five hours over two sessions (one group-based education class, one in-vehicle coaching drive) taking place at least two weeks apart results in a reduction of 20 hours of supervised driving practice from the log book. The course is based on higher-order GDE principles (Goals for Driver Education developed in a European Union-sponsored project; Hattakka et al. 2003) and aims to improve young driver capabilities in relation to decision-making, identifying risks, hazard perception and having a more realistic view of one's own ability to drive safely (i.e., low risk and without crashes; T. Senserrick, personal communication 2014). This course has not been evaluated so research is needed to determine its safety effects and the extent to which it reinforces the 120 hour minimum supervised driving requirement.

GDL, parental involvement, and driver education. GDL places a strong emphasis on parental supervision and practice driving hours in the learner period and this provides another opportunity to better integrate driver education within a GDL framework. In this regard, the Novice Teen Driver Education and Training Administrative Standards (NTDETAS) calls for coordinating driver education with GDL and parental involvement programs (NHTSA 2011). Such programs recognize that parents are role models and they can have an important positive or negative influence on the driving behaviors of their teens, including their initial learning to drive experiences when parents supervise driving practice. Parental involvement has also taken a variety of forms both in coordination with driver education programs, and independent of such programs. With a few exceptions, these programs have not been evaluated, so most fit into the rating category, expert-based, research needed to establish a strong evidence base (for a recent review of the literature on the effectiveness of parent-focused interventions see Curry et al. 2014).

Several states (e.g., Connecticut, Massachusetts, Montana, Northern Virginia, Washington), for example, now encourage parents to become more involved in their teen's driver education program by requiring them to attend a driver education orientation course. The one in Connecticut is a 2-hour, in-person, course for parents of 16 and 17 year olds. It covers topics ranging from GDL requirements, the parent's role, cognitive development, hazard awareness and the parent-teen contract. Some states and driver education programs (e.g., in Idaho) also require or encourage a parent to accompany the teen and driver instructor on a driving lesson(s), and for the driver instructor to provide an end of course briefing to parents about their teen's driving performance. The expert panel on the NHTSA-supported assessment of the Oregon driver education program also recommended that the ODOT-Transportation Safety Department (ODOT-TSD) should establish a procedure to provide an end-of-course evaluation or progress report to parents. This end-of-course "debriefing" could be a written student progress report which includes areas of successful completion of safe driving practices and any necessary recommendations for continued practice prior to licensing (Lewis et al. 2010).

Parental involvement has also been the practice in some jurisdictions outside North America. In Australia, the Royal Automobile Club of Victoria (RACV) developed the Parent Plus program, which initially invited the parent supervising the teen driver to attend an on-road lesson, as a back-seat observer, with the learner and a professional driving instructor (Johnson and Christie, 2005). The supervising parent was then encouraged to attend further free lessons tailored to the needs of both the learner and the supervisor. The driving instructor served as a mentor for both the learner and the supervisor. Several informational brochures relevant to each stage of learner development were also provided to the supervising parent before, during, and two months after the Parent Plus lesson. Parents who actively participated in the program reported being more likely to provide higher levels of supervised on-road experience to their learners (Johnson and Christie 2005).

The Parent Plus program is no longer operating in Australia. A newer program, keys2drive, is based on RACV's Parent Plus program. This national keys2drive initiative aims to increase understanding of GDL and involve parents (T. Senserrick, personal communication 2014). This involves a free professional driving lesson to learner drivers if their main supervisory driver accompanies them (see: www.keys2drive.com.au).

Additionally, Israel has the "Green Light for Life" program which involves a 45-minute home visit to explain the purpose of accompanied driving, encourage parents and teens to take many trips in different conditions, and enhance parents' abilities to share their experiences and hazard perception skills (T. Lotan, personal communication 2014). This program has been shown to be associated with lower self-reported crash involvement and lower injury crash rates (Taubman-Ben-Ari et al. 2011; Toledo et al. 2012).

Various tools and resources have also been developed for parents by DMV and/or driver education programs to assist them in supervising their teen's driving practice. These include parent guides to teen driving, video guides, and driving practice log books to record the number of hours of practice accumulated, under what conditions and where. Other types of parent involvement programs have included Parent-Teen Driving Agreements, such as the *I Promise* program and the *Checkpoints* program comprising persuasive messages and materials designed to increase adoption of the *Checkpoints* Parent-Teen Driving Agreement and to increase parent limit-setting on higher-risk driving privileges among novice drivers (Simons-Morton 2007; Simons-Morton and Ouimet 2006). The Checkpoints program has proven effective in reducing risk taking behaviors such as speeding, tailgating and unsafe lane changes (Simons-Morton et al. 2006; Zakrajsek et al. 2013). Recent research efforts with the Checkpoints program is a trial designed to determine the efficacy of an on-line version of the Checkpoints program offered through the American Automobile Association clubs. The study has been conducted with parents whose teenage children are enrolled in AAA-affiliated driving schools.

A review of safer driving agreements in Australia concluded that their potential effectiveness is limited to those young drivers who are already safety conscious, and is dependent on existing strong relationships with parents -- e.g., trust, honesty and respect (Soole et al. 2013). As well, the authors of this study observed that further research is required to determine their efficacy of reducing crash involvement in the Australian context.

Other, on-line programs have also been developed to assist learners to practice and pass their road test. In New Zealand, for example, "Practice" encourages and supports learner drivers to gain a wide range of driving skills and experience in a range of conditions and traffic situations. It covers all the situations currently examined in the practical vehicle license tests as well as situations not necessarily included in the tests, such as driving in a range of weather and light conditions (J. Furneaux, personal communication 2014; https://www.practice.co.nz/). The "Safe Teen Driver" on-line program provides a tool kit for parents of teen drivers in the learner and restricted stages of the New Zealand GDL program. The learner section of this program helps parents put together a training program to help teens pass the road test; the restricted section provides tools to help the parent and the teen manage the risks teens face when driving alone. This is an effort to encourage and support parents to 'stay involved' with their teenager's driving during the first 6-12 months of solo driving; the statistically riskiest period of their driving career (J. Furneaux, personal communication 2014; http://www.safeteendriver.co.nz/). According to Furneaux (personal communication 2014), in 2015-16, ACC and NZ Transport Agency plan to replace Practice and Safe Teen Driver with a more comprehensive driver education program that will span the entire GDL and more explicitly encourage the development of 'higher-order' driving skills and dispositions. In the United States, a web-based program, the Teen Driving Plan (TDP) was recently developed and assessed to determine if it could improve the driving performance of teenagers before licensure (Mirman et al. 2014). The TDP program includes brief videos for parent supervisors on structuring practice drives to focus on specific skills (e.g., merging, scanning) and creating a positive learning environment, interactive planning and logging tools, and telephone calls to promote program engagement. This program was found to improve supervised practice and driving performance as measured by an on-road driving assessment.

These types of parental involvement activities coordinated with driver education can support GDL and facilitate achieving its primary goal of ensuring teens receive much needed driving experience under conditions of low exposure to risk. Driver education, however, should not be used as a substitute for supervised practice which is a low-risk activity. The role of driver education should include encouraging teens to acquire more supervised driving practice, which is a primary goal of GDL. It should also encourage instructors to work cooperatively with parents to engage them further in the learning process and to structure how practice unfolds systematically, from simple to more complex and demanding driving situations. For example, initial driving should take place during daylight hours on familiar residential streets before progressing to nighttime driving on unfamiliar roads with higher speed limits. Working as a team, parents and driving instructors can play an important role in shaping and influencing the safety attitudes and acquisition of driving skill among teens, as well as maximizing the quantity and quality of driving experienced gained. Parental involvement programs need to be more closely examined and encouraged if they are found to positively influence the quantity and quality of supervised driving practice and, consequently, the quantity and quality of pre-license driving experience.

GDL tests and driver education. The Administrative Standards (NTDETAS) also called for coordinating driver education with GDL and the driver licensing process (NHTSA 2011). One approach to achieve this would be to shift responsibility for on-road license testing from DMV to driver education. In this regard, a few U.S. and Australian states have competency-based training and assessment programs (CBTA) that typically pre-date GDL (e.g., South Australia introduced CBTA in 1995; Kloeden and Mclean 2000). Under CBTA, the on-road skills test is waived for teens who successfully complete an approved training program. This is a relatively common practice for waiving the motorcycle beginner rider test with completion of rider education in many U.S. states but has only been adopted in a few states for teen drivers (e.g., CTC and Associates 2012). In Arizona, for example, a certificate of completion from a professional driving school allows for a waiver of testing requirements. In Illinois, specific driving instructors are certified for the cooperative driver testing program. The driver skills test is waived for teens who complete driver education at a public school that is part of this program. In Texas, the parent-taught driver education program actually allowed parents to waive the driver test for their teen. Previously, schools in Texas could administer the drive test and issue a waiver from DMV testing for the student, but this is no longer the case.

The rationale for CBTA is based on both safety and economic grounds. Since driver instructors spend more time with the novice, they should be better able to assess their skills and competencies. CBTA also has economic advantages in that it reduces or eliminates the need for DMV testing officers and consequently costs. In this regard, the use of CBTA expends fewer resources while still ensuring driver safety because the teen has met the competency-requirements of the training program.

While more and more states are considering CBTA, largely on economic grounds, there is no evidence from the few research studies that have been conducted to suggest that CBTA is more effective than traditional competency or skill (error-based) testing by DMV driver examiners (e.g., crash rates of CBTA teens do not differ from DMV road tested teens; Kloeden and McLean 2000). Based on the limited research, this suggests that CBTA at least does "no harm" given that crash rates are similar between teens licensed through CBTA or DMV testing, and therefore, may be a convenient and less costly route for teens obtaining a license to drive independently. However, some concerns about CBTA have been raised from a client service point of view. In particular, it has been argued that allowing driving instructors to assess the competency of drivers may lead to the "over-servicing" of learners, in order to increase the profits of commercial driver training (B. Watson, personal communication 2014).

The logic for CBTA from a safety perspective is compelling in that driver instructors who have driven with the teen over several hours should be better able than a driver examiner in a 15-minute road test to gauge the skill level of the teen driver. Traditional driver education programs, however, have not typically been proven to have safety benefits. Until improved driver education programs have been shown effective within an enhanced GDL framework, the recent trend towards adopting CBTA should be shelved for future consideration. This is especially the case because the use of higher-order skill tests, such as hazard perception testing, and/or an advanced exit test to move from the learner to intermediate GDL stages, may have more safety potential, especially if raising the competency standards, also results in commensurate improvements in the amount, type and format of training to meet the new, more demanding, test requirements (Cavallo and Oh 2008).

The content, focus, and delivery of driver education. Even if driver education is better coordinated with the structure of graduated licensing by being multi-phased and by partnering with parents for supervised driving practice, such programs may not achieve their potential without further improvements to their content and delivery. Certainly, a step forward would be for driver education to upgrade its curriculum to include more GDL information ensuring that the rules and rationale for GDL are an important part of the "theoretical" component of the program.

It is possible that driver education is too narrowly focused and fails to adequately address wider lifestyle issues which determine how drivers actually behave on the road and not how skilled they are at driving (i.e., what drivers actually do versus what drivers are capable of doing). In this context, the GDE principles mentioned previously were originally developed by the European Union in the Guarding Automobile Drivers through Guidance, Education and Technology (GADGET) project (Christ et al. 1999; Hattakka et al. 2003). The GDE Matrix provides a hierarchical schema of the driver's task, outlining the personal situation within which all drivers undertake driving, including preconditions, attitudes, abilities, demands, decisions and behavior, categorized into four levels: 1. Vehicle maneuvering; 2. Mastery of traffic situations; 3. Goals and context of driving; 4. Goals for life and skills for living. Traditional driver education programs in the United States typically focus on levels one and two, and to some extent level three, without any or much focus on the fourth level, despite the fact that these higher levels are likely the major influences on teen driving behavior giving rise to their elevated crash risk. Although applying GDE principles to improve driver education makes sense on logical grounds, the safety effects have not yet been evaluated.

Another more recent initiative by the European Union is the CLOSE TO project that examined the peer-to-peer education method, which involves having young offenders participating in the theory part of the driving training program to share with learner drivers their own experience and the dramatic consequences of a collision on their lives (Pfeiffer et al. 2006). Eleven EU countries have implemented the recommendations developed by the CLOSE TO project (G. Jost, personal communication 2014). The safety effect of such peer-education integrated into driver education within a GDL framework, however, has not been established.

Resilience training to address lifestyle factors, insight training to address optimism bias, and the "P" Drivers project to effect behavior change (programs discussed earlier in this report) have modest evidence and show promise, but further research is needed to determine whether, and how, to integrate these into improved multi-phased driver education that is better coordinated with graduated licensing (i.e., what is the proper mixture of these safety measures).

Driver education should also use the best teaching methods and learning principles. For example, computer-based instruction and driving simulation provide a protected way of exposing teens to the hazardous driving situations that contribute most to the elevated crash risk among adolescents. These methods provide a more efficient and possibly more effective means of transferring knowledge, attitudes, and skills, especially those related to hazard perception, than do didactic lectures, dated safety videos, and only minimal hours of in-vehicle training on-road. On-road and simulated driving teaching techniques, such as commentary driving (having novice drivers comment on the hazards and factors they take into account while driving), and in-car technologies (e.g., systems that warn about unsafe driving such as speeding) to train and monitor young drivers should also be considered, and are discussed in other sections of this report. It is important as well to match the learning experiences to the novices' needs and skill level, which speaks to better testing and diagnostic assessments by means of, for example, improved driving tests and computer-based training and testing (Mayhew 2006; TRB 2006). The issue of testing and GDL is discussed in the next section of this report.

Time discounts for driver education. The GDL programs in New Zealand, some Canadian provinces and a few U.S. states include a time discount for driver education (i.e., the length of the learner period is reduced by several months for those completing an approved driver education program). Until improved driver education is better integrated with an enhanced GDL system, time discounts for driver education should not be allowed for three reasons. First, time discounts are contrary to graduated licensing principles which are based on time in the system. Second, research has shown that driver education programs have generally not reduced crashes so the practice of reducing the length of time in a protective GDL system for successfully completing driver education is tenuous at best (Lonero and Mayhew 2010; Mayhew 2007; Thomas et al. 2012a; Williams et al. 2009; Williams and Mayhew 2008). Third, research has shown that time discounts for driver education actually compromise the safety benefits of GDL because drivers who receive the time discount have higher crash rates than those that do not (Hirsch 2006; Lewis-Evans 2010; Mayhew et al. 2002; Wiggins 2004). A few jurisdictions that have researched the merits of the time discount have chosen to modify their GDL program to allow the time discount in the intermediate stage rather than in the protective learner stage (e.g., British Columbia, New Zealand). Offering a time discount at the intermediate stage, however, can still be highly problematic since it can undermine the protective effect of the restrictions operating at this stage (Lewis-Evans 2010). For many jurisdictions, the time discount is offered as an incentive to complete driver education and many jurisdictions are hesitant to remove them. Alternative and equally enticing offers could be substituted to encourage driver education completion without compromising the safety of drivers, including insurance discounts, school credit, or as a means to pass an on-road test.

Introduction

License testing is an integral part of the progression from learner to pre-licensure. Passing a written test about road rules and knowledge of safe driving practices is a requisite for entering the learner stage. Passing a road test is then generally required to obtain a license to drive independently. There is substantial variation in written and road tests around the world, and those in the United States are in general less demanding than tests in many other countries (Bonninger et al. 2005; Haire et al. 2011). For example, most road tests in the United States and Canada take about 15-30 minutes to complete compared with 60-75 minutes in some Western European countries. However, there is limited evidence that the type of test or test performance produce any differences in safety outcomes, with the exception that very tough road tests such as those used in Great Britain can significantly delay license acquisition (Calian and Stecklow 2002; Williams 2009).

License tests in the U.S.

Although driver licensing rules have changed dramatically in the United States, testing requirements have mainly been carried over from pre-GDL times. This is unlike the case in other GDL countries, where new types of tests that dovetail with GDL stages and requirements have been added. One change that has occurred in the United States has been in Connecticut, where a task force appointed by the Governor recommended that the written and on-road tests for young drivers be made more comprehensive. In this case, only the written test was changed, increasing the number of questions from 16 to 25, and the pass rate criterion from 75% to 80%. Surveys of license applicants before and after the change indicated no measurable impact of this change (Haire et al. 2011). In New Jersey, a similar task force convened in 2009 also recommended that written and road tests be enhanced to more accurately assess driving skill and safety, noting that the present tests had not been changed in more than 50 years and might not be valid in today's environment. A bill was subsequently passed to change the written test, but that change has yet to be implemented.

The American Association of Motor Vehicle Administrators (AAMVA) has been developing driving test protocols intended to result in standardization of tests across states. The project includes the development of a model driver manual, knowledge tests, and on-road testing procedures. This exercise is not aimed at lengthening the tests or making them more difficult, but to increase uniformity across states based on a best practices assessment.

License tests in other GDL countries

In the meantime, New Zealand, several Canadian provinces and Australian states have added new tests, primarily involving more demanding road skills and hazard perception abilities (Mayhew et al. 2001; Williams and Mayhew 2008; Haire et al. 2011). The most popular have been "exit" tests, required to graduate from the intermediate license phase to full license status. Ontario was the first to adopt an advanced on-road exit test, which is more stringent than the road test that must be passed to move from the learner phase to an intermediate license. The purpose of an exit test is to ensure that novices have the necessary skills to operate on the roads with acceptable safety before being granted full driving privileges. The test is intended to "raise the bar" and motivate intermediate level drivers to practice so as to develop these skills. Part of the motivation for the exit test in Ontario was that without it, graduation to full license would be automatic after a set number of months of violation-free driving. The exit test was intended to deter novices from curtailing their driving while in the intermediate stage out of concern that they would incur a violation that would keep them from advancing.

Other jurisdictions outside the United States have also added exit tests, including Alberta, British Columbia, New South Wales, New Zealand, and Queensland. The tests vary but usually include road tests that are longer and more demanding than the basic road test, and in some cases hazard perception testing. Hazard perception testing comes in two forms, screen-based computer testing (e.g., Victoria, Queensland), and on-road testing in which drivers are asked to identify and verbalize to the examiner the presence of hazards in the immediate driving environment (Alberta, British Columbia, New Zealand).

Besides exit tests, some jurisdictions have also made changes to the road test to advance from the learner stage to an intermediate license. For example, in British Columbia the development of the new GDL exit test prompted the design of an improved basic on-road test, including an assessment of the applicant's hazard perception skills. New Zealand introduced a new test that encourages the accumulation of 120 hours of supervised driving and takes 60 minutes to complete.

New South Wales and Victoria illustrate how testing requirements have changed as GDL systems evolved. New South Wales has modified licensing rules several times. In 2000 a four-phase system was introduced which included: learner (six months), provisional P1 (one year), provisional P2 (two years) and full license. To move from learner to P1 a basic on-road driving test had to be passed, and passing a touch-screen computer-based hazard perception test was necessary to enter the P2 stage. The exit test to progress to a full license was contingent on passing a computer-based test, assessing advanced hazard perception scenarios, and knowledge or road rules and safe driving practices.

In 2007 the New South Wales system was again revised; the learner period increased from 6 to 12 months, the number of required supervised hours increased from 50 to 120, and a nighttime peer passenger restriction was added to the P1 stage. Accompanying these changes, the road test to move from learner to P1 was substantially revised. It was about twice the length of the previous version with extensive assessments, over 25 individual roadway segments, and the emphasis changed from vehicle maneuvering skills to checks of driver behavior associated with the avoidance of common crash scenarios of novice drivers.

Victoria adopted new GDL rules in 2008; a learner stage of 12 months, a P1 phase of one year including a peer passenger restriction, and a three-year P2 stage. An automated touch-screen hazard perception test had previously been developed based on an analysis of novice driver crash scenarios where hazard perception may have played a role. This is one of the few tests shown to have predictive crash probability (Congdon 1999). The test was developed as an exit test but has been used to assess readiness for moving from learner to P1, in conjunction with a basic on-road test. The basic road test was changed in 2008 with the intention being to develop a test that would discriminate between drivers with and without 120 hours of practice, which was an increase in practice hours introduced as part of the GDL enhancement. The previous test was developed during a time when most learners would have less than 20 hours of supervised driving experience. The new test takes about 30 minutes of driving time to complete, involves an assessment of basic car control skills in 50-60 km/h speed zones, and an assessment in more challenging driving situations, primarily in 60-80 km/h conditions. This new test complements the existing screen-based hazard perception test.

License tests in non-GDL countries

The discussion thus far has concentrated on license tests developed specifically for application to GDL programs. However, new tests have been introduced in non-GDL countries, particularly Western Europe, that could be considered in conjunction with GDL programs. For example, in 2008 the Netherlands introduced a new test quite different from standard tests (Vissers and Reitman 2007). Drivers are asked to drive to a specific location and to perform various maneuvers on the way. During this trip they are asked to verbalize what they see as the risks, predict what will happen, and how they intend to handle these situations. A final component involves reflecting on their driving behavior and their strengths and weaknesses.

The United Kingdom has had a hazard perception test in place for many years based on real-life video footage that is now being replaced by animated scenarios. Germany and the Netherlands are also developing hazard perception tests.

In recent years there has been some interest in using simulator assessment as a replacement for on-road tests. A simulated drive test might be a more effective way to assess hazard perception than is the case with current hazard perception tests using computer touch screen methods. In addition, a simulated drive test could conceivably be used as a pre-screening procedure in the GDL licensing process in both the pre-learner and pre-intermediate stages. For example, currently the vision and written tests are typically used as the basis to issue a learner license allowing supervised driving. A simulated test could be used to determine if the teen has sufficient motor and procedural skills to be allowed to operate a vehicle with a supervisor. Similarly, a more demanding simulated drive test could be used before undertaking an on-road assessment to determine the teen's readiness to drive with a driver examiner on road. In these ways, simulated drive tests provide additional safeguards to help protect the teen applicant, the driver examiner, and the public from the risks associated with real-world driving.

Safety benefits of new tests

Safety benefits of new tests that have been developed to accompany GDL programs are not well established. Historically, research in regard to driver licensing tests has yielded disappointing results. Driving tests that have been used vary in reliability and validity, many have poor psychometric properties, are relatively undemanding, capable of screening out only the very incompetent, and have little ability to predict who will be involved in subsequent crashes. The basic road tests that have been evaluated have generally not been found to be associated with safety benefits (MacDonald 1987; Mayhew et al. 2001).

However, the tests that have been developed to assess progress through GDL systems in Australia, Canada, and New Zealand have been carefully and thoughtfully designed, and they have considerable theoretical and logical appeal. With longer learner periods and supervised hours requirements, it makes sense to expect a higher level of driving competence at the time of the test. This may especially be so in jurisdictions like New South Wales and Victoria with long learner periods and 120 hours of supervised practice required. However, it is also the case in the United States that in the many states with 6-12 month minimum stays in the learner stage and 50 or more practice hours required, the basic road tests that have been in place for decades are inadequately demanding and need improvement. Although the extra time spent by GDL participants under supervised and restricted driving conditions provides more opportunity to gain driving experience than under predecessor licensing systems, it also makes sense to try to make sure that a satisfactory level of competence has been attained prior to full license status being allowed. This is particularly important in GDL programs in which graduation is delayed if violations/crashes occur, which may motivate some novices to limit their amount or type of driving.

Safety contributions from enhanced testing in GDL systems could come from knowledge or ability gained in preparing for the tests, and/or from delay in licensing resulting from extra preparation time or test failure. Exit tests in particular are intended to motivate novices to practice so as to enable them to improve their proficiency and pass the test and graduate.

Most of the research on the new GDL-related tests has dealt with predictive validity, the extent to which tests distinguish between safe and unsafe drivers. There is mixed evidence in this regard (Senserrick and Williams 2014) but positive evidence that some of the tests can identify safer drivers. For example, those passing the New South Wales hazard perception test on the first try have been found to have fewer subsequent crashes than those who do not, and the same is the case for the New South Wales exit test (Roads and Traffic Authority of NSW 2008). This enhances the usefulness of the test as a traffic safety measure. It also demonstrates the likelihood that the test can accurately identify those whose skills are insufficient and delay their advancement in the GDL system, providing a safety benefit.

A more important safety contribution would be if the introduction of the new test resulted in an overall reduction in crash incidence among those subject to the test, in comparison to those taking the prior test (or to novices in a prior period who did not have to take a test). This would be difficult to determine, since new tests are typically added at the same time as significant changes in the licensing system, which may also affect crash involvement. One attempt to isolate the individual contribution of an exit test was explored in British Columbia, but absence of an appropriate comparison group precluded any definite conclusions (Wiggins 2006). The only solid information for this type of analysis is based on a study in California where a new and improved road test (longer, more challenging) replaced the test that previously had been required. However, a well-designed field experiment did not find any improvement in crash involvement when those taking the new test were compared with those taking the old test both before and after the new test was introduced (Gebers et al. 1998). However, the California test to advance from the learner stage is not very comparable to the introductory tests introduced in New South Wales and Victoria, or to the exit tests in the jurisdictions where they exist, and do not necessarily predict the results that would be found if well-controlled studies such as the one in California could be done.

Recommendations for the GDL framework
(Expert opinion-based, research needed)

The action taking place in license testing to assess and monitor progress through GDL programs has been in countries other than the United States. The logic for these tests is compelling and they provide several models for the United States, both for initial on-road tests and exit tests. However, their safety effects are not known and are not likely to become known in the jurisdictions where they now exist.

Modify current tests to move from learner to intermediate license, add exit tests. Given this situation, it would be advisable that U.S. states consider changing their road tests for advancing from learner to initial license, and adding exit tests, simply for the logic of doing so. It is apparent that the road tests presently in use are dated and do not adequately discriminate between those who have and have not reached the performance level expected of novices who have practiced 50 or more hours, as was recognized but not acted on in Connecticut and New Jersey. Other countries have demonstrated that more appropriate tests can be devised that dovetail with and reinforce the GDL process. Adding exit tests would help to ensure that novices are ready for full driving privileges. Exit tests would be particularly appropriate for those who age out of GDL, that is, turn 18 and automatically graduate to full license although they have not completed all GDL stages. Exit tests might also be considered for those who do not begin the licensing process until age 18 or later, avoiding GDL rules. Given the recommendation to strengthen other components of GDL, requiring more stringent tests to ensure that these competencies have been met makes an abundance of sense. Note that exit tests could be on-road tests, computer-based hazard perception tests, or simply the maintenance of a clean driving record during the intermediate period, without any formal test.

The proviso for making these recommendations is that such changes would need to be accompanied by research to measure their effects. Assuming that no other significant changes were made simultaneously, that would be possible, and would provide a test case that would serve as guidance to other states.

Modify written tests to add GDL-related questions. Other than minor changes made to Connecticut's written test to determine entry into the learner stage, making changes to the written test to assist GDL programs has been given little consideration. However, it could be beneficial to add questions about state GDL learner requirements to the test (and to the accompanying DMV guidebook if need be), since there is concern that many learners may not know the rules, which can reduce compliance. It should be possible to add a few questions, particularly since the numbers of questions asked in present tests are relatively low. For example, the average number of questions in U.S. state tests is 30, compared with 41 in 28 European countries (Haire et al. 2011). Ideally, a research program would guide this effort as well, allowing the impact of the new version of the written test in augmenting GDL programs to be gauged.

What is in-vehicle monitoring technology?

Different methods have been applied or proposed to teach, monitor, and enforce the rules applied to young drivers as they are learning to drive on their own. One such method that has emerged relative to young driver safety is in-vehicle monitoring technology. While certain industries, like the trucking industry, have been using in-vehicle monitoring for years, little is known about the real-world application and effectiveness of these technologies as they apply to monitoring teen and novice drivers.

In-vehicle monitoring devices serve many different functions, and can be used in several different contexts. In general, these devices record and store data about specific actions, conditions or behaviors of the driver of a motor vehicle. Examples of monitored situations include: recording crashes or near crashes; speeding; abrupt changes in acceleration or braking; non-belt use; excessive distraction; the presence of passengers; and, even dangerous turning maneuvers or lane changes. Certain systems are also equipped with global positioning systems (GPS) so that parents can track where their son or daughter drives. Others give direct feedback to young drivers, letting them know through sound or light warnings that they are engaging in unsafe driving behaviors. There are several different types of systems, either on the market today or currently in development, that have the potential to be used to aid young drivers in learning to be safe and responsible drivers.

GPS measurement technologies allow parents to monitor and access the location of their teenager's vehicle at all times through real-time updates that are transmitted through the on-board system of the car. GPS also opens the door for several concurrent types of in-vehicle monitoring and tracking since it can be used for different purposes. One such application is to capture and monitor the speed at which young drivers are driving since these devices are able to calculate the speed at which a vehicle is travelling based on its position. Another possible application of GPS is to allow parents to set parameters for where their teenager is allowed to drive. This application is termed geofencing and alerts a parent if the teen driver travels into or out of a particular area that was predetermined and set into the system (Lerner et al. 2010). This technology could potentially serve as an extension to the supervisory period, usually mandated in the learner stage of a GDL program, and provide a kind of intermediate supervision to young drivers as they continue to learn to drive.

Video monitoring systems are also an available option to monitor and enhance the safety outcomes of young and teen driver activities. Such systems, unlike "black box" monitoring devices, also resolve problems associated with driver identification, especially in cases such as those where a family vehicle is used by multiple drivers. Digital video recordings that are captured by these devices can be saved and easily downloaded to a computer or other device where they can be reviewed by parents or educators. Some technologies allow for continuous recordings whenever the vehicle is driven, while others are designed to capture event-based recordings only. One example of such an application is DriveCam, created by DriveCam, Inc. in the United States. Safety systems like DriveCam are activated by a specific feedback response, such as airbag deployment or sudden braking. The device records 10 seconds of audio and video before and after the crash or incident occurs, which allows for parents, researchers, or police officers to interpret the incident objectively (Farmer et al. 2010). Although primarily used in large-scale trucking and transportation industries, video recording devices are already being used in "naturalistic" research studies of teen driving behaviors (Klauer et al. 2011; McGehee et al. 2007). The applications for this type of monitoring technology are plentiful as they show parents how their teens are driving when they are not in the car, create objective records of incidents, as well as allow researchers and policy makers to better understand the behaviors and actions of young and novice drivers as they are learning to drive.

Direct feedback systems are designed to immediately notify teens when they are driving in an unsafe manner. Sensors in the vehicle can detect whether or not the driver and passengers are wearing a seatbelt; if the music or entertainment system is too loud; if they are driving too fast; or, if they are deviating too far from their lane or are driving too close to another car (also used in adaptive cruise control). The feedback aspect presents itself in the form of verbal warnings, beeping or buzzing sounds, blinking lights, or the implementation of adaptive vehicle functioning, such as reducing the volume of the stereo when seat-belts are not fastened. Parents can also be informed via text or email alert when these warnings are engaged. In some systems, teens have the opportunity to correct the behavior before their parents are informed (Farmer et al. 2010). These technologies are already beginning to be used as a standard safety feature in vehicles today. For example, the Ford MyKey® system has been growing in popularity with an increasing number of Ford and Lincoln vehicles integrating this feature as an added safety benefit to parents of teen drivers. Smart keys, like MyKey®, allow parents to set a predetermined speed limit for the vehicle, activate a seatbelt-reminder system, and even set a maximum stereo volume when a specific set of keys is used by a driver (Ford 2013). These devices can provide a particularly appealing function for young drivers, in the sense that they curb risky driving behaviors, but do not necessarily require that a parent or authority be notified of the behavior.

Other technologies are also being developed which could allow for even more effective monitoring of young and teen drivers. Such technologies include: passenger occupancy sensors; cellphone detectors and blockers; sensors that monitor cognitive/emotional states to detect fatigue or alertness in drivers; road condition sensors; driver attention systems; and, road sign detectors (Lerner et al. 2010). The successful implementation of these technologies will depend on their effectiveness, availability, cost, feasibility of implementation, as well as public acceptance of their use.

Research and effectiveness

Available research has largely shown that in-vehicle monitoring technologies have the potential to reduce the crash risk, as well as engagement in risky behaviors by young and novice drivers. Results from several studies show that using in-vehicle monitoring technologies can significantly reduce the occurrence of risky driving among drivers (Bolderkijk et al. 2011; Farmer et al. 2010; Horrey et al. 2012; Lerner et al. 2010; McGehee et al. 2007; Toledo et al. 2008). However, little is known about which technologies provide the greatest benefit in reducing crash risk as many studies use more than one or a combination of multiple technologies, making it difficult to determine their individual effectiveness. As well, these studies largely evaluate the effectiveness of using on-board safety monitoring systems and parental feedback and notification, but little research has evaluated the effectiveness of other devices discussed previously, such as smart keys, geofencing, or technology blockers. This can be attributed to the fact that their use has not been widely implemented or piloted by jurisdictions.

One of the most positive findings coming from the research on in-vehicle monitoring devices is that they not only have the potential to reduce overall crash risk for young drivers, but also to significantly reduce the risk of young drivers who are at the greatest risk of being involved in a crash. A study conducted in the United States found that the experimental intervention using visual feedback features to notify teens of a negative behavior, as well as reporting driver behavior to parents, dramatically reduced the safety-related events that occurred for the 'high frequency' (i.e. highest-risk) group of young drivers in the study (McGehee et al. 2007). These findings imply that in-vehicle monitoring technologies have the potential to target and reduce the crash risk for teens that are at the greatest risk for being involved in road crashes.

Although most studies only show reductions in risky driving behaviors in the short-term while the devices are installed in the vehicle, the associated benefits of using in-vehicle monitoring technologies may still be well worth it (Bolderkijk et al. 2011; Farmer et al. 2010; Toledo et al. 2008). As evidenced in previous sections of this report, it is widely known that the most vulnerable time for newly licensed drivers to be involved in a crash is within the first months of unsupervised licensure. The fact that in-vehicle monitoring technologies have been shown to reduce potentially risky behaviors of teen drivers, even in the short-term, means that they could be effective in reducing crash rates of young drivers at precisely the time when they are most at risk. A review of the literature indicates that one of the most effective strategies of in-vehicle monitoring technology in reducing risky behaviors of teen drivers is to employ systems that are designed to report driving behaviors directly to parents (Bolderkijk et al. 2011; McCartt et al. 2010a; Prato et al. 2010). It appears that the protective effect of having a parental or adult supervisor in the vehicle with a teen driver is carried over in this instance, as these devices present the possibility that parents will be informed of negative driving behaviors, even though they are not present in the car. Young drivers may also be less susceptible to the dangers of the peer influences of teenage passengers if they know that their parents will see a report of their driving behaviors (Guttman and Gesser-Edelsburg 2011). It should be noted that while existing studies show positive effects resulting from some in-vehicle monitoring devices, they cannot be considered a substitution for parental involvement and coaching. As well, despite their promise, there are many controversies and limitations surrounding these technologies which may pose barriers to their implementation and effectiveness, and some of these are discussed in a subsequent section of this report.

Integration into GDL and recommendations for the framework

(Expert opinion-based, research needed)

The primary goals of in-vehicle monitoring technologies are to improve the safety of young and novice drivers, and to ultimately reduce the number of collisions on roads. However, there are several different theories about how in-vehicle monitoring can most effectively be used to achieve these goals. The two most prevalent strategies involve either an enforcement or educational approach. Neither of these strategies has been applied in a GDL context, so they are recommended as options on logical grounds based on expert opinion, recognizing that research is needed to establish their effects on safety.

The first approach proposes to incorporate in-vehicle monitoring of young drivers as a strategy to reinforce compliance to GDL restrictions. In this instance, in-vehicle monitoring technologies, such as cameras, speed governors, or feedback systems would become mandatory for young drivers during specific stages of the GDL process, along with the possibility of enforcing penalties for non-compliance or misdemeanors. Compliance could be monitored by parents, licensing agencies, or police enforcement, depending on the approach that is taken. However, this approach may be subject to adverse public reaction, as well as economic implications which will be discussed later on.

Another popular approach to using in-vehicle monitoring technologies as a means to complement GDL is to use them as a tool to help parents continue to mentor and coach their teens as they begin to drive without a supervisor. As opposed to parental feedback, which may cause emotional stress and tension between parents and teen drivers, in-vehicle monitoring can provide an unbiased response to teens to let them know that they should adjust their driving. This strategy allows for prolonged parental involvement and monitoring of teen drivers past the initial learner stage of GDL. In this approach, in-vehicle monitoring would not be mandatory, but encouraged as an educational tool for parents to enhance communication with their teenager and keep them safe while they continue to learn how to drive.

It is also possible for in-vehicle monitoring technologies to combine both an enforcement and educational approach in support of GDL requirements. Recently, for example, researchers at the UNC Highway Safety Research Center have developed a research-based software application for parents of teen drivers called "Time to Drive". This application automatically records the amount of driving (day and night), records hard stops and driving conditions (e.g. bad weather, heavy traffic, rural roads) and generates a log for DMV. It also encourages the parent-teen team to meet driving goals, shows maps of past trips and provides tips for parents. And, there is modest evidence that log books reinforce GDL requirements related to supervised driving hours (see GDL features section), however, their electronic application requires further research and evaluation.

An extension of this approach might be for driver instructors, offering driver education, post-license training and/or remedial driver improvement courses, to use in-vehicle monitoring as a means to assess the teen's skills and learning progress when they are driving independently between lessons. The recorded information on the teen's driving behavior could be reviewed and applied by the instructor to better tailor training to the skill level and needs of the teen driver. In this way, in-vehicle monitoring devices could also be incorporated into license testing programs to provide objective measures of driver performance. These recommendations make sense on logical grounds but need to be piloted and evaluated to establish an evidence base.

Car insurance companies across the world have begun to combine both of these approaches to incorporate in-vehicle monitoring as part of their coverage plans. Companies in several jurisdictions, including North America, Europe, Asia, Australia, and New Zealand, are using in-vehicle monitoring to set premiums on insurance packages. A Dutch study evaluating the effects of pay-as-you-go insurance on teen speeding using GPS technologies found that relative to pre- and post-measurement and control groups, the use of this technology and resulting insurance fees significantly reduced speed violations of young drivers (Bolderdijk et al. 2011). This suggests that the threat of resulting penalties or fines for risky driving behavior that is made possible by in-vehicle monitoring, can result in safer driving practices by young drivers. Incentives for installing these devices involve reduced rates for complying with speed limits, driving for decreased distances, and other safe driving practices. As well, many companies offer specific programs or packages for use with in-vehicle monitoring devices that are specifically targeted at young and teen drivers (Lerner et al. 2010). Carrot Car Insurance, operating in the UK uses a black box-type device they call *i-box*, which collects various data (e.g., speed, swerving, and usage patterns) that are then rated and combined into a 'Driving Style' score that is used to determine if the driver is eligible for a cash reward. As a cautionary note, depending on the policy or issuing company, records of unsafe driving behaviors could ultimately lead to cancellation of an insurance policy. Similarly, in Australia there is also growing interest in the possibility of combining in-vehicle monitoring technologies with gamification principles (i.e., applying game playing techniques to engage and motivate people to achieve a certain goal) in order to change driver behaviour (B. Watson, personal communication 2014).

Public attitudes and concerns

It can be very difficult to introduce new policies and restrictions on driving regulations, especially when they are not accepted by the general public. Several studies involving focus groups and interviews have been conducted to ascertain how parents and teens feel about the use of in-vehicle monitoring technology. The overwhelming consensus in the literature shows that teenagers, as well as many parents, are not in favor of in-vehicle technologies, perhaps as a result of misconceptions and wariness regarding the intended consequences of their use. The main concerns cited in these studies were that teens and parents felt that monitoring technologies pose a threat to their privacy; restrict their independence; create a barrier to trust and create tension within the parent-teen relationship; prolong the length of the accompaniment period (which was viewed by most teenagers as a negative consequence); and, will increase the fear and potential of having parents use the technology to impose sanctions and penalties, rather than using it as a teaching tool (Gesser-Edelsburg and Guttman 2013; Guttman and Gesser-Edelsburg 2011). Teenagers also indicated that they found the in-vehicle monitoring devices to be annoying, and were relieved to have them removed from the vehicle (McCartt et al. 2010a). Policy makers must also consider the cost of making such devices mandatory for young drivers, as some technologies may pose significant economic burdens to licensing and enforcement agencies because of the associated implementation costs and time needed to manage and enforce such policies. However, it must also be considered that many vehicle safety features, such as the airbag, were initially met with strong opposition before their universal acceptance and recognition as essential vehicle safety components (Tullis 2013).

In-vehicle monitoring devices used in a personal or family vehicle, also pose ethical concerns when it comes to privacy. As opposed to its application in the professional trucking or fleet-vehicle industries, where hired drivers do not own the vehicle they are operating, requiring young drivers to install devices that record their actions is perceived by many as a violation. As well, many parents and teens have concerns that the information collected by monitoring technologies could potentially be leaked to unauthorized individuals, or ultimately be used to impose unfair penalties on young drivers. These fears could be quelled by promoting this technology as an optional tool to accompany and enhance a GDL framework in which devices would only be used as a feedback system for parents and teens to learn from and about their own driving practices.

On the other hand, several studies indicate that people do see the benefits of in-vehicle monitoring for teens. An Israeli study by Guttman and Gesser-Edelsburg (2011) that examined perceptions of these technologies found that many parents and teenagers saw the value in these devices. These benefits included being able to virtually accompany young drivers when parents were not present; moderating risky driving practices; helping young drivers to not be influenced by their peers when driving; providing the opportunity to open a dialogue between parents and teen drivers; and, that they could be used as a means for teenagers to prove to their parents that they are a safe driver. The traffic safety research field has also identified the benefit of these devices in being able to further understand the characteristics and behaviors of young and novice drivers and to be able to use this information to further reduce the risks associated with learning to drive (Jun et al. 2011; Lee et al. 2011; Prato et al. 2010).

In a world where technology is advancing every day, it is clear that it will be increasingly fused into various aspects of our lives, including our driving practices. However, what is unclear is to what extent we will allow technology to dictate the way we educate and create policies for young and novice drivers. While we do know that in-vehicle monitoring devices have the potential to decrease the crash risk of young drivers, we also know that enforcing the use of such technologies may result in challenges for policy makers and enforcement agencies. Unfortunately, we do not yet know how in-vehicle monitoring devices would impact the driving experience in a larger, real-world context which is why further pilot studies and research into the implications for young drivers are needed.

The review of the scientific evidence, the environmental scan of current and best practices, and the international expert panel discussion provided guidance on how to enhance GDL and better integrate safety measures for young and novice drivers within a comprehensive GDL framework, including driver education and training, license testing, and in-vehicle monitoring technologies. The GDL framework described in this section comprises evidence-based initiatives along with those that are largely unproven but make sense on logical grounds based on expert opinion. This is similar to the situation several decades ago when the concept of GDL was initially developed and promoted. At that time, there was limited or no research on the safety effects of GDL and most of its components, with the exception of a night driving restriction which early studies had shown to have safety benefits. However, the concept of a GDL system that introduced beginners into the traffic environment while protecting them as they gained experience made sense on logical grounds (see: Warren and Simpson 1976). As jurisdictions implemented GDL and evaluated it, GDL emerged as a popular and successful policy with proven safety benefits.

The GDL framework is described below followed by an illustration of the framework. Since the strength of the evidence in support of a specific component being recommended varies from strong to lesser or insufficient evidence, the illustration uses a gold star to denote components with a strong empirical base. Other components are based on expert opinion having a solid logical basis for consideration. These lack strong empirical evidence because available research, although promising, has been limited or they have not been evaluated even though they may have been in place in one or more jurisdiction(s) for some time or they have only recently been made available for consideration. These practices are recommended as part of the GDL framework since they may reinforce GDL principles and operation but need to be researched further to determine their safety effectiveness and/or the extent to which they contribute to GDL's overall success.

Learner stage

Eligibility age. GDL should apply to all beginners, regardless of age, although some rules could be relaxed for adult learners and novices.

Minimum entry age. The minimum entry age should be no younger than 16.

Minimum length in learner stage. The minimum length required to remain in the learner stage should be no less than 12 months.

Entry requirements. To obtain a learner license, applicants must pass knowledge and vision tests, which should include items relating to GDL requirements.

Supervised driving. The minimum number of supervised driving hours that should be a requirement to progress through GDL should be greater than 50 hours, optimally 80-120, and should span all seasons of driving. Log books should be required to increase knowledge and promote compliance with the required number of supervised hours. Also, log books could provide evidence of requirement fulfillment. In-vehicle monitoring could be used as a method to more accurately monitor practice driving hours.

Restrictions. Seatbelt use should be required for drivers and passengers. Supervisors should be restricted to a low or zero BAC. Phone/electronic device use by learners should be prohibited. Vehicle decals, designed to help police enforce GDL laws and encourage compliance with GDL restrictions, should be required for all drivers in this stage. Although not shown in the framework illustration, if GDL is extended to older novice drivers, a zero alcohol limit should be applied.

Driver education. Jurisdictions should regulate driver education to meet Novice Teen Driver Education and Training Administrative Standards (NTDETAS) in a multi-phased approach, including an initial phase of driver education (Phase 1), which would include in-vehicle and theoretical instruction that teaches basic vehicle handling skills and rules of the road to learners. Phase 1 driver education for young learners should: be teen-oriented; include a mandatory parent orientation course and encourage parental involvement throughout the GDL process; include GDL rationale and requirements in the curriculum; provide end of course reports/debriefings to parents that include recommendations for areas that need improvement; and, provide information about available in-vehicle technologies that can enhance the safety of young and novice drivers. The completion of driver education should not result in a reduced length of time spent in the learner stage. Driver education in-vehicle hours could be applied to reduce the mandatory minimum supervised driving hours if they are set at 120 hours or more.

Intermediate stage

Minimum entry age. The minimum entry age should be no younger than 17, and should not include exemptions for drivers who have completed driver education courses.

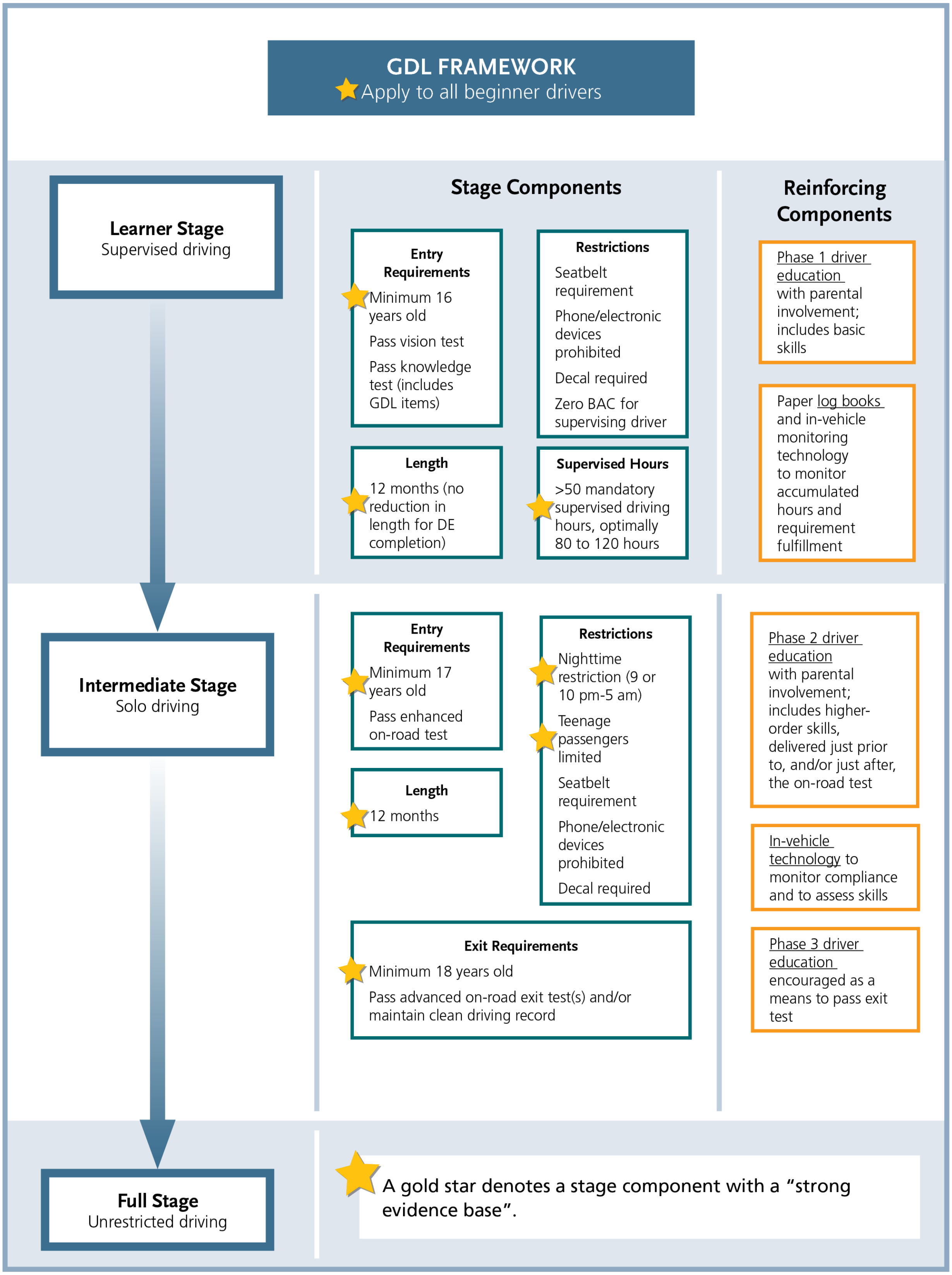
Minimum length in intermediate stage. The minimum length required to remain in the intermediate stage should be no less than 12 months, regardless of age at the time of entry. This ultimately means that the minimum possible age to progress to full licensure should be 18 years old.

Entry requirements. Requirements for obtaining an intermediate license should include passing an on-road, standardized entry-test. This test should include hazard perception skills. In-vehicle monitoring technology is encouraged as a means of objectively assessing driving skills and abilities. The completion of a second phase of driver education (Phase 2) which would involve advanced instruction to teach safe driving procedures including perceptual and decision-making skills (could include hazard perception training and incorporation of driving in high-risk situations, such as highway driving) should be jurisdiction-regulated and encouraged. Phase 2 driver education should be delivered just prior to the on-road test, or alternatively or in addition, in the first few months after the road test when teens are driving independently for the first time and experiencing their highest crash risk.

Restrictions. Unsupervised nighttime driving restrictions beginning at 9-10 pm and ending no earlier than 5 am should be required for all intermediate drivers. With the exception of a supervising driver and family members, intermediate license holders should be restricted to have no more than one teenage passenger in the vehicle at all times. Seatbelt use should be required for drivers and passengers. Phone/electronic device use by intermediate drivers should be prohibited. Vehicle decals, designed to help police enforce GDL laws and encourage compliance with GDL restrictions, should be required for all intermediate license holders. Although not shown in the framework illustration, if GDL is extended to older novice drivers, a zero alcohol limit should be applied.

Exit requirements. In order to progress to a full, unrestricted license, intermediate license holders should be required to pass an advanced on-road or computer-based exit test that includes measures of higher-order driving skills such as hazard perception, situational awareness, and decision-making. This test provides incentive for novice drivers to obtain additional driving instruction (in the form of Phase 3 driver education) and practice during the intermediate stage, in order to attempt the exit test and obtain a full license. In addition, or as an alternative to testing, graduating from this stage to a full license could be contingent on having a clean driver record.

Additional features. Technology, such as Smart Keys, in-vehicle feedback systems and other resources and tools, including on-line safety-oriented programs, should be promoted by licensing and insurance agencies, as well as driver education programs to help: enforce seat belt use; limit speeding; provide warnings of dangerous driving behaviors (e.g., lane deviation); and, reduce distractions (e.g., vehicle stereo volume) to novice drivers. As well, this stage should encourage continued parental involvement through in-vehicle monitoring technologies that automatically alert parents of risky driving behaviors. This could include a 'two-strike system', where teens are given the opportunity to correct an unsafe behavior before their parents are alerted.



From GDL framework development to implementation

The GDL framework describes what could or needs to be done, not how to implement it. From operational and policy perspectives, there are likely the proverbial “1,001” reasons why this integrated GDL framework will not work. In fact, several decades ago, there were certainly a plethora of reasons raised as to why GDL should not, and could not, be implemented. Today, however, all U.S. states, Canadian provinces/territories, Australian states, New Zealand, and a growing number of European countries have adopted some version of GDL. The enhanced and integrated GDL framework is also based on initiatives that are already in place in one or more jurisdictions demonstrating that they work in practice so obstacles to implementation could be addressed and potentially overcome. Although it is unlikely that jurisdictions will ever achieve uniformity in their licensing and safety-related policies and programs given economic, geographical, cultural, political, and other considerations, the implementation of as much of the GDL framework as is feasible, along with research to evaluate these enhancements, would be important steps forward in addressing the safety needs of young and novice drivers. The purpose of this report is to address what needs to be done and not to confront and become “mired” in implementation issues. This will be for consideration at a later date and in different forums.

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Traffic Injury Research Foundation

Information on GDL and Other Safety Measures for Young and Novice Drivers

Thank you in advance for your assistance. The information you provide will help us enhance our understanding of the current and future approaches to Graduated Driver Licensing (GDL), driver education, license testing/assessment, and in-vehicle monitoring technologies. When returning this document to us, please forward any related materials (e.g., reports, articles) of interest to us as well.

Please fill out the following information to the best of your abilities in the space provided. If you do not know the details with respect to a specific area of interest, please provide us with the name and email of a contact or agency that may have further information.

Your name: Email:
Your organization:

1. Are you aware of any recent or planned efforts to upgrade or enhance the features of a GDL program(s)?
   No ☐ Yes ☐ , if yes:
   - What are they:
   - Where is this happening:
   - When:
   - Contact person/agency:
   - Email address:

2. Are you aware of any recent or planned efforts to integrate GDL and driver education or to improve driver education programs?
   No ☐ Yes ☐ , if yes:
   - What are they:
   - Where is this happening:
   - When:
   - Contact person/agency:
   - Email address:

3. Are you aware of any recent or planned efforts to integrate GDL and driver license testing or improve driver license testing for young/new drivers? This includes the use of simulated drive tests, hazard perception tests and waiver programs (i.e., completing driver education exempts an individual from having to take a licensing exam/test from the driver licensing authority to obtain their driver license).

   No ☐ Yes ☐ , if yes:

   > What are they:

   > Where is this happening:

   > When:

   > Contact person/agency:

   > Email address:

4. Are you aware of any recent or planned efforts to use in-vehicle monitoring and feedback approaches as part of the GDL process (e.g., installing mandatory speed monitoring devices in the vehicles of novice drivers)?

   No ☐ Yes ☐ , if yes:

   > What are they:

   > Where is this happening:

   > When:

   > Contact person/agency:

   > Email address:

5. Are you aware of any recent or planned evaluations of the operational and/or safety effectiveness of these types of programs: GDL, driver education, license testing, waiver driver license test programs, in-vehicle monitoring and feedback?

   No ☐ Yes ☐ , if yes:

   > What are they:

   > Where is this happening:

   > When:

   > Contact person/agency:

   > Email address:

6. Other than the above, are you aware of any unique applications of driver education, license test/assessment, and other licensing features even if they are not presently well integrated with GDL?

   No ☐ Yes ☐ , if yes:

   > What are they:

   > Where is this happening:

   > When:

   > Contact person/agency:

   > Email address:

7. What would you recommend as best practices for improving GDL features and combining other safety measures with GDL?

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