How would changing driver training in the Queensland licensing system affect road safety?

Deliverable 1: Trends in driver education and training

Lyndel Bates
Ashleigh Filtness
Judy Fleiter
Barry Watson
Megan Tones
Amy Williamson

October 2013

The Centre for Accident Research & Road Safety - Queensland

is a joint venture initiative of the Motor Accident Insurance Commission

Executive summary

This report is the first of three reports in a program of research that examines driver education and training with a focus on how education and training interact with Graduated Driver Licensing systems, particularly Queensland's. This first report describes approaches to driver education and training in jurisdictions that are similar to Queensland. Thus, the report includes a comprehensive literature review on driver education and training as well as summaries of the licensing process in other jurisdictions that are considered comparable to Queensland.

Young, newly licensed drivers experience the highest crash risk when compared with all other groups of drivers. Driver education and training is a countermeasure frequently suggested to reduce the crash risk of young novice drivers. Driver education and training is not an homogenous countermeasure. It includes a number of different types including supervised on-road driving experience, professional driving instruction, simulator training, resilience training, procedural skills training, hazard perception training, situation awareness training and insight training. Each type of education and training uses different methods to reduce the crash risk of novice drivers. Additionally, driver education and training is delivered at different places within the licensing process. It can be delivered pre-licence which is when a person is unable to drive a vehicle by themselves (in Queensland, this would be pre-learner or learner) or post-licence, which is education or training delivered after the person is able to drive by themselves (in Queensland, this would be provisional or open).

The Goals for Driver Education (GDE) framework outlines the components that need to be addressed within driver education programs. The GDE framework operates as a hierarchy ranging from basic operational vehicle driving skills to higher order skills. The layers of the hierarchy are: vehicle manoeuvring (operational), mastery of traffic situations (tactical), driving goals and context (strategic) and goals for life/skills for living.

Graduated driver licensing programs are implemented in many jurisdictions internationally. An essential feature of these systems is that they require novice drivers to learn to drive and obtain driving experience over an extended period of time. While there may be a number of mechanisms used to achieve this aim, some jurisdictions require learner drivers to obtain and record in a log book a fixed number of driving hours. In other jurisdictions, learner drivers may be able to move to the next stage of licensing earlier if they complete a formal driver education course.

Many learner drivers use both professional driving instructors and private supervisors when they learn to drive. There are advantages in both forms of education and training. Some pre-licence training programs are delivered in high schools. However, the research evidence for the effectiveness of this type of education and program is weak.

Simulator training is addressed more comprehensively in the second report in this program of research. However, while more high quality research is required, the use of simulators for driver education and training and PC-based hazard perception training and education does appear to show promise.

Resilience training, which involves reducing risky behaviours in young people, does address the higher levels of the GDE matrix. However, more research is required before strong conclusions can be drawn regarding the link between resilience training and crash outcomes. Resilience training may be a useful addition to more formal driver education and training programs.

There is limited research evidence to support procedural skills training for post-licence novice drivers. In contrast, there may be some benefits in providing situation awareness and hazard perception training to this group.

An evaluative assessment was made for each of the approaches reviewed within this document[1]. This assessment relates to each of the education/training approaches and focussed on three aspects: 1) the effectiveness of the approach in reducing road crashes among the target group, based on the available evidence, 2) the strength of the available evidence, and 3) the scope of the training in terms of the extent to which each training and education approach addresses key aspects of the Goals for Driver Education (GDE) principles (see section 3.1 for greater detail of GDE). While the review of the literature clearly identified a large range of possible education and training initiatives, the research evidence does not identify one form of education and training as superior to all others in terms of road safety benefits. The role of the licensing system is also critical. The licensing system used within a jurisdiction has a strong influence on the likelihood that novice drivers will undertake a formal education and training program. Finally, an overview of the novice driver licensing approach used in Australian jurisdictions as well as in New Zealand, the United Kingdom, Sweden, the Netherlands, Germany, the United States of America, and Canada is provided.

[1] These initial ratings were further refined (changed) based on consultation with an expert panel of novice driver road safety researchers. This process and revised ratings are fully documented in project Deliverable 3 (Report 3), “How would changing driver training in the Queensland licensing system affect road safety?”

Contents

List of Abbreviations

AMAP	Attention Maintenance Assessment Program
BF17	Accompanied Driving from Age 17
CARRS-Q	Centre for Accident Research and Road Safety - Queensland
DBQ	Driver Behaviour Questionnaire
DMV	Department of Motor Vehicles
EU	European Union
FOCAL	Forward Concentration and Learning
GDE	Goals for Driver Education
GADGET	Guarding Automobile Drivers through Guidance Education and Technology
IPSGA System	Information, position, speed, gear and accelerate system
NHTSA	National Highway Transportation Safety Administration
NSW	New South Wales
PC	Personal computer
PDL	Pre-driver licensing course
RAPT	Risk Awareness and Perception Training
SPC	Safe performance curriculum
SPIY	Skills for Preventing Injury in Youth
TMR	Queensland Department of Transport and Main Roads
UK	United Kingdom
USA	United States of America
YARD	Young People's Attitudes to Risky Driving
YHTK	You Hold The Key

1 Background

The Queensland Department of Transport and Main Roads (TMR) called for responses to a tender to investigate how changing driver training in the Queensland licensing system would affect road safety. Following successful application by the Centre for Accident Research and Road Safety – Queensland (CARRS-Q), a program of work was developed. The project has three objectives:

- Identify the policies and practices related to driver education and training, with a particular focus on jurisdictions comparable to Queensland
- Consider the potential for simulator use in novice driver education, training and assessment
- Inform decision makers and policy developers of the ways in which different types of driver education and training for novice car drivers might be incorporated into the Queensland Licensing System and the likely effects on road safety

1.1 The program of research

Deliverable 1: The current report represents the first deliverable of the program of research. The central aim of this literature review is to describe approaches to driver education and training in jurisdictions that are comparable to Queensland. Findings from this report (and those from Report 2) will be used to inform Deliverable 3.

Deliverable 2: A report to provide a targeted literature review on simulators for skill acquisition training and assessment, and their impact on road safety.

Deliverable 3: A fact sheet summarising the reviews conducted in Reports 1 and 2. The fact sheet will be approximately six pages in length, suitable for download by the public from the TMR website and written in simple language suitable for a wider audience.

Deliverable 3[2]: Evidence-based driver education considerations for policy options. This report will draw upon the research reviewed in Reports 1 and 2. It will aim to inform decision makers and policy developers of the ways in which different types of driver education and training for novice car drivers might be incorporated into the Queensland Graduated Driver Licensing (GDL) system and the likely effects on road safety.

The current report may be considered as two phases (literature review and jurisdictional comparisons). To ground the context of the findings from the literature review, the current report initially defines the key terms of 'novice driver', 'driving training', 'driver education' and what is considered pre and post licence training. It is important that these terms are clearly understood to contextualise the remainder of the report. Next, there is a section discussing outcomes of interest from driver training, followed by a section which outlines the difficulties associated with driver training and education evaluations and finally, a brief discussion on the role of theoretical approaches in driver training and education. The literature review then provides information relating to key areas of interest in novice driver training and education. At the end of each section of the

[2] The original scope of this project included a fact sheet (referred to in the project brief as deliverable 3), however during the course of the project, it was decided that TMR would develop a series of fact sheets informed by these series of reports. Thus, for this and future reports, the former project brief deliverable 4 (Report 3) has been renamed as deliverable 3.

literature review, an evaluative assessment is made relating to each of the education/training approaches, focussing on: 1) the effectiveness of the approach in reducing road crashes among the target group, based on the available evidence, 2) the strength of available evidence, and 3) the scope of the training in terms of the extent to which each training and education approach addresses key aspects of the Goals for Driver Education (GDE) principles (see section 3.1 for greater detail of GDE). A rating is applied for each of these three assessment categories and provides a guide to the effectiveness, strength of evidence, and scope of the driver training or education. The ratings that were used for this purpose are:

Effectiveness:

*****	Demonstrated to be effective by several high-quality evaluations with consistent results
****	Demonstrated to be effective in certain situations
***	Likely to be effective based on balance of evidence from high-quality evaluations or other sources
**	Effectiveness still undetermined; different methods of implementing this countermeasure produce different results
*	Limited or no high-quality evaluation evidence

Strength of Evidence:

***	Many high quality evaluations
**	Some high quality evaluations
*	Few high quality evaluations

Scope of Training:

A	Addresses at least one curriculum category within goals for life/skills for living
B	Addresses at least one curriculum category within driving goals and context
C	Addresses at least one curriculum category within mastery of traffic situations
D	Addresses at least one curriculum category within vehicle manoeuvring

The rating system is designed to provide an indicative summary of each education/training approach. Besides assessing how effective each approach is, the rating system is designed to characterise its scope, as measured against the GDE. The availability of published research has a direct impact on the robustness of the ratings provided within this report. The lack of research, or recent research, is a limitation of this rating system. The publication of new research, which is an on-going and frequent process, will impact on the ratings provided within this report. Additionally, the summary of a large amount of information within this report has been done in a subjective manner. There may be individuals or organisations that disagree with the ratings provided within this report.

Finally, the report considers the approach used by different jurisdictions to train novice drivers. Although the skills required to operate a vehicle may be universal, the approach taken to train a novice driver varies between jurisdictions. To visualise these differences, phase two uses flow charts demonstrating the process to obtain an open driving licence in each Australian jurisdiction. Additionally, five international flow charts (New Zealand, UK, Sweden, Germany, and the Netherlands) and two summary tables (USA, Canada) present the process to obtain an open driving licence in seven international jurisdictions. The report ends with an overall conclusion.

1.2 Method

The primary objective of the report is to critically review the scientific research literature evaluating evidence of the efficacy of various techniques for training novice drivers. The majority of evidence is

in regard to novice driver skill acquisition, however, where possible, impacts on road safety are discussed. Report 1 covers two main issues:

1. Recent advances in driver education and training within the scientific literature
2. Recent advances in driver education and policy in jurisdictions that are comparable to Queensland

The two phased approach provides both an overview of the current situation and identifies training and education options not yet translated into practice in Queensland.

Outcomes

This report has three main outcomes:

1. The most common approaches to novice driver training and education are identified and summarised from the literature (professional driving instruction, driving simulators, resilience training, procedural skills training and higher order cognitive skills) including consideration of where the driver is within the licensing system and how (on or off road) the different approaches are used

2. An evaluative scoring system to assess driver training and education literature against has been developed

3. Current practices by jurisdiction (identified above) are visually represented in flow charts, allowing comparisons between jurisdictions

1.2.1 Scope

The literature review focused on the more recent developments (within the past 10 years) in novice driver training and education. However, where deemed appropriate, older literature was accessed and considered.

Driver education and training is an extensive area. In order to ensure that the report is focused on TMR's requirement to examine the road safety effects of driver education, vehicle handling skills training and driving simulators, the following areas are considered in scope for Report 1:

- Professional driving instruction (on and off road): training and/or education administered by a qualified person generally in return for a financial payment
- On-road driving experience (supervised): training and/or education provided by a private supervisor who is an experienced driver
- Simulator training (a brief overview is provided here because Report 2 will discuss this area in greater detail): use of a computer interface to train and/or educate
- Resilience training: driver education focusing on interpersonal skills which are peripherally related to road safety, such as avoiding riding with a drunk driver and resisting peer pressure to drive unsafely
- Procedural skills training: training of vehicle handling skills, beyond basic vehicle manoeuvring including, but not exclusive to, skid pads and track driving, defensive driving, both on and off road
- Higher order cognitive skills training: including hazard perception (driver's ability to interpret complex driving situations and respond appropriately), situation awareness (understand the hazard and respond by predicting how the hazard will behave) and insight training (awareness of one's own limitations as a novice driver)

The following areas are considered out of scope:

- Competency Based Training and Assessment
- Older driver training and testing
- Motorcycle rider training
- Heavy vehicle training/licensing
- Recommendations for/against different types of driver training and/or testing
- Type of experience provided by private supervisors (as opposed to quantity of supervised practice provided)

1.2.2 Literature search

The systematic search for literature was conducted using the following search engines and databases: “Science Direct”, “Web of Knowledge”, “TRID online” and “Google Scholar”. Due to time constraints, the search was focused on TRID online.

Additionally, relevant conference proceedings were examined (e.g. Australian road safety, policing and education conference) and cross referencing of obtained studies undertaken.

The search terms used were:

"Driv* train*"
"Driv* instruct*"
"Driv* education"
"Pre OR post" AND "licence train*"
"novice driver"
"on road" or "off road" AND "professional driv* instruction"
“driv* school”
“simulator training”
“resilience training”
“interpersonal skills” and “driv*”
“cognitive maturity” and “driv”
“psychological” or “personality” and “driv*”
“risk behave” AND “driv*”
"procedural skills train*" AND "driv*"
"on road" or "off road" AND "vehicle manoe*"
"on road" or "off road" AND "defensive driv*"
"higher order cognitive skills" and "driv*"
"hazard perception" and "driv*"
"situation aware*" and "driv*"
"insight train*" and "driv*"
"GADGET" OR "Guarding Automobile Drivers through Guidance, Education and Technology"
"Best practice*" AND "driv*"
"safe*" AND "driv*" OR "road"
"effect*" AND "driv*"

A search of article titles and abstracts for relevance was initially undertaken. From the studies found, those most relevant to the aims of the review were selected for further review and investigation. The review only included literature published in English. The main focus was on peer reviewed

scientific literature, however, grey literature was also considered if it came from a reputable source such as the websites of recognised road safety organisations. Research published since the year 2003 was given highest priority although earlier publications were included where appropriate.

1.3 Future work

The next stage of the project involves a review of the literature regarding driving simulators for novice driver training and assessment (Deliverable 2).

2 Literature review

2.1 Introduction

The term 'novice driver' typically refers to a person commencing on the path to becoming a fully licensed, experienced driver. It is important to note from the outset that the majority of the research literature and evidence contained in this report pertains to young drivers, because in the majority of jurisdictions where research has been conducted, novice drivers are young people (Watson, Fresta, Whan, McDonald, Dray, Bauermann, & Churchward, 1996). A young novice driver is generally defined as a new driver who is below 25 years of age (Beanland, Goode, Salmon, & Lenne, 2013; Scott-Parker, Hyde, Watson, & King, 2013; Wiggins, 2004).

Drivers experience their highest crash risk in their first six to 12 months of unsupervised driving (Lewis-Evans, 2010; Mayhew, Simpson, & Pak, 2003; McCartt, Shabanova, & Leaf, 2003; Williams, 2003). This crash risk falls rapidly during the first 6 to 8 months of driving before falling more slowly for the next 18 months to two years (Beanland et al., 2013; Engstrom, Gregersen, Hernetkoski, Keskinen, & Nyberg, 2003; Lewis-Evans, 2010). This pattern of crash risk has been consistent for at least the past 30 years (Elvik, 2010).

Reviews of crash patterns of younger drivers in Europe (Engstrom et al., 2003), Australia (Beanland et al., 2013) and the United States of America (USA) (Bingham & Hockanson, 2008) demonstrate that younger drivers are over-represented in serious single vehicle and/or loss of control crashes at night or on weekends. Other factors associated with crashes and risky driving behaviour in young drivers include inexperience (McCartt, Mayhew, Braitman, Ferguson, & Simpson, 2009), speed (Scott-Parker et al., 2013; Vassallo et al., 2007), distracted driving including driving while using a mobile phone (Cazzulino, Burke, Muller, Arbogast, & Upperman, in press; Nemme & White, 2010; Vassallo et al., 2007; White, Walsh, Hyde, & Watson, 2012), driving under the influence of alcohol or drugs, (Begg, Langley, & Stephenson, 2003; Marcotte, Bekman, Meyer, & Brown, 2012; Vachal & Malchose, 2009) presence of peer passengers (Begg, Stephenson, Alsop, & Langley, 2001; Curry, Mirman, Kallan, Winston, & Durbin, 2012; Lam, Norton, Woodward, Connor, & Ameratunga, 2003; Preusser, Ferguson, & Williams, 1998), gender (Al-Balbissi, 2003; Prato, Toledo, Lotan, & Taubman-Ben-Ari, 2010), sensation seeking (Jonah, 1997; Jonah, Thiessen, & Au-Yeung, 2001; Prato et al., 2010) and the use of older cars without modern safety features (Ivers et al., 2009; OECD/ECMT, 2006; Williams, Leaf, Simons-Morton, & Hartos, 2006).

Driving a vehicle is a complex task that requires new drivers to master a range of knowledge and skills necessary to operate and control a car within traffic situations, as well as the attitudes, behaviours and cognitions to drive safely (Beanland et al., 2013). Driver education or training is intended to ameliorate the risks faced by novice drivers (OECD/ECMT, 2006). The remainder of this review focuses on the wide variety of aspects pertaining to driver education and driver training with particular attention given to literature that covers the more recent developments in the area (i.e., within the past 10 years).

2.1.1 Definitions

Within this report, a number of terms are used. To ensure consistency of understanding regarding these terms, they are defined here. A novice driver is frequently young and is new to driving. They

are sometimes defined as drivers within a certain age group such as, for example, 16-25 years (Scott-Parker, Watson, King, & Hyde, 2012).

Driver training and driver education are two distinct, yet related concepts, although the terms are often used interchangeably. Driver training refers to the teaching of procedural and/ or cognitive driving skills with specific objectives in mind, such as obtaining a licence or learning particular skills. Driver education, however, is broader than training and encompasses the teaching of topics regarding safe and responsible driving, such as road rules, road safety, risk taking activities, and awareness of how personal characteristics may influence driving behaviour (Beanland et al., 2013; Engstrom et al., 2003; Langford, 2002; Watson et al., 1996). Education may include a component of driver training, and tends to include in-class, theoretical components (Zhao et al., 2006). As outlined below, there are different types of driver education and training:

Supervised on-road driving experience: A novice driver receives supervised on-road driving experience when a more experienced driver provides the novice driver with an opportunity to practise their driving on the road (Bates, Watson, & King, 2006). This practice, while frequently provided by parents, is also provided by people with a range of other relationships to the learner driver (Bates, Watson, & King, 2014b).

Professional driving instruction: Professional driving instruction occurs when the training is delivered by an individual whose specific role is to provide people with the knowledge and skills needed to function safely within a road environment in a systematic and structured manner (Faulks, Irwin, & Morphett, 2010). The training can occur on the road or in an off road facility. The professional driving instructor normally receives a payment for their assistance.

Simulator training: Simulator training involves the use of a computer to assist in the driver training or education. Driving simulators offer control over the driving experience but may lack some similarities to driving. Additionally, some people may develop simulator sickness (Roenker, Cissell, Ball, Wadley, & Edwards, 2003).

Resilience training: The role of resilience training is to reduce novice drivers taking risks by improving their interpersonal skills. Some courses in this area may not contain content that is specifically focussed on driving, however, the skills taught within the course can be applied more broadly including in the driving context (Beanland, Goode, Salmon, & Lenne, 2013).

Procedural skills training: This type of training involves teaching novice drivers how to undertake a sequence of actions that may become automatic after practice. This could include manoeuvring or operating the vehicle (Beanland et al., 2013).

Hazard perception training: Hazard perception training is designed to improve individuals' abilities to recognise potential hazards and hazardous situations while driving. It also provides some potential options that the driver could take in order to avoid hazards (Wallis & Horswill, 2007).

Situation awareness training: Situation awareness training is designed to improve novice drivers understanding of the environment around them. This type of training aims to improve novice drivers' cognitive skills (Beanland et al., 2013).

Insight training: Insight training does not teach novice drivers how to control a vehicle or undertake driving related tasks. Instead, the training is designed to increase the understanding of young people regarding the dangers they face while driving. By doing so, the training aims to reduce the over-confidence of young drivers (Senserrick & Swinburne, 2001).

Education can be delivered at different times during the licensing process. It can be delivered pre-licence or post-licence. Pre-licence training refers to training that occurs before an individual is able to drive a vehicle by themselves (Beanland et al., 2013; Haworth, Kowadlo, & Tingvall, 2000). Thus, it includes any driving that occurs before the individual obtains a learner licence as well as any driving that occurs while on a learner licence. In comparison, post-licence training occurs after a driver is able to drive by themselves (Beanland et al., 2013). It therefore includes both drivers who hold a provisional licence as well as those who hold an open licence.

2.1.2 Outcomes of interest

The clear identification of the outcome measure is key to understanding the actual and potential impact of driver education and training programs. For many people, the crash rate is seen as the ideal measure to identify the effectiveness, or the lack of, for these programs. However, there are issues associated with the use of this outcome measure. These issues include the relative rarity of crashes which makes it difficult to detect differences between drivers that have undertaken driver training and those that have not. Not all crashes are reported to police and thus are not included in administrative databases (Beanland et al., 2013). There is some concern that self-reported crashes by participants may lead to the under-reporting of crashes (Bates, Watson, & King, 2009), although recent research suggests that self-reported crashes by novices is comparable to administrative data from licensing authorities (Boufous et al., 2010). Finally, novice driver crashes are caused by a range of factors (Bates et al., 2009). It is unlikely that driver education and training is able to address the full range of factors related to novice driver crashes (Beanland et al., 2013). Using offences as a measure to identify if driver education and training has altered novice driver behaviour has many of the limitations associated with using crashes as an outcome measure.

An alternative outcome measure is whether the behaviour of novice drivers has changed as a result of their education and training. For instance, previous research has considered the impact of education and training on driving related attitudes, dangerous driving behaviours and perceptions of enforcement and crash risk (Senserrick & Swinburne, 2001). Additionally, other outcome measures for driver education and training could include the impact of driver education and training on simulated driving performance (Beanland et al., 2013; Dorn & Barker, 2005) or on their driving behaviour within a vehicle using unobtrusive recording devices (Beanland et al., 2013).

2.1.3 Evaluation difficulties

Evaluating driver education and training is important for two main reasons. Firstly, it enables the providers of education programs to improve them. Secondly, evaluations of driver education programs enables a demonstration of the effects (or lack of effects) of the program (Lonero & Clinton, 2006). However, while evaluating driver education and training is important, there are a number of issues that are traditionally associated with this task.

Firstly, despite the significant number and wide range of education and training programs, there has been very little evaluation conducted in the area (Lonero, 2008). Therefore, any conclusions drawn

about the effectiveness of education and training program relies only on the small number of evaluations that have been conducted which may exclude a large number of programs.

Secondly, randomised control trials are traditionally seen as the most appropriate method to evaluate an intervention, particularly in the health and safety areas (Lonero, 2008). However, there are very few randomised control trials conducted in the area of driver training which limits the ability to draw the conclusion that the observed effects are actually due to the training intervention that was implemented (Beanland et al., 2013). When individuals are not randomly assigned to groups, other methods are used to select the control and experimental group such as comparing a group that have completed a course with a group that is enrolled but has not yet completed the education program (eg. Senserrick & Swinburne, 2001). Even in situations when a randomised control trial is conducted, there may be other methodological issues that occur that are not controlled for. As one example, more participants may leave one group when compared with the number of participants that leave the other group. This could occur when the control group actually consists of administratively collected data which is then compared with the group of people that complete the training. More individuals may fail to complete the training program and evaluation than controls creating potentially biased groups (Stock et al cited in Beanland et al., 2013).

Thirdly, many of the evaluations in the driver training and education area are conducted on a short-term basis with limited long-term follow up of the effects of the driver education and training. However, a longitudinal evaluation enables a fuller assessment of the benefits of the program and identifies if the effects of the driver training and education program decay over time (Beanland et al., 2013).

Fourthly, there are ethical issues associated with the evaluation of driver education and training. For instance, it is not ethical to deny one group of participants' access to a program that the research team genuinely believe is likely to result in mobility or safety benefits. This is particularly an issue for driver education and training that occurs with learner drivers. It is less of an issue with provisional drivers, as this group has already obtained a driver's licence (Lonero, 2008).

Additionally, within the driver education and evaluation field, there are frequently methodological issues associated with the design of the evaluations. This could include failure to control for confounding variables or issues associated with sampling (Lonero & Clinton, 2006). There also tends to be a lack of appropriate and systematic follow-up to previous evaluations. This means that it is difficult to build upon previous research (Lonero & Clinton, 2006).

Finally, the content of driver education programs is diverse or may not be described fully within the evaluation report. As a result, it is difficult to draw conclusions from the evaluation to the broader field of driver education and training (Beanland et al., 2013).

2.1.4 Theoretical perspectives on driver training and education

A range of theoretical approaches are applicable to the field of driver education and training. Yet it is argued that one reason many driver education strategies have not been effective in reducing crash risks is that they lack a theoretical basis in young driver behaviour and behaviour modification in general (Lonero and Mayhew, 2010).

In order to reduce crash risk, driver education and training needs to provide learner drivers with knowledge and skills to be safe drivers, plus the motivation to apply these skills to on road driving. Application of theory to explain learning, motivations and behaviour in relation to driving may provide some insight into how to best train drivers to produce the positive outcomes of safe driving behaviours and reduced crashes. Given the breadth of content and the importance of the information that a novice driver must acquire in order to safely and successfully negotiate road use, the principles of adult learning are highly relevant. Adult learning principles are underpinned by the concept of the androgogical approach which stresses the importance of a self-directed focus, as compared to the pedagogical approach (i.e., a structured approach that aims to impart knowledge to the naïve learner) (see Choy & Delahaye, 2007, and Delahaye, 2005 for a general review of this topic). A primary consideration in the novice driver training context is the relevance of two different aspects in the pre-licence and the post-licence phase. In the pre-licence phase, there is a need for a learning paradigm so that information and skills can be imparted. However, in the post-licence phase, there is likely to be need for a behaviour and/or attitudinal change paradigm so that safe driving practices and motivations can be attained. This difference is likely to present a challenge for androgogical approaches to training, especially for those high risk drivers who do not perceive a need to change their driving behaviour – the type of driver that authorities would most want to change. In that sense, androgogical approaches are likely to be best suited to the pre-licence training phase because people are likely to be motivated to learn/change their behaviour in order to successfully achieve licensure.

Gregersen and Bjurulf (1996) built a complex model of crash involvement in novice drivers. They posited that learning, individual and social aspects have an indirect effect on crash involvement. Learning in general impacts upon driver skills and knowledge, such as calibration, automation and perceived crash probability, which in turn influences motives for driving, driver behaviour and ultimately crash involvement. Individual and social factors will also have an independent influence on motives and behaviours of driving, and impact crash involvement. An Australian study by Deery and Fildes (1997) demonstrated how personal and situational factors are associated with driving. Specifically, the researchers identified driver profiles via cluster analysis and compared the driving performance of different groups via a simulator. They found that poor driving performance was associated with aggressive and competitive driving behaviours, sensation seeking, depression, and hostile, irritable or resentful feelings, alcohol and drug use, traffic violation and male gender. With respect to learning, calibration skills have been of particular interest to researchers, as earlier research repeatedly suggested that overconfidence hampered any safety benefits of driver education. For instance, Molina, Sanmartin and Keskinen (2013) identified that novice drivers were interested in improving their self assessment skills in driving, and that drivers who lacked confidence were less likely to report risky driving behaviours and were more interested in post-licence training.

2.1.4.1 The GADGET matrix

Based on the assumption that the driving task can be described as a hierarchy, an extensive European Union (EU) project defined the Goals for Driver Education (GDE) as needing to address three essential components: 1) knowledge and skills, 2) risk-increasing factors and, 3) self-evaluation under four hierarchical levels of behaviour (Hatakka, Keskinen, Gregersen, Glad, & Hernetkoski, 2002). This model, also referred to as the GADGET matrix (Guarding Automobile Drivers through Guidance Education and Technology), outlines the basic components which need to be addressed in

driver education programs. The GDE identifies four levels which need to be achieved by novice driver training: 1) Goals for life/skills for living, 2) Driving goals and context (strategic), 3) Mastery of traffic situations (tactical) and 4) Vehicle manoeuvring (operational). Within each level, there are three categories of essential curriculum: 1) Knowledge, 2) Risk, and 3) Awareness, creating 12 aspects which the ideal novice driver training approach should address, as represented in the tables below.

The four levels which should ideally be addressed by novice driver training:

Goals for life/skills for living	Personal motives and tendencies in a broader perspective
Driving goals and context (strategic)	Journey related skills
Mastery of traffic situations (tactical)	Ability to safely interact with other road users
Vehicle manoeuvring (operational)	Ability to perform specific manoeuvres, parking etc

The three categories of essential curriculum within each level:

Knowledge	Providing the knowledge a driver needs for driving under different circumstances
Risk	Training dealing with aspects of driving/traffic that may increase risk. Includes perception of situations, speed adjustment and risk acceptance
Awareness	Training to enhance the driver's capability to assess their own performance. Critical self adjustments

The 12 aspects which the ideal novice driver training approach should address:

Goals for life - risk	e.g. Acceptance of risks, addressing sensation seeking, use of alcohol/drugs, values and attitudes towards society
Goals for life - awareness	e.g. Personal skills for impulse control, personal risky habits, negative safety motives
Goals for life - knowledge	e.g. How to control personal tendencies which affect driving behaviour, peer group norms, personal values
Driving goals and context - risk	e.g. Risks connected with driver condition (mood, BAC etc), the purpose of driving, driving environments (urban/rural), passengers
Driving goals and context - awareness	e.g. Personal planning, typical driving goals, understanding risky driving motives
Driving goals and context - knowledge	e.g. Knowledge and skills concerning planning and choosing routes, evaluation of driving time, effects of social pressures, evaluation of the effect of journey goals on driving
Mastery of traffic - risk	e.g. Risks caused by wrong expectations, driving style (e.g. aggressive), unsuitable speed adjustment, vulnerable road users, difficult conditions (e.g. dark, weather)
Mastery of traffic - awareness	e.g. Awareness of strong and weak points of traffic skills, personal driving style, personal safety margins, strong and weak points for hazard situations.

Mastery of traffic - knowledge	e.g. Knowledge and skills concerning traffic regulations, observation of signals, anticipation of developing situations, speed adjustment, safe distance
Vehicle manoeuvre risk	e.g. Risk connected with insufficient skill, unsuitable speed, difficult conditions (e.g. low friction)
Vehicle manoeuvre - awareness	e.g. Awareness of strong and weak points of manoeuvring skills, strong and weak points of skills for hazard situations, realistic self evaluation
Vehicle manoeuvre - knowledge	e.g. Knowledge and skills concerning control of direction and position, tyre grip, vehicle properties, physical phenomena

The two lower levels (mastery of traffic situations and vehicle manoeuvring) are often the sole components of driver education and training. The two higher levels (goals for life/skills for living and driving goals/context) are less often discussed, and relate to the role of driving in life and its relation to personal factors at the highest level, and the purpose of driving and contextual factors in a given journey context at the next highest level. Each level is further broken into knowledge and skills, risks associated with that area, and self evaluation or awareness related to the self (Berg, 2006). One significant issue with driver education is that the lower two levels of the matrix tend to be the focus, yet the complex task of driving takes all levels of the matrix into account simultaneously (Brezillon & Tijus, 2007; Rowden, 2012). Considering the various levels of influence, it can be seen how a focus on vehicle operation might lead to over confidence if higher levels of the GDE are not addressed through discussion of driver attitudes and their influence on behaviour for example.

In the EU TRAINER project, Hoeschen, Verwey, Bekiaris, Knoll, Widlroither, de Ward, Uneken, Gregersen, Falkmer and Schelin (2001) attempted to map driver education and training against the GDE matrix in an attempt to better understand the driving task in terms of decisional and motivational aspects. As expected, that mapping exercise found that current training initiatives were heavily focused on knowledge and skill development in vehicle manoeuvring and mastery of traffic situations. The authors noted that driving manoeuvre skills may be taught in simulators, although braking and stopping cannot be fully replicated accurately via a simulator (due to the lack of physical feedback of feeling like the car is slowing down). Despite advances since 2001, this remains one of the greatest challenges for simulator training. Risks associated with manoeuvres include difficulties judging speed and time to collision in learner drivers or under certain conditions, and the variation in car control aids in different vehicles. It was recommended that self assessment should also be addressed via demonstration of, and comparison with, actual skills (Hoeschen et al., 2001). The authors noted that the management of traffic situations appears to allow more opportunities for understanding risks and self awareness, as these are virtually considered skills in managing traffic situations themselves. For example, hazard perception involves the identification of, and response to, risky road situations as a skill. However, the risks of information overload, inadequate anticipation skills, risky driving styles and insufficient automation should be explicitly stated, and opportunities for knowledge and skill development balanced with insight training and reflection on driving style and skills to reduce the risk of overconfidence. Another outcome of the mapping exercise was that driver training and education at the higher GDE levels were less evident in training programs. Training that addresses goals for driving should relate to knowledge about safety issues

and economic driving, awareness that mental state and motivations can affect driver behaviour, and evaluation of personal driving goals and motives that could compromise journey safety. Training that addresses goals for life may be delivered in terms of knowledge about the relationship between lifestyle and demographic factors and driving, awareness of the risks posed by sensation seeking, social pressure, alcohol and drugs, and awareness about general personal risk factors.

The two frameworks described above (i.e., the model of crash involvement and GDE) integrate both learning how to drive and driver behaviour in some way. Gregersen and Bjurulf's (1996) model of crash involvement theorises about how learning experiences, personal characteristics and the situational context can influence crash involvement. The GDE makes no explicit claims with respect to crash involvement, yet driver behaviours are integrated into the learning process itself through practices such as reflection, insight and self awareness (Rowden, 2012). The GDE thus addresses behavioural change in addition to learning knowledge and skills, rather than simply the co-influence of driver behaviour on crash risk.

In summary, the use of theoretical approaches to driver training offers an important avenue for better understanding the way people learn and how they apply this knowledge to become safe road users. However, it is important to acknowledge that there is a lack of empirical validation of these approaches. To date, the GADGET matrix appears to offer the most comprehensive model against which to assess driver training and education programs, something that the evaluative rating scale developed for the current report attempts to achieve.

2.2 Graduated driver licensing

First adopted in New Zealand in 1987, many jurisdictions across Australasia and North America have implemented a graduated licensing system with various restrictions that aim to reduce high-risk exposure (e.g., exposure to known risks of fatal crashes in this population) and increase low-risk exposure (Begg et al., 2003; see Senserrick, 2009 for a summary of Australian jurisdictional requirements; Williams & Shults, 2010). These restrictions may pertain to the learning phase, such as mandated hours for supervised practice, or early licensure, such as curfews for night driving and restrictions on passenger numbers or mobile phone use. GDL systems have generally been found to considerably reduce the crash rates of novice drivers (Foss, 2007; Lewis-Evans, 2010; Scott-Parker, Bates, Watson, King, & Hyde, 2011). In the USA, the GDL is nationally recognised as an effective road safety countermeasure (Goodwin, Kirley, Sandt, Hall, Thomas, O'Brien & Summerlin, 2013).

Indeed, Foss (2007) emphasised that GDL has been unique in its contribution to reducing road trauma because of the size of the effect that it has had on its target group (i.e., new drivers). Foss also stressed that GDL is not a law, nor is it simply a series of regulations or rules designed to 'crack down' on teen drivers. Rather, GDL is a concept that attempts to 'transform non-drivers into reasonably good (i.e., safe) new drivers' (2007, p. 185). Furthermore, in describing GDL schemes, Foss noted that 'novices — as a cohort, not merely individuals — should obtain as much practical experience as possible, driving in realistic conditions, while simultaneously being protected to the greatest feasible degree from the inherently high risk of crashing attendant to novice driver status' (2007, p. 185).

An essential feature of many GDL schemes is that they require new drivers to gain practice and experience over an extended period of time (Bates, Watson, & King, 2013). This time period provides

the opportunity for the new driver to develop skills while under supervision of a more experienced driver (Mayhew, 2003) and also provides the opportunity to obtain experience with handling a vehicle, the road and traffic environment, and the behaviours of other road users (Foss, 2007).

In Queensland, significant changes were made to the GDL system from 1 July, 2007. The major changes were: the doubling of the minimum learner period from 6 months to 12 months; reducing the minimum age of eligibility to obtain a learner licence to 16 years (from 16.5 years of age); introducing a mandatory minimum of 100 logbook hours of supervised practice including 10 hours of night time driving, all of which must be recorded and certified in a log book (note: one hour of professional driving instruction can be recorded as three log book hours for the first 10 hours of professional instruction); a 2-phase probationary (provisional) licence period; mandating the display of L and P plates on vehicles driven by novice drivers, and; mobile phone, high powered vehicle, and late night peer passenger restrictions (Newstead & Scully, 2013; Scott-Parker et al., 2011). A preliminary evaluation of these changes using a quasi-experimental design examined changes in crash risk of GDL groups before and after the licensing requirement changes compared to a comparison group (25-35 year old experienced drivers in Queensland). Results of the preliminary evaluation conducted on crash severity at a global level as well as at the individual GDL phases indicated that changes to the scheme in Queensland were associated with a 30% reduction in fatal crashes of novice drivers and a 13% reduction in novice driver fatal and serious injury crashes combined (Newstead & Scully, 2013).

GDL will be discussed in greater detail in Report 3 of this project. However, what is relevant to the current report is the possible influence that GDL has on driver education and training. The goal of driver education and training is to prepare learner drivers to become competent, safe road users once licensed. GDL may impact driver education and training via mandates on supervised practice prior to licensure (e.g. Bates, 2012a), or by offering "time discounts" as an incentive for undertaking driver education and training. For example, it could occur by allowing reductions in mandated hours of supervised practice in exchange for lessons with a professional instructor (as occurs in Queensland up to a maximum limit of 10 hours), or enabling provisional drivers to progress to fewer restrictions following advanced driver training. Each of these issues is discussed in more detail below.

2.2.1.1 Mandated hours of practice

Some jurisdictions require learners to obtain and record in a logbook a fixed number of driving hours because research suggests that requiring supervised driving increases the amount of practice undertaken (Waller, Olk, & Shope, 2000). As noted above, Queensland learner drivers are required to obtain 100 hours of supervised practice that is recorded in a log book (Bates et al., 2013). Evidence sighted by the National Highway Transportation Safety Administration (NHTSA) found supervised hours reduce fatal crashes (Baker, Chen, & Li, 2006; Lyon, Pan & Li, 2012). However, two recent national evaluations found no relationship between the number of required supervised driving hours and fatal crash involvement among young drivers (Foss, Masten, Goodwin, & O'Brien, 2012; McCartt, Teoh, Fields, Braitman, & Hellinga, 2010). Based on telephone interviews with parents in five States, only 32% knew the correct number of supervised driving hours their teen was required to complete (Foss et al., 2012; O'Brien, Foss, Goodwin, & Masten, 2013). Thus, the lack of parental knowledge of the supervised driving requirements may help explain the lack of effect on fatal crash outcomes.

Within the USA, the requirement of supervised hours varies from 20 to 50 hours, although there appears to be little research evidence for the selection of particular time limits (Foss, 2007). Some research supports learner drivers obtaining close to 120 hours of practice (Gregersen et al., 2000), although the study examined the duration of the learner period, rather than hours of practice, in the Swedish context. Evidence from that Swedish research suggests that supervised learning reduced post-licence crash rates for learners who had attained an average of 118 hours practice (see below).

The Gregersen et al. (2000) study evaluated the effects of a licensing reform that lowered the age limit for learning to drive from 17½ years to 16 years while maintaining the licensing age for solo driving at 18. This provided learner drivers more opportunities to practice (Gregersen et al., 2000). Those who commenced learning to drive at 16 years had an average of 118 hours of supervised practice. Those who started learning to drive at 17½ years, prior to the introduction of the change, practised for an average of 47 hours. Those who started to learn at 17½ years, after the introduction of the change, practised for approximately 41 hours (Gregersen, 1997). This licensing system change resulted in a reduction in crash risk of approximately 15% during the following two years. In making this comparison, a combined evaluation technique was utilised. It was not desirable to conduct a simple before/after comparison as this would be biased by time-related changes such as economic changes in society. Instead, the crash trend among young drivers over the time period of the evaluation was analysed along with a before and after comparison for 17½ year olds. When compared to the period before the change, those who used the early practice period had their crash risk reduced by approximately 40% (Gregersen et al., 2000). In comparison, McCartt, Teoh et al. (2010) identified that those USA jurisdictions that increased the minimum hours of practice that learner drivers had to complete by 10 hours or 20 hours (compared with USA jurisdictions with lesser requirements) had a very small, non-significant effect on the crash rate for 15 to 17 year olds.

In Germany, an extended period of practical driver preparation under low risk conditions was not in place before 2004 and not fully operational at a national level until 2008 (Funk, 2012). Changes to the way that novice drivers attain supervision was introduced in the 'Accompanied Driving from Age 17' program (AD17), also known as BF17 (Begleitetes Fahren ab 17 Jahren). Importantly, historically in Germany, driver education and training has been professionally run through driving schools – the use of private supervision (i.e., training by parents) was not allowed. However, the introduction of the BF17 scheme saw a change to the system. Upon receiving a conditional licence after attending and completing driving school curriculum (theoretical and practical examinations) prior to their 17th birthday, the novice driver can only drive if they are accompanied by a person who meets certain conditions (e.g., at least 30 years old, has held a valid licence for at least 5 years, has no more than 3 demerit points accumulated, has a BAC level below 0.05 mg/100ml, and is not affected by illegal drugs). The first process evaluation of the new scheme suggests that it has been well accepted by novice drivers and relevant family members (Funk, 2012).

Furthermore, a survey of 3,780 novice drivers associated with the BF17 program in Germany found that both learners and their parents were motivated by safety, while learners were also motivated by their desire to drive and parents were encouraged by lower insurance premiums (Willmes-Lenz, Prucher, & Groemann, 2010). An introductory session was offered to learners and their instructors to prepare for engagement with the program. However, there was no mention of whether there was any form of ongoing support for instructors or integration with professional instruction; factors

which have been shown to lead to better outcomes, based on findings from earlier studies (Hatakka et al., 2003; Nyberg, Gregersen, & Wiklund, 2007). Most learner drivers were accompanied by their mothers, and driving practice was incorporated into normal activities such as travelling to and from school. Students drove an average of three times a week for approximately 25 minutes. Learners reported a decrease in driving stress over a period of three months, at which they subjectively indicated more experience. Willmes-Lenz et al (2010) also reported three separate analyses that evaluated BF17 trained novice drivers against a conventionally trained control group. Each of these studies examined crash and traffic offence rates during the early months of unsupervised driving with large samples of at least 7,000 participants in the BF17 group. At three months, conventionally trained drivers were observed to have increased risks of 20% and 30% in traffic offences and crashes respectively. Findings were similar after 18 months of supervised practice, with a 22.5% reduction in traffic offences and a 28.5% reduction in crash rates for BF17 participants. A length of supervised practice phase of greater than six months was associated with almost double the reduced crash risk for BF17 participants at 57%. A 12 month follow up taking into account confounding variables such as mileage, gender, education, vehicle access, and quality of parental role model also yielded the similar result of a 20% reduction in traffic violations and a 22% reduction in crashes.

Additionally, an extensive analysis of crash and offence rates of novice drivers who had been trained under the AD17 program was conducted by the German Federal Motor Transport Authority (2013). Comparisons were conducted on two large samples (one group trained under AD17 and one group trained under the conventional model, matched for age) that were randomly selected from the Central Register of Driving Licences (ZFER). Rates of crash involvement and traffic offences were compared in both a self-report questionnaire (N = 19.000) and an analysis of 75,000 drivers whose records were retrieved from the Central Register of Traffic Offenders. During the first year of solo driving, the AD17 model-trained drivers had significantly lower rates of both crash involvement (19%) and traffic offences (18%) than those who received conventional driver training. It was reported that these differences were present, irrespective of gender.

There may be drawbacks associated with requiring learners to complete a mandated number of hours while on their learner licence. The mandated number of hours, for instance 50 hours, may imply to learners and their parents that this is all the time it takes to learn the many skills required to learn to drive (Foss, 2007). It may also imply that learning to drive is a simple task that is 'finished' as soon as the learner requirements are fulfilled (Foss, 2007). However, requiring new drivers to complete a certain amount of practice may also delay licensing and thus reduce their exposure to the risk of crashing (Simons-Morton, 2007). Additionally, a recent review suggests that there may be an increase in the number of learner drivers from disadvantaged backgrounds that drive unlicensed or without an authorised supervisor (Naylor, 2010). Therefore, careful consideration needs to be given to the amount of hours that are mandated to ensure that there are limited negative safety effects (Bates, Watson, & King, 2009).

Log books may provide a number of benefits to novice drivers including encouraging learner drivers and the supervisors to more effectively structure their supervised practice or to facilitate information sharing between professional driving instructors and private supervisors (Bates, Watson, & King, 2008a). Log books were not compulsory in Queensland prior to the changes to the graduated driver licensing system introduced in 2007. Learner drivers were unlikely to complete a voluntary log book prior to 2007 (Bates, Watson, & King, 2008b, 2010b). Research suggests that, prior to the

introduction of compulsory log books, approximately two-thirds of learner drivers reported that they were unaware that a voluntary log book was available for completion (Bates et al., 2009). Despite the community indicating concern prior to the introduction of log books in Queensland that log books could be falsified (Solomon, King, & Moore, 2006), it appears as if the majority of learners complete their log books accurately. One Queensland study identified that 83.4% of participants who were learner drivers reported that their log books were accurate (Scott-Parker, Bates, Watson, King, & Hyde, 2011). Parents also reported that their child's log book was accurate (Bates, Watson, & King, under review-a).

While Australian jurisdictions require the learner driver to complete and record their practice time in a log book, there is a different system in place within the USA. In many jurisdictions within the USA, an honour system is in place regarding the completion of compulsory hours of practice while on a learner licence (Williams, 2007). While Maryland does require a detailed log book of supervised driving practice, in states such as Washington, Minnesota, South Carolina and Ohio, parents sign a form to indicate that their learner has completed the required hours of practice. Completion of the log book in states where it was not compulsory was low (O'Brien et al., 2013).

While other people supervise learner drivers, parents are very important in the process of accumulating supervised driving hours. Parents, and other family members, think that parents should be strongly involved in the learning to drive process (Bates et al., under review-b). It appears that, in Queensland and elsewhere, mothers tend to have the primary role in supervising learner drivers (Bates, Watson, & King, 2013; Bates et al., under review-b; Goodwin, Foss, Margolis, & Waller, 2010; Scott-Parker et al., 2011). However, there are likely to be cultural differences with fathers in Israel more likely to be the primary supervisor for learner drivers (Taubman-Ben-Ari, 2011).

2.2.1.2 Time discounts as an incentive

In many jurisdictions a 'time discount' is granted for learner drivers who participate in driver education; allowing them to drive unsupervised earlier, despite little evidence of a safety benefit and consistent evidence of increased crash risk (Hirsch, Maag, & Laberge-Nadeau, 2006; Mayhew, Simpson, & Singhal, 2005). Adolescents who attend driver education are able to be licensed between three months and two years earlier than those who do not in 37 of the 62 North American jurisdictions (Mayhew et al., 2005).

Lewis-Evans (2010) studied the impact of GDL on crash rates in New Zealand where a time discount of 6 months (i.e., a reduction to 12 months, down from 18 months) is offered on the restricted phase (equivalent to the Australian provisional/probationary phase) if the learner takes a government approved educational course. The restrictions applicable to New Zealand drivers with a restricted licence are: a nighttime driving curfew between 10pm and 5am unless accompanied by a supervisor, no carrying passengers less than 20 years of age unless accompanied by a supervisor, and a lower blood alcohol limit (0.03 mg%) than other drivers (0.08 mg%) (Begg & Stephenson, 2003). Data on licensing and fatal or injury crashes were obtained from national statistical databases from 1997 to 2005, and three groups of licence holders were examined for crash risk. These groups were: 1) drivers who had taken advantage of the time discount to obtain an unrestricted licence in under 18 months, 2) drivers who did not obtain a time discount and received their unrestricted licence after 18 months or longer on a restricted licence, and 3) drivers who had not progressed to an

unrestricted licence despite holding a restricted licence for over 18 months. Due to a higher proportion of young drivers registering for the time discount, course attendance data analysis was restricted to those aged 15 – 20 years at the time of full licensure. Individuals who gained a full licence within 12-18 months of holding a restricted licence due to the time discount associated with completing an educational program (i.e., group 1), had a crash risk nearly three times higher than those drivers who were still on a restricted licence due to not obtaining a time discount, even after taking into account any underlying differences in age and gender. Findings suggest that despite the completion of an approved educational course, there is greater benefit in remaining on the restricted licence for the full 18 month period (Lewis-Evans, 2010).

In their prospective study of a cohort of 1,804 novice drivers, Hirsch et al. (2006) explored the role of driver education in the licensing process in Quebec, Canada. Attendance at driver education for a time discount was associated with younger ages, greater financial support from family and fewer hours of supervised driving practice with a learner's permit. Most participants, particularly males under 19 years of age, attended driver education partly or entirely to save time or money; with these motivations associated with higher violations and crash rates. Data analysis was conducted separately for males and females to remove any confounding affect of gender. Analysis was conducted by logistic regression controlling for age, driving exam preparation and number of hours supervised driving practice. The authors concluded that the time discount should be abolished and other measures favoured such as raising the driving age, increasing the predictive validity of the driver's permit exams and ensuring that each novice driver has sufficient supervised experience before driving alone (Hirsch et al., 2006).

Mayhew et al (2005) reported similar results in an evaluation of the GDL program in British Columbia (by Wiggins, 2004). Crash rates of GDL drivers who had completed an approved training course and received a time discount were higher than the crash rates of those who had not. When results were re-examined and age, gender and driving exposure were controlled for, the crash risk (for both liable crashes and any crash) was still higher for those who completed an approved course than for those who had no formal training or had taken a driver education course that was not approved. Mayhew et al (2005) concluded that there is no justification for offering a 'time discount' for taking part in driver education and that it should not be used as an incentive for novice drivers. It should be acknowledged that the majority of studies investigating 'time discount' incentives use a study protocol where participants self select whether they are in the 'time discount' education group or not. As a result of this the exact reason for the ineffectiveness of driver education 'time reduction' courses cannot be determined. For instance, it may not be the course material itself which is inefficient; it may be because those courses attract people that have an increased crash risk.

2.2.2 Evaluation of evidence

	Effectiveness	Strength of evidence	Scope of Training
GDL	*****	***	A,B,C,D
Mandatory hours	****	**	B,C,D
Time discount incentives	*	**	C,D

2.3 Stages of training

The points at which training and education can be delivered will now be discussed. For the purpose of this review, we have classified types of training in two ways:

1. Pre licence training: undertaken prior to or during the learner licence period, but before obtaining a full licence (i.e, can include school-based, professional instruction, or private supervision); and
2. Post licence training: offered to licensed drivers to further their driving skills. This relates to those with provisional or open licences.

The content of pre and post licence training differs in that pre licence training tends to focus on rudimentary driving skills associated with operating a car, whilst post licence training covers more advanced skills such as skid training or defensive driving courses.

2.4 Pre licence training

Prior to obtaining a provisional licence, drivers must be able to operate a car safely within the confines of road laws. While operating a car involves procedural skills (i.e., a series of actions that become automated over time), driving in traffic involves a combination of procedural and higher order cognitive skills. Pre licence training can be aimed at both pre learners and learners (those with a learners licence) and may involve several different training methods to address different knowledge and skills including:

- Professional (learn to drive) driving instruction
- Supervised on-road driving experience
- High school education courses
- Private driver education courses
- Simulator training
- Resilience training

2.4.1 Professional (learn to drive) driving instruction

Professional driving instruction refers to driver training undertaken with a driving instructor. Many drivers learn to drive by using a combination of both professional driving instruction with a driving instructor and other supervised practice with private supervisors (see next section) (Hirsch et al., 2006; Nyberg et al., 2007) including in Queensland (Bates, Watson, & King, 2010b; Scott-Parker et al., 2011). Multiple surveys of learner drivers in Victoria (Harrison, 2004), Sweden (Nyberg et al., 2007) and the United Kingdom (Groeger & Brady, 2004) have shown that the majority of learners utilise a combination of professional driving instruction and private supervision in learning to drive at 92%, 85% and 60% respectively.

Hatakka et al. (2003) reviewed driver training models in Europe for the BASIC project and concluded that professional instruction may be beneficial to learner drivers if the training is structured towards learning goals, and instructors provide quality feedback to students. The disadvantages of driving instruction is that learning periods may be brief and not allow for the development of higher order skills beyond basic vehicle operation. Further, there is potential that instructors may focus teaching only those skills necessary to pass the driving test which may not include higher order skills. While such a strategy may reduce the time a learner takes to pass their driving test, the result may be an

under skilled driver and the situation may be further exacerbated if the practical driving test is not reliable and/or valid. The latter may encourage learner drivers to focus on mobility rather than safety, enabling drivers to become licensed with minimal practical experience. Survey research of driving instructors in the USA (Braunstein, Nordyke, Benson, & Peterson, 2011) and Australia (Bailey, 2003) has indicated that standardisation of driving curricula, professional development of instructors and a balance between teacher and student focused learning may help to overcome these issues.

Professional instructors provide a different learning experience to learner drivers than private supervisors (i.e, lay instructors). For instance, Groeger and Brady's (2004) observational research identified that professional instructors identified more errors made by learner drivers and provided feedback, while private supervisors provided more varied driving experience, including night driving. Therefore, both forms of instruction are advantageous to the learner driver (Hatakka et al., 2003).

The decision to undertake both professional and private instruction might also involve financial considerations, as the requirement to complete a mandated minimum number of hours of supervised practice while on a learner licence could be cost prohibitive if only professional instruction was used (Bates et al., 2010b). Additionally, focus group research conducted with young drivers living in rural locations in New South Wales identified that there may be limited access to professional driving instructors (Knight, Iverson, & Harris, 2012).

Surveys of young learner drivers attest to the benefits of mixed professional and lay instruction (Nyberg et al., 2007), and the unique contribution of professional instruction (Tronsmoen, 2010). For instance, Nyberg et al (2007) revealed that several attributes of driving instruction influenced provisional driving test pass rates in a sample of 1,645 learner drivers in Sweden who presented at driving test centres in 2004. Findings from a binary logistic regression indicated that learners were more likely to pass their driving test if they: reported both private supervision and professional driving lessons; took lessons at the middle, end or throughout the entire period of driving instruction rather than just at the beginning; reported "very good" cooperation with their driving instructor; and used educational software at their driving school. A focus on the tasks of parking and speed adaptation was also associated with a higher probability of passing the driving test. However, it is important to acknowledge that those novice drivers who acquire sufficient skills in order to pass the test and attain their licence (e.g., successfully complete a parallel park) may not necessarily have acquired all the skills necessary to make them a 'safe' driver; an issue that is related to the validity and reliability of the driving tests.

Tronsmoen's (2010) survey of 1,419 novice drivers aged 18-20 in Norway found that professional and lay instruction were associated with differential effects on safety attitudes and self-assessment of driving ability. Specifically, a greater number of lessons with a professional instructor was associated with a less favourable self-assessment of driving ability during the learner phase and more positive safety attitudes, while the opposite was observed for lay instruction. Poor attitudes towards safety were associated with increased hours of lay instruction (irrespective of the amount of professional instruction hours), and associated with more traffic violations. The individual's assessment of their own driving skill, their attitudes towards safety and self-reported driving behaviour accounted for almost 80% of the variance in explaining the novice driver's crash involvement. Findings were controlled for exposure as measured by months with a licence. The authors concluded that both methods of instruction were beneficial, in that professional instruction

fostered favourable safety attitudes while lay instruction enabled learners to obtain more experience, both of which were found to be necessary for avoiding crashes on the road.

Groeger and Brady (2004) have noted that learner drivers aged 17-19 years who pass their driving test on the first attempt have fewer hours of professional instruction (34.54%) compared to their counterparts who fail on the first attempt (45.9%), and that this gap widens with age. This suggests that older learner drivers who have repeatedly failed their driving test, possibly due to a lack of skill, have sought professional instruction in a bid to improve their chances of passing.

A substantial change in the content of novice driver training in Denmark in 1986 provided an opportunity to better understand the impact of various aspects of training (Carstensen, 2002). Prior to the change, all training was conducted by professional instructors with no supervision or input from family or friends allowed. The theoretical content of training before the change focussed primarily on technical knowledge of the car and on traffic laws. After the change, training included car handling skills, defensive driving and hazard perception where learner drivers were instructed on how to judge potential dangers in traffic and how to react appropriately to them. Private instruction was still not part of the training regime after the 1986 change. Participants represented two groups, a 'before' group who took their test prior to the changes and an 'after' group who took their test after the changes. All participants were followed for 5.5 years from the time that they took the test. A regression analysis was used to compare the before and after groups which included controlling for gender, age, driving experience (urban/rural) and driving exposure (self-report number of kilometres driven). Additionally, t-tests and chi squared tests were used to verify that driving exposure did not differ between the two groups. In evaluations using both official and self-reported crash data, analyses revealed that there had been a significant decrease in young driver crashes after the change. More specifically, there were reductions in both multiple-vehicle and manoeuvring crashes.

2.4.1.1 Evaluation of evidence

	Effectiveness	Strength of evidence	Scope of Training
Professional on-road driving instruction	****	***	B,C,D

2.4.2 Supervised on-road driving experience

This section discusses the role of supervision as part of the on-road driving experience provided to learner driver licence holders. In Queensland (and comparable jurisdictions), the majority of on-road supervision is provided by parents and relatives (i.e., non-professional, lay drivers) (Bates et al., 2013).

Survey research suggests that parents of learner drivers in Queensland provide supervised driving practice during 'normal' activities such as the learner driver, while under supervision, driving themselves, their siblings or friends and their parents to and from activities that would have been attended anyway. Parents also supervise their learner driver while they undertake special trips with the express purpose of practising their driving under supervision (Bates et al., 2013).

As already noted, private supervised practice or 'lay instruction' forms a significant component of driver training for pre-licence drivers. Hatakka et al (2003) distinguish between professional and lay instruction. This EU project defined the purpose of the former as being to teach driving skills, while

the role of the lay instructor as being to supervise practice for safety purposes. Earlier Australian (Victorian) research conducted by Harrison (2004) revealed that supervised practice tended to be conducted during daylight hours in dry weather. The average amount of supervised practice undertaken was 20.8 hours in a two year period, and driving was often challenging to both the learner and supervisor as a result of distress during practice sessions.

Supervised practice can be high risk, as Swedish research indicates that the majority of injury or fatal crashes involving learner drivers occurred with lay instructors rather than during lessons with professional instructors (Gregersen, Nyberg, & Berg, 2003). A literature review by Simons-Morton and Ouimet (2006) of studies conducted within Europe and the USA indicated that the effect of supervised practice on novice driver crash rates was inconclusive and further research was required to identify the ideal amount of supervised driving practice. However, there were some limitations associated with the studies they reviewed. The studies were not randomised control trials, the supervised driving practice period varied from 570 kilometres (USA) to 5,880 (Sweden) and licensure did not occur until 18 years of age. In the European studies, participants who obtained extra practice got their licence earlier than the comparison group.

However, Vaa et al (2012) note that the introduction of laws permitting lay instruction in Sweden was associated with a 17% reduction in personal injury crashes in the post licence probationary period, from 0.98 to 0.81 per million km of driving. While it is not possible to state exactly what this change is attributed to, the changes introduced lowered the age limit for driving training from 17.5 years to 16 years and allowed novices to be supervised by a private instructor. The private instructor was required to be 25 years or older and to have held a driving licence for more than 5 years. Following the changes, formal driver training increased 8% while private supervised instruction increased 100%.

It is noted that parental supervision does have some possible drawbacks including overconfidence and poorer safety attitudes compared to professional instruction (Hatakka et al., 2003; Tronsmoen, 2010) as well as the potential for the adoption of parental risky behaviours (Brookland, Begg, Langley, & Ameratunga, 2008). Despite these concerns, Groeger and Brady (2004) note that learner drivers who undertook supervised practice gained experience in more varied driving conditions than learners who trained exclusively with a professional instructor. Despite the mixed evidence relating to parental instruction on novice driver crash outcomes, efforts have been made to formalise parental involvement (e.g. training of supervisors, increased communication between instructors/licensing agencies and parents, minimum hours of practice requirements, log book hours recording) in learning to drive programs. For instance, in Europe (Engstrom et al., 2003), supervised practice forms a significant part of the learning process and is formalised in France, Germany and Austria (Hatakka et al., 2003). The implementation of GDL in the USA (Thomas, Blomberg, & Fisher, 2012), Australia (Bates, 2012a) and New Zealand (Brookland et al., 2008) has made progress towards formalising the process of parental involvement.

The quality of private instruction can lead to varying degrees of program success in terms of driving test pass rates and crash risks following licensure, as the two programs in France and Austria described by Hatakka et al (2003) demonstrate. The French system requires learners to participate in 20 hours of professional instruction prior to supervised practice with a lay instructor. The conditions of supervised practice include a minimum age of 28 years for the lay instructor, at least 3000 km of

driving practice and two meetings with a professional driving instructor to assess progress. The first evaluation of this program in the 1980s revealed that learners who self-selected into this mode of instruction had a 70% pass rate on their first attempt at their driving test and a 33% reduction (no comparison group stated) in crash risk after five years of driving compared to individuals who undertook traditional training. Subsequent evaluations have indicated a higher crash risk and greater mileage during the first two years of unsupervised driving in individuals who opt for lay instruction. However, evaluations were confounded by factors including mileage, residency and gender. Qualitative interviews with learners and their private supervisors revealed that lack of private supervisor preparedness and the routine nature of trips had the potential to undermine the program via the supervisor transmitting poor driving habits and providing a limited range of driving experience. In the case of the Austrian program, it appears that private supervisors may have received very limited support and guidance on their role in instructing learners. Given that only 20 hours of professional instruction was given at the beginning of the learning to drive process, private supervisors may have been inadequately prepared for the responsibility of teaching.

The L17 program in Austria differs from the program in France in that periods of private supervision are dispersed with professional instruction which both the private supervisor and professional instructor attend every 1000km. As per the French model, a minimum of 3000 kilometres of supervised practice with a lay instructor is required. Analyses of statistical data and surveys strongly indicate a reduction in traffic offences per 1000km travelled for novice drivers trained under the L17 system compared to traditional training, as well as a reduction in crashes per 1000km for males only. However, all females indicated a lower rate of crashes compared to males regardless of training. Novice drivers trained under the L17 system were also more likely to pass their driving test on the first attempt, and considered themselves to be safer and more skilled than drivers who reported traditional training. The authors do not directly compare the self-report measures to crash risk so it is not possible to tell that those who are more confident have fewer crashes. However, as those attending L17 had fewer crashes and were more confident, there is a potential for a relationship between the two factors. There was also a sharper decline in crash risk for novice drivers who had undertaken the L17 after the first six months of unsupervised practice compared to traditionally trained drivers. While it is impossible to complete a fully controlled comparison between the two systems, the Austrian system seems to have performed more favourably than the French system when compared with a suitable control group (Hatakka et al., 2003).

As discussed previously, GDL systems often mandate a minimum number of hours of supervised practice during the learning period. In the United States, mandated hours range from 0 to 100 with 40-50 being the norm, yet some states offer substantial time discounts for learners who participate in driver education (Foss, Masten, Goodwin, & O'Brien, 2012). A qualitative study of 50 families in North Carolina explored the experience of supervised practice through interviews with parents and teens and video recordings of driving sessions (Goodwin, Foss, Margolis, & Waller, 2010). It was found that parents were chiefly concerned with their children obtaining practice in controlled circumstances and many had introduced driving in an empty car park. Driving practice tended to focus on basic skills and operation in residential areas with low density traffic, however more complex situations such as night driving or heavy traffic were gradually introduced and approximately three quarters of the sample had experienced these conditions by the 12th week. Parents were interviewed 10 times over the year-long study, and reported that their children drove an average of 3.21 days and a total of 1.6 hours in the week prior to the interview, which increased

to 4.32 days and 2.33 hours by the last interview. Teen drivers were reported to improve their driving performance within one to two months of driving. However, approximately 12-13% experienced difficulty in the learning to drive process due to busy schedules, disinterest of the teen or severe anxiety. In addition, roughly half of the parents reported concern that their children were becoming overconfident and taking risks. The concerns reported by parents in this study demonstrate the need for resource materials and support for parents in the task of teaching their children to drive, especially with respect to anxiety and overconfidence issues. In their review of driver education and training in America, Thomas et al (2012) suggest that parents may benefit from preparatory training to teach their children safe driving practices and to understand and enforce GDL restrictions after licensing.

2.4.2.1 Evaluation of evidence

	Effectiveness	Strength of evidence	Scope of Training
Supervised on-road driving experience	****	**	B,C,D

2.4.3 High school driver education

Developed in 1949, the standard model for driver education in the USA consisted of 30 hours of classroom instruction and 6 hours of driving instruction behind the wheel (Williams, Preusser, & Ledingham, 2009). From the 1950s onwards, high school driver education spread throughout the USA and the rest of the world, partially as a result of early research showing an association between driver education and reduced crash rates (Engstrom et al., 2003). These studies from the 1960s onwards suffered from "volunteer bias" whereby individuals who self-selected into driver education possessed personal qualities that led to lower crash risk and it may have been these qualities rather than the education itself that influences safe driving (Williams et al., 2009).

However, students are also motivated to undertake driver education by factors that increase their crash risk, such as time discounts on licence restrictions or an increase in the number of demerit points that they can accumulate before licence suspension occurs (Abbott & Freeth, 2003). Driving schools eager to achieve a high pass rate for their students may also focus on driving education that "teaches to the test" rather than the mastery of safe driving skills (Bingham & Hockanson, 2008). Driver education also leads to early licensure in general, producing younger drivers on the road with more limited experience (Engstrom et al., 2003). While policies that delay the age at which people start driving are good from a road safety perspective, they have other social and mobility impacts (Bates, Watson, & King, 2010a). It can be seen that the context of driver education may strongly influence the safety outcomes of crash rates and traffic violations. Arguably the most well-known driver education study conducted in the USA, the Dekalb County project, demonstrates the complexities of evaluating driver education.

The Dekalb study was a four year longitudinal project of the recorded licensure violation and crash patterns of 16,388 high school students aged 15 years or over (Engstrom et al., 2003). Students were randomly assigned to one of three groups: the Safe Performance Curriculum (SPC) - a 72 hour program including significant on-road instruction; the Pre-Driver Licensing course (PDL) which delivered the minimum training required for licensure; and a control group with no driver education during schooling (Vernick et al., 1999). Findings from four different analyses of the data yielded mixed results.

The first analysis by Stock, Weaver, Ray, Brink & Sadoff (1983, cited in Engstrom et al., 2003) indicated that students who had participated in either driver education program had lower crash and traffic violation rates than the control group in the first six and 12 months of licensed driving respectively, although these effects had dissipated six months later. Drivers in each education group were licensed earlier than drivers in the control group, and while students in the trained groups had 23 days more driving experience than controls (Peck, 2011), controls had driven more miles post licence than trained drivers (Vernick, Li, Ogaitis, MacKenzie, Baker, & Gielen, 1999). This observation alone suggests that limited driving exposure may have protected trained drivers from crash and violation risks. Subsequent analyses by Lund, Williams and Zador (1986) and Davis (1990) used the entire randomised sample rather than simply licensed drivers, and found that students from the SPC group experienced a higher rate of crashes and violations compared to the control group (Peck, 2011). However, a higher percentage of students in the trained group were licensed (69%) at six months compared to the control group (59%; (Peck, 2011), while controls had driven more miles than the trained group (Vernick et al., 1999). Both of these factors would have served to reduce the crash risk of the control group via older age at licensure, and more driving experience.

The final analysis of the Dekalb data was conducted by Peck (2011), and served to replicate and improve upon the analysis by Stock et al (1983) by restricting the education group to those who completed the education course, which excluded the 28% of the sample who failed to enrol or failed to complete the course once assigned. Additionally, Stock et al (1983) did not control for exposure. As a result of this restriction and controlling for exposure by duration of licensure, it was found that crash and violation rates were not only lower after the first six months of licensure, but they were also lower after the four follow up time periods were aggregated at two years, compared with the control group. A focus on students who had actually attended and completed the driver education would be expected to result in the most accurate evaluation of the program. However, together with the exclusion of non-licensed drivers, this restricted sample effectively removes the randomisation of the design (Peck, 2011).

Williams et al (2009) identified two further issues with the Dekalb study. Firstly, the original sample would have been large enough to detect a 15% reduction in crashes as a result of driver education by chance, and reducing the sample would only lower the statistical power of the study. This would result in making it unclear whether changes in the outcomes in reanalyses are due to the application of appropriate control or to a reduction in the sample size. Secondly, students assigned to different groups would have likely been friends and discussed the training, so potentially the control group's experience of "no training" was contaminated.

Driver education evaluation research since the Dekalb study has generally demonstrated a nil effect for driver education in terms of traffic violations and crash rates with very few exceptions (Christie, 2001; Engstrom et al., 2003; Peck, 2011; Vernick et al., 1999; Williams, 2009). Aside from the issues with driver education research already identified (early licensure and overconfidence), more recent reviews have consolidated several methodological flaws common to previous studies. These include insufficient sample size to detect smaller reductions in crash risks (Peck, 2010), the assumption that traffic violations and crashes is an appropriate dependent variable to study the efficacy of driver education, and inconsistency in curriculum (Engstrom et al., 2003).

Recently in the USA there has been a push for standardisation of driving curriculum by the NHTSA which has resulted in a revision of the previous driver education model developed in 1949 to include 45 hours of classroom instruction across 10 units, 8 hours of driving instruction, as well as supporting resources for instructors, parents and students (Braunstein et al., 2011; Williams, 2009). While the reasoning that was employed to arrive at this change is unclear, given the limited information regarding the theory and evaluation of driver education (Lonero & Mayhew, 2010), recent studies have indicated that parent involvement via private supervision of their teen learner drivers has the potential to reduce crash risk via increased and varied driving experience (e.g. Christie, 2001).

More recent studies of driver education have generally replicated earlier studies with larger sample sizes and have provided scant evidence of reduced violation and crash risk. For example, Braunstein, Nordyke, Benson and Peterson (2011) conducted a review of driver education in South Dakota utilising state and national statistical data, as well as surveys of relevant populations including provisional drivers who had been educated under the South Dakota system. They identified a correlation of $r = .288$, ($p<.05$) indicating a limited relationship between per capita young driver fatal crashes and type of driver education required across all states in the USA. The authors noted that those USA states with high fatality rates for young drivers did not mandate driver education. However, other factors such as shorter minimum permit holding times also influenced fatality rates in these states. The authors went on to focus their analysis on South Dakota, and conducted an analysis on young drivers aged up to 24 years using state data. Young drivers were classified as having completed driver education if they had received an exemption on the written driving test on the grounds of successful completion of a driver education program run by an accredited instructor during high school. A total of 119,690 drivers met the criteria, and incidents in their driving records were rated and summed using a scale ranging from "0 – no record of infraction or accident" to "6 – serious accident with incapacitating harm and/ or death." Drivers who had received an exemption from the written test on the basis of completing driver education indicated lower scores on the driver infraction scale overall, with a larger mean difference for drivers who had experienced at least one crash, and smaller, yet significant, mean difference where infractions were considered. However, effect sizes were not reported and, due to the large sample size, it is possible that the reduction in crash or violation risk was fairly small. Their survey of 358 provisional drivers indicated that 84% of participants took their driver education seriously, and that cooperation with other road users, driving under unusual road conditions, defensive driving and the effects of alcohol were the most widely remembered topics, recalled by over 70% of respondents. Despite these findings, respondents indicated that personal experience and parental instruction were the most influential elements of their driver training, rather than driver education.

An Ontario study by Zhao, Mann, Chipman, Adlaf, Stoduto, & Smart (2006) investigated the effects of driver education on crash risk, controlling for demography, risky driving behaviours and traffic violations. The participants included year 11 or 12 students across seven schools with G1 or G2 licence, which is similar to Australian learner and provisional licences, respectively. Surveys were completed in 1996 and 1998 with a sample size of 153 students. The content of the survey included demographic data, risky behaviours, participation in driver education, and reported traffic violations and collisions. In Ontario, approved driver education courses must include 25 hours classroom and 10 hours behind the wheel instruction, and are intended to produce safe, responsible driving via the transmission of positive skills and attitudes. There was a statistically significant positive effect of education on reducing crash risk in learner drivers. However, for provisional drivers a non significant

negative effect of education on crash risk was detected, while being female, months of licensure and mileage increased crash risk. So while driver education appeared to contribute to safety in learner drivers who are already at a low risk of experiencing a crash, it failed to offset the risk of exposure to unsupervised driving for provisional drivers. It is unusual to find young female drivers to be at a higher risk of crashes than young male drivers. However, Christie (2001) states that the impact of overconfidence as a result of driver education may be particularly detrimental to females. Sagberg and Bjornskau (2003) note that inexperienced female drivers have poorer car handling skills than inexperienced male drivers, which, when combined with overconfidence, could lead to an elevated crash risk.

In summary, the majority of driver education research described above demonstrated no evidence of efficacy in reduced crash rates or traffic offences beyond the first six months of driving experience post licensure. In fact, an English summary of a Norwegian report by Vaa, Fybri and Sorensen (2012) suggested that learners who participate in formal driver training (not clearly defined) have 11% more crashes per km driven than learners who do not participate in formal training. However, the methodological flaws and context surrounding driver education makes it impossible to determine whether driver education is truly ineffective. For instance, it is possible that certain types of driver education has a very small effect on crash rates, possibly via an indirect effect on safety attitudes (as was found for professional instruction), for example. Furthermore, a reduction in crash rate and traffic offences in the first six months may, in itself, be considered beneficial because novice drivers are most vulnerable to crash risk during this earliest phase of licensure. In the next section, the review turns to newer forms of driver training for pre licence drivers (learners and pre learners): simulator training and resilience training.

2.4.3.1 Evaluation of evidence

	Effectiveness	Strength of evidence	Scope of training
High school driver education	**	*	C,D

2.4.4 Simulator training

The next stage of the project involves a review of the literature regarding driving simulators for novice driver training and assessment (Deliverable 2). A brief discussion of simulator training however is provided here. Driving simulators are considered to be interfaces that allow the novice driver to actively engage and interact with a virtual environment, allowing trainees to influence travel within the environment. These are considered separately from PC-based training, whereby the trainee is an observer of a pre-recorded environment (such as watching a video) without an ability to alter travel within the environment.

The use of a driving simulator to train learner drivers appears to have high face validity as it would be expected that this method of training would be transferrable to driving in real world situations. Driving simulators also have several advantages over supervised driving: there is no risk of a crash in a simulator, exposure to traffic situations can be fully controlled, and rare driving situations, such as extreme weather conditions, can be practiced at any time (Kappé, van Emmerik, van Winsum, & Rozendom, 2003). The inability to crash in a simulator allows trainees to be exposed to crash-likely conditions which would not be ethical to expose trainees to in the real world (Caird & Horrey, 2011). However, driving performance in simulators may present a skewed view of actual driving performance, for instance, due to a lack of motivation, because there is “no risk” trainees may not

be motivated to drive as safely as they would on the real road (Caird & Horrey, 2011). Further, the learner period is associated with low crash rates (Lewis-Evans, 2010; Williams, 2003), so using driving simulators for training during this period of training is not likely to have large practical impacts on reducing crash rates. However, this may be because on road learner instruction avoids crash-likely situations which could potentially be manipulated in a driving simulator.

The Netherlands are currently world leaders in the use of simulators for driver training, as simulators are used initially to teach driving skills, which are further taught and practiced with an instructor on the road (Beanland et al., 2013). However, in a summary of a larger report not currently available in English, Kappe and van Emmerik (2005) described how the fidelity of simulators used for training is variable, and can range from low fidelity simulators consisting of a screen, car seat and controls, to high fidelity simulators that involves the use of a stationary car and full screen projection of the traffic situation. Students use the simulators at driving schools with support from a human driving instructor and virtual instruction, via the simulator. Kappe & van Emmerik (2005) summarise that simulators enable the learning of basic skills, however car control and interaction with other road users must be taught via on-road supervised practice.

Since the early 2000's, Allen and colleagues (Allen, Cook & Rosenthal, 2001; Harmsen, Allen, Rosenthal, Aponso & Markham, 2002; Allen, Rosenthal, Aponso & Park, 2003; Allen, Park, Cook, Rosenthal, Fiorentino, Viire & Jolla, 2004; Park, Allen, Rosenthal & Fiorentino, 2005; Allen, Park, Cook & Fiorentino, 2007; Allen, Park & Cook, 2010; Allen, Park, Terrace & Grant, 2011; Allen, Park, Cook & Fiorentino, 2012) have investigated the use of driving simulators to teach and refine driving skills in learner and novice drivers in the USA, and the impact of fidelity. Their research has focused on the use of low, medium and high fidelity simulators to teach skills associated with basic vehicle operation and mastery of road situations. The low fidelity simulator was intended for use with a single computer screen, and is accompanied by a steering wheel, floor pedals and buttons to enable the user to look left and right (Allen et al., 2001). The medium fidelity simulator consisted of a similar set up to the low fidelity simulator, except three screens were used to represent a 135 degree field of vision (Allen et al., 2004). A projector screen was used to represent a life sized version of the driving scenario in the high fidelity simulator and the user operated the simulator from within a fully instrumented cab (Park et al., 2005). One of their earlier studies demonstrated that novice drivers were capable of improving their procedural driving skills when taught and assessed via the low fidelity driving simulator (Allen et al., 2001). Later studies suggested that errors related to speed and steering as measured by the simulator were less common in medium and high fidelity simulators compared to low fidelity simulators (Park et al., 2004; Allan et al., 2012). However, the authors attributed this finding to hardware, in that drivers in the lower fidelity scenarios may have had fewer vehicle related cues to rely on, and noted that there was no difference in "crash" rates during simulator tasks between the three groups (Park, Allen, Rosenthal, & Fiorentino, 2005). More recent studies have applied the simulators to a real world context. Allen et al (2011) determined that low fidelity simulators may be beneficial in training hazard perception skills to novice drivers, in that trained drivers were able to avoid crashes in a simulator environment more often than non-trained drivers. However, other research (Allen, Park, & Cook, 2010; Allen, Park, Cook, & Fiorentino, 2007) indicates that only high fidelity simulator training actually effects crash rates. The impact of fidelity on training appears complex and in many ways dependent upon the training goal. While high fidelity simulators may be necessary to present a real world context, in the

case of a specific skill (e.g. hazard perception) there is evidence that a low fidelity simulator is sufficient to meet training needs.

Low fidelity simulators have shown promise in teaching hazard perception skills to novice drivers (e.g. Fisher, 2008; Thomas et al., 2011). A series of studies chronicled the development of the Risk Awareness and Perception Training (RAPT) program, which started as a computer-based instructional tool (Pollatsek & Pradhan, 2006). Originally, the RAPT program presented users with a series of top down diagrams of driving scenarios, and the user was required to imagine themselves driving through the scene, and identify (1) areas that should be scanned continuously, and (2) areas where a potential hazard could not be seen by a driver (such as a child walking out from between parked cars). Version 2 of the RAPT program used actual photographs from the driver's perspective in addition to the diagrams, while version 3 combined photographs in a sequence, and version 4 upgraded to a low fidelity simulator (Fisher, 2008). This method of training is known as part task training (Fisher et al., 2002), and is a common method of hazard perception training (Beanland et al., 2013). The RAPT training program has consistently shown improvements in hazard perception and responses in learner or novice drivers, as measured by eye tracking devices in driving simulators (Fisher et al., 2002; Fisher, Narayanaan, Pradhan, & Pollatsek, 2004), and more recently on the road (Fisher, Pollatsek & Pradhan, 2006). These studies have utilised a randomised control design, although sample sizes have been low, at less than 20 participants per group, and follow up tests undertaken a maximum of 2-4 weeks after training (Fisher, 2008; Pradhan, Fisher, & Pollatsek, 2005).

De Winter, de Groot, Mulder, Wieringa, Dankelman and Mulder (2009) investigated the effects of learner performance in driving simulators on driving test pass rates. In their study, proficiency data on 804 learner drivers completing the Dutch learner driver curriculum as recorded by driving simulators was obtained and compared to practical driving test performance an average of 6 months later. The simulators used in the study were medium fidelity with three screens projecting the driving scenario for the purpose of beginner driver training. In addition, the simulators were capable of providing the learner with feedback based on their performance. Faster progression through training and fewer traffic violations on the simulator modules were also associated with fewer steering errors, suggesting that drivers with superior driving skills as measured by the simulator were more likely to pass the drivers' test. However, the authors (de Winter et al., 2009) caution that passing the driving test on the first attempt will not necessarily mean that the student will be a safe driver.

A more recent program developed by Thomas (2008) known as Forward Concentration and Attention Learning (FOCAL) used a variant of commentary training to teach novice drivers to avoid glances away from the road for more than two seconds. Commentary training involves the novice driver either verbalising or receiving a commentary of the hazard perception task as it unfolds (McKenna, Alexander, & Horswill, 2006). The FOCAL training involved a simulator task called the Attention Maintenance Assessment Program (AMAP), which required participants to complete the dual tasks of identifying hazards in a driving simulator test, and following a road map. Both the driving scenario and the map were displayed on the same screen. Following the training task, users were presented with a video of their performance, where the screen went blank for the duration that users looked away from the road (Thomas, 2008). As the training became more advanced, the commentary training was intended to demonstrate appropriate behaviour by blanking the screen

only when the user looked away for more than two seconds in training and displaying the map for a maximum of three seconds when the user diverted their attention to the map. A series of three studies were completed with either learner drivers or newly licensed drivers serving as the participants. Pre-tests showed that participants performed similarly on the AMAP test described above. The first study determined that trained novice drivers significantly reduced the duration of their glances away from the road compared to untrained controls in a simulator task. The second and third studies required participants to complete a driving task in either a car with an instructor or a high fidelity simulator, and a non driving task such as finding a CD, taking money out of a cup holder, or locating a street on a map. Trained drivers in both conditions took glances away from the road for shorter durations than untrained drivers, however sample sizes were small and post tests were undertaken immediately after training.

Low fidelity simulators are less expensive and arguably less effective at reducing crash rates than high fidelity simulators (Beanland et al., 2013). A study by Allen, Park, Cook and Fiorentino (2012) compared crash rates as recorded by the Department of Motor Vehicles (DMV) in the state of California, USA amongst a sample of 554 adolescents aged 14 to 18 years who were trained via a driving simulator with cumulative crash rates of traditionally trained novice drivers in California and Nova Scotia, Canada. The study did not control for when participants received their licence, but it was noted that 55% of participants had obtained their licence 12 months after training, a figure that rose to 84% at 24 months after training. The majority of participants obtained their licence at either 16 (approximately 55%) or 18 (about 25%) years of age. Three different levels of simulator fidelity were tested in this study: a high fidelity simulator configuration that consisting of a fully outfitted car with the driving situation projected on screens, a medium fidelity simulator consisting of three monitors to simulate the windscreen and side windows, both of which groups were recruited at a local DMV, and a low fidelity simulator consisting of a single screen which was used by high school students. Following licensure, participants were followed over a two year period. Crash rates were reduced in the high and medium fidelity simulator groups compared to Californian and Canadian novice drivers trained via conventional means, however there was no difference in crash rates for participants in the low fidelity group. It should be noted that participants in the medium and high fidelity groups were not randomly assigned and included lower percentages of males (37% and 41% respectively), while the high school sample who used the low fidelity simulator was not randomly assigned and was 48% male (Allen et al., 2012). The ages of each group were not reported, however the authors stated that almost all 14 year olds (10% of the whole sample) were in the high school group which suggests that the low fidelity simulator group may also have been younger when they received their licence compared to the other groups. While the variation in gender balance and participant assignment between the three groups may confound the results somewhat, the results are still promising with regard to the use of simulators because only 5.1% and 6.7% of participants experienced a crash in the high and medium fidelity groups respectively, compared to 13% for the low fidelity simulator group.

However, depending on the purpose of the training to be delivered via the simulator, an expensive, high fidelity machine may not be necessary. De Winter, Wieringa, Dankelman, Mulder, van Paassen, and de Groot (2007) state that lower fidelity simulators have been used as a pedagogical tool to help learner drivers develop and practice higher order cognitive skills that are usually developed over time as a novice driver. Arguably the most important and highly researched of these cognitive skills is hazard perception. According to Whelan, Senserrick, Groeger, Triggs and Hosking (2004), hazard

perception is the ability to identify a hazard - and inability to scan roadways and accurately identify hazards is the most frequent recurring factor in novice driver crashes. Several studies have used computer-based training to teach hazard perception skills to learner drivers, without the need for a simulator.

2.4.4.1 Evaluation of evidence

	Effectiveness	Strength of evidence	Scope of training
Simulators	***	**	C,D

2.4.5 PC-based hazard perception training and education

It has long been recognised that novice drivers need to devote greater attention to monitoring their driving performance and decision making than do experienced drivers (Watson et al., 1996). It is because of such deficits that additional training, such as in the area of hazard perception, have been developed. Isler and colleagues (Isler & Starkey, 2011; Isler & Starkey, 2012) evaluated the New Zealand based eDrive program, which aims to teach the cognitive skills of situation awareness, hazard perception and risk management in learner drivers. The program involves an excess of 100 video based traffic scenarios filmed to display a 360 degree view from inside a car: the windscreen, driver and passenger seat windows, dashboard and mirrors are displayed. Thus an attempt was made to represent the entire driver's view on a single screen. The videos are shown across five modules increasing in complexity: visual search, hazard anticipation, risk management, road commentary and speed choice (Isler & Starkey, 2011). Aside from the modules, the program also included a self-evaluation exercise, night driving scenarios, and pre and post hazard anticipation tests to determine the effectiveness of the program (Isler & Starkey, 2011). A subsequent study compared pre and post hazard anticipation scores amongst 634 eDrive users (Isler & Starkey, 2012). It was found that learners significantly improved their hazard detection skills and timing of hazard detection by 10 and 11%, respectively. These findings suggest that eDrive may be beneficial in improving hazard perception skills in simulated driving performance. However, the study suffers from several methodological weaknesses inherent in driver education program research. The design was not randomised, there was no control group, and the duration between completion of training and post test was not reported.

Another New Zealand study by Lewis-Evans (2006) compared provisional drivers who had completed the Practice or ProDrive education programs with provisional drivers who had not completed either of these programs. The Practice program was computer-based and involves the completion of an electronic logbook of driving practice and a CD-ROM which aims to improve hazard perception skills. The ProDrive program was a short in-car driving course intended to improve vehicle handling skills in an off road location. It should be noted that driver education was generally completed prior to licensing (during learner phase); however some participants had completed ProDrive as a provisional driver. Data on traffic violations and crashes was obtained for all provisional drivers aged 15-20 years from the licence database. Drivers who had completed either of the driver education programs had fewer traffic violations after six and 12 months of licensure. However, this effect did not persist to 18 months except in the case of disqualifications and suspensions for drivers who had completed ProDrive as learners. There was no difference in the crash rates between licence holders who had completed either driver education program and licence holders who had not completed either one. The authors noted that females were overrepresented in the Practice group and males in the ProDrive group. However, no attempt was made to control for gender, driving experience, driving

exposure or other variables likely to impact on driving behaviour. In addition, there was no mention of the sample sizes of drivers who had completed either program.

A more recent study by Petzoldt, Weiss, Franke, Krems and Bannert (2013) conducted in Germany compared the use of computer-based training to teach learner drivers to detect hazards in horizontal and vertical positions during simulated driving situations. This was an attempt to overcome novice drivers' tendencies to focus only on the space immediately in front of the vehicle. It should be clarified that the learners were not operating the simulator, rather they were advised of the driving route and required to respond to hazards as though they were driving. A total of 26 training videos resembling a simulator were shown to learner drivers in which similar hazard patterns were replicated in slightly different configurations to reinforce learning. Drivers were engaged in hazard perception via a pause in the video followed by a series of questions asking first whether a hazard was present, and if so what course of action should be taken and why. The program consisted of a pre-test based on the written driver exam, instruction and training. Participants were selected on the basis that they were all drivers with less than five hours of practical experience. Participants were randomly assigned to computer-based training (n=12), paper-based training intended to match the content of the computer-based training (n=12), and 11 participants served as a control group who received no training. The study process included a session to complete the pre-test questionnaire of driver theory knowledge and the assigned training, followed by a testing of their hazard perception skills in a high fidelity simulator fitted with an eye tracking device to monitor glances two days later. The simulator test consisted of a training and practice session on how to operate the simulator, whereby participants were faced with hazardous situations similar to those presented in the computer or paper-based training. Some simulator scenarios resembled situations included in the training as closely as possible, to allow for the assessment of the 'near transfer' of acquired knowledge. In other situations, a general link between a hazard indicator and a critical area in the training environment was shared, whereas specific elements of the respective situations differed. For such situations, greater effort to apply acquired knowledge was expected, allowing for the assessment of 'far transfer'. It was found that participants trained using the computer-based method demonstrated correct eye glances indicative of hazard perception more quickly overall compared to the paper-based or control groups with a medium effect size. However, when near and far transfer of training to hazardous situations were separated; computer-based training was superior to paper-based training only. Although the sample size was small and there were some inconsistent results when the effects of driver training were compared for each driving simulator scenario separately, the results do suggest that computer-based training provides an advantage over paper-based training, possibly via increased automation of skills and transferability.

As noted in the section on simulator training (2.4.4), Fisher, Pollatsek, Pradhan (2006) also studied the impact of a computer-based program, RAPT, on hazard perception of learner or novice drivers. The RAPT program was designed to maximise deep learning (the concept that the deeper the level of processing of an event, the more likely the event is to be stored in long term memory) and near transfer (the recognition of risky scenarios on the road that resemble, but can never be identical to, the ones they see in training), via strategies such as requiring students to visualise where hazards might present, using 'top down' schematic plan views to indicate where to scan for hazards, and identifying general principles of hazard perception. Forty eight high school students were randomly assigned to a RAPT training or a control group that received no training. The pre and post tests were

completed by both groups and consisted of hazard perception tests which involved the identification of areas to scan continuously. The pre and post test results indicated that learner drivers who completed the training were two to three times more accurate at the hazard perception task following training, while the untrained group performed poorly in the pre and post test groups. The RAPT was modified slightly and delivered to novice drivers with 1-4 years experience of driving by themselves. Findings indicated that the RAPT training increased hazard perception from pre to post-test irrespective of whether a PC, high fidelity simulator, or on-road methodologies was used. However, sample sizes were small for novice drivers, and all post-tests appeared to be conducted almost immediately after training so it is possible effects would dissipate over time. The RAPT program has since been used as a hazard perception training tool in other studies (Fisher, 2008; Pradhan, Pollatsek, & Fisher, 2007) with similar results, although sample sizes in these other studies were also small.

One significant problem inherent with driver education is that any positive effects achieved by the intervention may be offset by overconfidence. Weiss, Petzolt, Bannert and Krems (2013) address this issue in their study of computer-based learning and learner drivers' ability to assess and calibrate their driving skills. As Petzoldt et al (2013) already identified, PC-based training may enable learners to automate skills more readily than conventional paper-based training methods, possibly due to the higher fidelity of PC instruction to realistic driving scenarios. The higher fidelity of PC-based training might also give learners a more realistic perception of their own skills due to increased complexity compared to paper-based training, and nearer transfer to on-road driving. The study involved learner drivers who either completed 90 minutes of computer-based instruction on hazard perception (n=12) or equivalent content via paper-based training materials (n=13). Two days after the training, participants were examined on their hazard perception skills via a high fidelity simulator task. The tasks involved two five minute drives with six scenarios intended to evaluate near and far transfer of training in two and four lane situations. Participants also rated the probability that they would be able to recognise and respond to hazard cues in vertically and horizontally distance areas of the traffic environment and rear and side view mirrors. As per Petzoldt et al's (2013) findings, superior performance, as measured by eye tracking cameras, was detected in the computer trained group, and the effect size was large. However, both groups had moderate levels of confidence in their ability to anticipate hazards, which meant that computer trained drivers underestimated their abilities while paper trained drivers overestimated their abilities. Computer training seemed superior as it led to faster detection and scanning of hazards, and contrary to expectations, while the training did not lead to more accurate predictions of performance; it increased the insecurities of the participants, thereby reducing the risk that student drivers would overestimate their own competence. As Tronsmoen (2010) identified in a study of driving instruction, underestimation of skills was associated with safer driving attitudes. It should be noted, however, that these results do not allow for conclusions to be drawn about the degree to which overconfidence may differ between those trained by a simulator and those trained in an on-road setting.

2.4.5.1 Evaluation of evidence

	Effectiveness	Strength of evidence	Scope of training
PC-based hazard perception training and education	***	**	C

2.4.6 Resilience training

Resilience training is a very specific form of driver education that refers to reducing risky driving behaviours in novice drivers (Beanland, Goode, Salmon & Lenne, 2011). Rather than traditional road safety or driver education, resilience training focuses on interpersonal skills which are peripherally related to road safety, such as avoiding riding with a drunk driver and resisting peer pressure to drive unsafely. Resilience training appears to be a fairly recent phenomenon, possibly originating from Danish and Norwegian safety campaigns that encouraged passengers to speak out against unsafe driver behaviours, resulting in a decline of passenger and driver fatalities in novice driver crashes (Vaa et al., 2012). Furthermore, researchers in resilience training have generally attempted to address the shortcomings of older research into driver education by involving much larger samples, describing programs in greater detail, and incorporating a broader range of outcome variables, which has generally led to efficacious findings, at least in the short term.

King, Vidourek, Love, Wegley, Alles-White (2008) evaluated the You Hold the Key (YHTK) program, which was intended to increase safe driving and responsible passenger behaviour among adolescents within the USA aged 15-19 years. The program was implemented in schools across 10 weeks, and consisted of interactive discussions and lessons, safety promotion education, cooperative learning (working in small learning groups to develop effective strategies to prevent high-risk driving behaviours and situations), and videos and presentations to promote safety. The curriculum included potential driving hazards such as driver distractions and dangerous behaviour, as well as resistance skills and strategies to reduce crashes. The study assessed the pre-test and post-test (both immediate and 6 month follow up) efficacy of the YHTK program, with a focus on seatbelt use, drink driving and driver behaviours. The sample included 1,365 participants from three high schools who had participated in the program. There was a significant difference in intended driver behaviours immediately following the program, with students more likely to agree with statements on seatbelt use and drink driving situations, with effects generally persisting six months later. In addition, female students appeared to report greater assertiveness as a result of the program, as they reported greater improvement in limiting passengers to the number of seatbelts, avoiding distractions when driving, and avoiding riding with a drunk driver compared to male students. However, no effect sizes were reported for this study and, due to the large sample size, it is possible to obtain a statistically significant result with a very small effect size.

A United Kingdom (UK) program, Wasted Lives, was evaluated by Brainbox Inc in 2009. The program encourages young people to evaluate and change risky attitudes and behaviours via four training modules: (1) seatbelts and speeding, (2) alcohol, (3) prescription and recreational drugs, and (4) exploring the aftermath of a road fatality on immediate family and community. The sample included 550 participants (69% male) from six colleges and a workplace. One fifth of the sample was licensed drivers. Data collection included completion of the Young Peoples' Attitudes to Risky Driving (YARD) scale, a driver profile, and open ended questions about personal driver and passenger behaviours, which were completed pre and post intervention, and three months following intervention. There were also focus groups with 6 to 8 participants in four of the colleges.

The survey findings indicated that YARD scale scores dropped from 56.9 to 52.1 immediately after the program, and had risen to 54.13 by the three month follow up. However, the difference between the pre-test and the both the post-test and follow up were statistically significant, although outcomes suggest that the effects of the program will decrease over time. There appeared to be a

stronger overall effect for females, who took fewer risks prior to the program compared to males. When the risky driving behaviours of drink driving, not wearing a seatbelt or speeding were considered in isolation, there were no lasting effects of the Wasted Lives program at the three month follow up. Open ended questions indicated that 76% of participants had changed their driving behaviours after the program, and this effect was retained three months later for 40% of participants. Comparable figures for passenger behaviour were 70% and 54%. Two thirds stated they would take "a lot fewer risks" and 21% "a few less risks", due to an awareness of how their behaviour could affect others and that risky behaviour was not worth taking, considering potential consequences. Focus group participants indicated that they enjoyed the interactive delivery of the program. This study was affected by several limitations including the lack of a randomised control design, attrition of 80% of the sample by time 3 and the absence of objective outcome data.

Senserrick, Ivers, Boufous, Chen, Norton, Stevenson, van Beurden, and Zask (2009) report the results of the DRIVE Study, a large prospective cohort study of 17-24 year olds on their provisional licence in New South Wales (NSW). They compared a resilience program with a general education program for NSW high school students and claimed a 44% reduction in crashes for participants of the resilience training. All drivers who were a resident in NSW, aged 17-24 years and held their first provisional licence between June 2003 and December 2004 were invited to complete an online survey and give consent for their survey data to be linked prospectively to routinely collected data held by state jurisdictional authorities. Outcome variables included recorded traffic offences and crashes from the Roads and Traffic Authority spanning 1996 to 2005, giving a minimum 2 year follow up for the majority of participants. The questionnaire asked about their participation in one of the two driver education programs. The two programs appeared to be similar in terms on their focus to educate participants about road safety issues, driver attitudes, avoiding dangerous behaviours, risk taking and peer relations. In each case, the program was administered by local police and health workers. However, the first program had more of a driver focus because driving instructors, road trauma victims and financial service personnel also contributed to administering the program, while the second program was supported by the local council, university and radio station, state emergency services, and state motoring and road safety organisation.

The second program was more encompassing in terms of reducing risky behaviour and fostering resilience via a developmental approach, and included activities such as presentations, drama, peer education, and real life experiences. Ongoing strategies were also used including training for peer facilitators, teachers, health workers and community members, and fact sheets for parents. A total of 1676 students completed the first program (driver focussed) and 540 students completed the second program (resilience focussed) at age 16. There was no difference between participants that completed either education program, and the comparison group regarding traffic offences. However, only the second education program was associated with a lower crash risk, with a 44% reduction after controlling for student characteristics such as age, socioeconomic status, gender, remoteness, risk taking behaviour, sensation seeking, average weekly mileage, length of time on learners licence and provisional licence, penalties during supervised driving, and number of driving test attempts. The authors note that the survey was completed 6 to 12 months after the program for 85% of participants. It was not possible to determine the response rates of participants who completed the program, and whether the sample obtained was biased towards participants who benefited especially from the resilience program. More driver-focused program participants were in the highest socio-economic status quartile, and most live in urban areas, whereas more resilience-

focused program participants were in lower socio-economic status quartiles and live in inner regional areas, reflecting the populations targeted by the respective programs. The findings are nonetheless very promising and attest to the importance of controlling for extraneous variables known to be associated with crash risk.

Given that resilience training may concern safety attitudes and behaviours that are only peripherally related to driving, this form of education has the potential to directly benefit non-driving populations, including younger teens. Mann and Lansdown (2009) reported that driving attitudes often become less safety conscious as adolescents become interested in driving, and may be motivated by goals such as popularity or mobility. The authors report a study where participants report on a program, Crash Magnets, which was distributed by Road Safety Scotland to 155 students aged 12 to 16 (46% male) from 12 schools. The program included a DVD and resource pack outlining topics such as passenger behaviour, driver safety, consequences of crashes and optional activities to facilitate discussion about consequences of driving behaviour. Participants completed a survey on intentions and attitudes towards speeding, drink driving and not wearing seatbelts, which was modelled on the theory of planned behaviour and moral norms. The survey was completed before the program, immediately after the program and six months later. Students reported speeding as more “enjoyable” from time 1 to time 2 and time 1 to time 3. However, this finding only applied to females when gender differences were examined, and females had less positive views of risky driving behaviour than males in general. Intention to speed and the belief that it was acceptable to speed decreased from time 1 to time 2 and time 1 to time 3, and gender differences attributed these finding to males only. Both adolescent males and females reported a strong decrease in acceptability to drink drive or not wear a seatbelt from time 1 to time 2, and time 2 to time 3. In short, the Crash Magnets program appeared to have a positive effect on attitudes towards drink driving and not wearing a seatbelt for all students, as well as a favourable effect on attitudes and intentions towards speeding for males. However, there was no control group and it was not known whether teachers used any of the resources other than the DVD. Additionally, preliminary evidence suggests there is potential to deliver a web based public health intervention within the road safety area (Chapman, Buckley, & Sheehan, 2009).

A study conducted in secondary schools in Queensland and the Australian Capital Territory assessed the effectiveness of a school-based curriculum to reduce risk-taking and injury among young adolescents (13-14 years old) (Chapman, Buckley, & Sheehan, 2012). The Skills for Preventing Injury in Youth (SPIY) program consisted of a theory-based intervention that was delivered by trained secondary school teachers in weekly 50- minute sessions across 8 weeks. The program aimed to reduce risk-taking and injury and increase personal and peer-protective behaviours, including passenger-related risk taking (e.g., riding in car with dangerous driver and drink driver). Compared to students in a control group, those students who participated in the intervention (SPIY) were significantly less likely to report passenger-related risk-taking at 6 month follow up. Indeed, the two assessed behaviours of riding with a dangerous and a drink driver both increased among the control students. This outcome suggests that such programs can have considerable impact on adolescent transport-related risks and may be useful adjuncts to traditional driver training programs for young novice drivers.

2.4.6.1 Evaluation of evidence

	Effectiveness	Strength of evidence	Scope of Training
Resilience training	***	**	A,B

2.4.7 Summary

Equipping novice drivers with the appropriate level of skill and knowledge in order to facilitate them safely negotiating the road network should be the primary consideration of any driver training/education scheme. Considerable research and evaluation over many decades leads to the conclusion that no single driver training method adequately addresses all requirements for safe driving (Hatakka et al., 2003). Furthermore, it is apparent that multiple methods should be utilised in an integrated approach to train novice drivers because no one method has demonstrated unequivocal evidence of reducing young novice driver over-representation in crashes. The review documented above has illustrated that each training method has potential merit in improving the safety of novice drivers, be it via promoting more favourable attitudes towards safe driving as in the case of some forms of driver education, or improved hazard perception skills as in the case of computer-based and simulator training. On the other hand, almost all training methods are at risk of jeopardising safety by unintentionally promoting attitudes or practices that prioritise mobility and independence (i.e., "getting your licence more quickly") over mastery of skills and safety. There is a need for further research in this area as the research conducted to date has failed to provide a definitive response regarding whether formal driver education and training in its many forms reduces crash risk for novice drivers.

Finally, it is important to consider two potential outcomes from compulsory novice driver training/education schemes. First, a compulsory pre licensing scheme may actually discourage young people from commencing the process of attaining their licence because of the demands of the licensing requirements. This may have a positive road safety outcome in that it is likely to lead to reduced exposure on the road by this high risk group. It is important to acknowledge, however, the possibility that this may also produce negative outcomes via an increase in unlicensed driving. Second, it is important to note that pre licence schemes that encourage young people to become drivers sooner than they might otherwise have done is likely to increase their exposure to risks on the road, thereby producing a negative effect on road safety (Watson et al., 1996). Ultimately, there is a need to strike the right balance between mobility, safety and exposure for young novice drivers and their families. Additionally, there is a need for widespread support for and acceptance of novice driver educational and licensing requirements among the broader community.

2.5 Post licence training

Training provided to drivers before they are able to drive unaccompanied aims to teach general knowledge, skills and attitudes about vehicle operation and control. In contrast training that is provided to a new driver after they have obtained a provisional licence often aims to teach specific skills. The training is provided to drivers once they are able to drive on the road unaccompanied. This type of training is also known as second phase training, particularly in the European context (Roelofs, Vissers, van Onna, & Kern, 2012). Post licence training falls into two broad categories: procedural skills training and higher order cognitive skills training. Procedural skills training encompasses advanced driver training, where novice drivers are taught complex vehicle handling skills and manoeuvring, while defensive driving combines these procedural skills with cognitive skills that contribute to safe driving (NRMA, 2007). Higher order cognitive skills training may encompass

hazard perception (already discussed in the section on simulator training), as well as situational awareness (i.e., the ability to interpret and react appropriately to potential hazards) and insight training (i.e., to improve self-awareness of own skills to prevent overconfidence and to adjust behaviour according to traffic complexity), all of which aim to improve driver safety in the wider context (Beanland et al., 2013).

In some European countries, second phase training is compulsory as novice drivers progress through the driver licensing system. For example, in Finland, Luxemburg, Austria, Estonia and Switzerland, all novice drivers must participate in such training (SWOV Fact Sheet). Finland introduced this type of training in the early 1990s and it formed the basis of the EU ADVANCED project. This project specified 'Ten Golden Rules' which represent the preconditions that post licence training courses for novice driver training programs should strive to meet (Bartl et al., 2002). In many cases, much of the training occurs in a group context. The ten rules are:

1. The course must be varied and highly interactive

2. The group must not be so large that participants can avoid being noticed, or that the instructor is unable to provide individual attention. However, the group must be sufficiently large to stimulate group discussion

3. Practical exercises (for instance, performing an emergency stop) must be regarded more as a starting point for self-reflection than as a means of learning complex skills. Each practical exercise must therefore be discussed afterwards

4. In order to prevent distraction and keep attention focused on the subject, discussions should be held in classrooms wherever possible. The instructor should ensure that the arguments put forward during the discussion are made visible (e.g. on a blackboard), so that everyone can participate and remember the issues better

5. Training ground exercises should be carried out in such a way that they stimulate self-reflection regarding the limitations of the participant's skills and encourage self-reflection in general. As stated in point 3, the key issue is not to learn a skill, but to avoid high-risk situations

6. Instructors must make sure that the exercise does not lead to undesirable side effects, and that participants have not shut the door to critical self-reflection from the outset

7. Course designers must keep a watch on whether certain course elements could actually lead to the participant overestimating his own skills

8. The training methods and teaching aids used must be as varied as possible (training grounds, discussions, reviewing actual crashes, solving problems, self-assessment based on questionnaires, videos followed by discussion, drives in traffic whereby the instructor and the other participants observe the actions of the novice drivers, etc.)
9. The instructor must ensure that the course is concluded in a positive way and in a relaxed atmosphere. The participants must be able to indicate what influence the course will have on their own behaviour in traffic in the future

10. It is important to recognise that although the course aims to increase risk awareness, the participants may regard it as a skills training (with risk compensation as an undesirable side)

Outcomes from the Finnish course have been evaluated in terms of effects on crash rate (self-report) as well as with data from insurance companies (Keskinen, Hatakka, Katila, Laapotti, & Peraaho, 1999). When compared with novice drivers who did not undertake the compulsory driver training (i.e., drivers who were licensed prior to the implementation of the program), those trained under the compulsory scheme had no reduction in crash rate in the 18 months after obtaining their licence to drive. However, significant differences were found between the groups at various time periods after that point (e.g., two, three, and five years after obtaining a provisional licence), although it is not clear whether this occurred because of the training or because of other factors, such as economic developments in Finland providing opportunities for novice drivers to access newer (safer) vehicles.

Following this less than ideal outcome from the ADVANCED project, another EU project was launched – the European NovEd project (Sanders & Keskinen, 2004). This project aimed to evaluate post-licence training courses which were based on the ten golden rules described above. Not all EU countries adopted this program. The Netherlands participated with two provinces offering one day training courses which included a driving skills analysis (45 minute drive in traffic with a 25 minute post-drive evaluation) and group discussion to allow participants to reflect on their own behaviours and attitudes in traffic. Evaluations were conducted at both training sites, producing mixed results. Using only participant questionnaire data, changes in attitude, self-assessment and risk acceptance were initially found to have not changed. However, further analyses revealed that those novice drivers who attended one of the two training locations showed improvement in driving behaviour as measured through the driving assessment component (vehicle control, driving skills and calibration skills) whereas those attending the other location experienced a deterioration. While the reasons for this change are not clear, it has been suggested that differences in levels of motivation of the instructors at the different locations may help to explain this outcome.

2.5.1 Procedural skills training

Sagberg and Bjornskau (2006) note that poor vehicle handling skills may contribute to crash risk in the early months of driving post licensure, as novice drivers make more errors and are more inconsistent in their driving skills than more experienced drivers (Malik, Rakotonirainy, Larue, & Maire, 2011). Beyond basic operational skills, vehicle manoeuvring (e.g., emergency braking) is not typically taught to learner drivers, with the exception of skid handling in Scandinavia (Beanland et al., 2013; Vaa et al., 2012). Training for novice drivers in vehicle handling skills is typically offered through defensive driving courses. Kelly and colleagues (Kelly, 2005; Kelly & Stanley, 2006; Stanley & Mueller, 2010) evaluated a single day advanced driving course for Montana adolescents that covered vehicle manoeuvring and defensive driving. A total of 347 adolescents participated in the program over a four year period. Surveys and DMV records were used to compare the driving records of adolescents who completed the program in comparison to a control group who did not receive the training. It was found that training did not influence crash risk or traffic violation once driving exposure was controlled for. However, several driver behaviours measured during the course were found to be predictive of near misses, crashes and traffic violations (Stanley & Mueller, 2010). Australian studies by Petersen and colleagues (Petersen & Barrett, 2009; Petersen, Barrett &

Morrison, 2006; Petersen, Barrett & Morrison, 2008) have noted that defensive driver training can produce improvements in driver vehicle handling immediately following training, however there was no long term follow up and effects may be highly context specific.

There is no evidence that advanced or defensive driver training reduces crash risk, possibly due to the short duration of training and potentially hazardous outcomes of practicing manoeuvres in real life. Findings from Isler et al.'s (2009) study indicated that participants who received the procedural training may have become overconfident as indicated by their self reported response to the confidence questionnaire, although the finding was not statistically significant. This finding reflects the general pattern of pre licence driver training studies where overconfidence potentially overrides any positive effects of the program. However, the higher order cognitive skills training reviewed so far (e.g. Weiss et al., 2013; Isler et al., 2009) has been shown to lead to lower ratings of driver confidence.

2.5.1.1 Evaluation of Evidence

	Effectiveness	Strength of evidence	Scope of Training
Procedural skills training	*	*	C,D

2.5.2 Hazard perception education and training

Higher order cognitive skills broadly relate to the driver's ability to interpret complex driving situations and respond appropriately, which is especially important to anticipating risks and avoiding crashes. As discussed previously, hazard perception is one of the most important and widely studied cognitive skills. Situation awareness builds on hazard perception and refers to the ability to not just detect potential hazards, but interpret and anticipate how these hazards will behave in a driving situation (Whelan et al., 2003). Insight training is designed to raise the novice driver's self awareness of their own driving skills to prevent overconfidence, and to calibrate their driving behaviour according to the complexity of traffic situations (Liu, Lenne & Williamson, 2009).

Hazard perception skills are considered to be amongst the most critical skills in driving (Lidestam, Lundqvist & Ronnberg, 2010), so much so that passing a hazard perception test is a condition for advancing through graduated licensing systems in some jurisdictions (e.g. Engstrom et al., 2003) including Queensland (Bates, 2012b). Novice drivers have lower capacity to detect hazards and are slower to react to hazardous situations in driving compared to experienced drivers (Isler, Starkey & Williamson, 2009). For example, novice drivers tend to focus on the road straight ahead whereas experienced drivers monitor a wider section of the road (Malik, Rakotonirainy, Larue & Maire, 2011).

Hazard perception training is generally accomplished in one of two ways: part task or commentary training. Part task training involves the completion of activities in response to video clips depicting hazards. The studies previously described in the PC-based hazard perception training and education section are examples of this (Isler & Starkey, 2011; Isler & Starkey, 2012; Petzoldt et al., 2013; Fisher et al., 2006; Weiss et al., 2013). Commentary training involves the novice driver either verbalising or receiving a commentary of the hazard perception task as it unfolds (McKenna, Horswill & Alexander, 2006).

McKenna et al (2006) provide an example of commentary training and part task assessment of hazard perception in novice drivers. Participants included 91 United Kingdom university students with an average age of 18.9 years. All had full licences with a maximum of three years unsupervised

driving experience. Half of the participants completed commentary training, which involved watching a 21 minute video of road situations from the driver's perspective, accompanied by a recorded commentary of hazardous events and how to perceive them. The control group watched the video without commentary. Following the video viewing, participants were required to complete a series of hazard perception tests. Three videos of traffic scenarios regarding speed, following distance and turning into a gap in traffic were presented, and participants indicated how their speed would differ from the driver in the video, at what distance they would feel comfortable or uncomfortable following the car in front, and which gaps they believed would be suitable to merge with traffic. In addition, participants also completed a video hazard perception test where they were required to push a response button whenever they perceived a hazard. Participants completed a survey of demographics, driving history and violations and estimated their skill as a driver compared to the average driver. Trained drivers were found to respond to hazards more quickly, and take fewer risks on the violations and speed video tests. However, there was no difference between trained and untrained drivers in perceived skill. Other studies using similar commentary training methodology found an improvement in hazard perception amongst novice drivers compared to control groups who did not experience the commentary (e.g. Williamson, 2008; Isler, Starkey & Williamson, 2009). Variations on commentary training including watching a video of an experienced driver negotiate a hazardous situation (Wang, Zhang, & Sakvendy, 2010), playback of own driving performance (Thomas, Pollatsek, Pradhan, Divekar, Blomberg, Reagan & Fisher, 2011), or teaching learners to self commentate during driving instruction (Crundall, Andrews, van Loon & Chapman, 2010) have also led to improved hazard detection assessed via a driving simulator. Cantwell, Isler & Starkey (2013) also recently confirmed the effectiveness of commentary training for hazard perception with a significant increase in the percentage of hazards identified. Additionally, preliminary eye movement data indicated that road commentary training may have influenced visual search behaviour of participants by 'prompting' them to allocate extra visual attention capacity to hazard rich areas, as evidenced by an increase of their fixation of clusters across the visual field.

One issue with cognitive skills training studies is that training and assessment is often done in a single session (Beanland et al., 2013). Carpentier, Wang, Jongen, Hermans & Brijs (2012) trained 15 novice drivers aged 17 to 25 years based on the RAPT (Fisher, 2008) method, which in that study involved a combination of part task and commentary hazard perception training. Along with 14 novice drivers who served as the control group, the trained sample completed a simulated drive prior to and immediately after training, and 2 to 4 weeks after the test period. In the simulator, eye tracker software was used to identify glances indicative of hazard detection and mirror use. The trained and untrained drivers performed similarly on the pre-test, however trained drivers demonstrated a marked decline in hazard detection time (30.45%) compared to untrained drivers (4.39%). The training condition involved a simulated drive as part of the commentary training, which may have influenced the results for the trained group immediately post-test. However, in the retention test trained drivers retained a 12.4% reduction in hazard detection compared to the pre-test, while the equivalent figure for the control group was 7.04%. This indicates no real change in hazard detection over time for the control group; however their performance was still inferior to the trained group.

Isler, Starkey and Sheppard (2011) evaluated a training camp for 36 novice drivers aged 15-18 who had recently obtained a restricted licence in New Zealand. The program included an on-road driving assessment, a video based hazard perception test and self report questionnaires on risky driving and

driving confidence, all of which served as the baseline. The training component was undertaken in the first week and typically involved 4-6 hours instruction per day. Participants were split into three equal treatment groups: higher order cognitive skills training, vehicle handling training, and a control group with no training. The higher order cognitive skills training focused on improving situational awareness, hazard perception and anticipation, and self awareness and insight into their driving abilities and behaviours. A variety of training methods were used in the higher order cognitive group such as computer-based instruction, commentary and self evaluation while driving, and focus groups. The second group received practical instruction on vehicle manoeuvres such as road position, steering, parking and braking, either on road or on a closed track. The third group took part in leisure activities that had nothing to do with driving. At the end of the camp, participants completed an on-road driving assessment, a video based hazard perception test, and questionnaires on driver attitudes and confidence to serve as the post-test. In the six months after the camp, all participants kept a diary of their driving experience. Findings indicated that higher order cognitive skills training led to improvements from pre to post-test in the visual search and composite scores of the on-road practical test, while novices who received training in vehicle handling skills experienced improvement in speed choice, direction control and composite scores on the on-road practical test. In addition, the group that received higher order cognitive skills training demonstrated an improvement from pre to post-test on the video based hazard perception test. However, there was no main effect for treatment group in either the practical driving test or hazard perception test (i.e., no group out-performed any other group on these tests). In addition, participants who completed the higher order cognitive skills training demonstrated safer driving attitudes and less confidence in their driving ability.

It is important to acknowledge a limitation that is evident in many of the evaluations assessing the effectiveness of hazard perception training; namely, that they are conducted in simulated environments, rather than using on-road environments or objective crash/offence data. Nonetheless, there is evidence to suggest that hazard perception training, whether through part task or commentary design, provides a promising picture of effectiveness, with demonstrated improvements in hazard detection as a critical higher order driving skill, as well as improvements in safer driving attitudes and reductions in overconfidence.

2.5.2.1 Evaluation of effectiveness

	Effectiveness	Strength of evidence	Scope of Training
Hazard perception education	***	**	C,D

2.5.3 Situation awareness

The hazard perception training literature discussed above also provides some evidence of improved situation awareness as a result of training, in that trained drivers were able to identify hazards more readily than untrained drivers. However, situation awareness also requires drivers to understand the hazard and respond by predicting how the hazard will behave (Helman, 2008). Three forms of situation awareness training have been reported in the literature, which are the use of a simulator, commentary training, and defensive driving. Each method has unique potential benefits for the novice driver. A simulator offers a safe way for novice drivers to experience unpredictable behaviour by other road users, a situation that is often ignored in training yet occurs on the road (Hoeschen et al., 2001). A report by Vlakveld (2011) documents a simulator training program where novice drivers were required to complete simulated drives where hazards presented demonstrated that trained

drivers were capable of detecting hazards and responding appropriately by adjusting speed or braking, for example. Another method, commentary training, was already discussed in relation to hazard perception above, enables the novice to verbalise thought processes and receive feedback from their trainer (Helman, 2008). For example, a study by Underwood, Crundall and Chapman (2011) revealed that novice drivers who had received commentary training to develop their hazard perception skills detected hazards earlier and reduced their speed to a greater degree in a simulator assessment compared to untrained novice drivers. This suggests that the trained drivers interpreted and responded to the hazard in addition to perceiving it. Studies of advanced driver training have shown that advanced coaching of novice drivers (based on the information, position, speed, gear and accelerate system [IPSGA system] described below, insight and an individualised approach and distributed practice can lead to improved situation awareness, resulting in safer driving behaviours as measured by a practical driving test, and a greater perception of control over driver situations. The IPSGA system of car control, upon which a number of UK based advanced driver coaching regimes are based is a technique that equips the driver to negotiate hazards in safer way. The system provides the driver with a driving schema guiding the drivers' behaviours, assisting the interpretation of information and directing action (Stanton, Walker, Young, Kazi, & Salmon, 2007; Walker, Stanton, Kazi, Salmon, & Jenkins, 2009).

2.5.3.1 Evaluation of effectiveness

	Effectiveness	Strength of evidence	Scope of Training
Situation awareness	***	*	C,D

2.5.4 Insight training

Previously discussed studies (Isler, Starkey, & Williamson, 2009; Weiss et al., 2013) have tentatively shown that higher order cognitive skills training can lead to a greater awareness of one's own limitations as a novice driver. Hoeschen et al (2001) argue that the goal of a training program on the topic of overestimation – the feeling that young drivers are strong enough to hold tight in a crash – should be to make them understand that this is not possible at normal speeds. They discuss the Stora Holm Driver Training Centre that implemented a training concept, "Insight". It was comprised of 6 different stations, the purpose being to raise pupils' awareness of the benefits to be gained from using safety equipment in cars and to get them to appreciate the importance of speed and large safety distances in order to be able to drive safely in traffic. The stations included the head of a crash test dummy, a crash sledge, a roll over simulator and 3 different video films. A discussion also takes place at each station between the pupils and the instructor. Results of an evaluation indicated that a visit to "Insight" had positive effects on pupil attitudes regarding the use of seat belts. However, the visit did not result in pupils thinking differently about the distance between their vehicle and the vehicle in front, speed, or road conditions, compared to those who did not visit the "Insight" Centre (Nyberg & Engstrom (1999) cited in the EU TRAINER report).

There is very little research into insight training and novice driver safety. However, insight seems to be conceptually similar to resilience in that both concepts relate to skills that are aligned with interpersonal and self awareness, as opposed to vehicle control or knowledge of road rules. In the EU TRAINER report, Hoeschen et al (2001) also discuss the issue of realistic self-evaluation and how to increase driving skills without increasing confidence in these skills (and without promoting the use of them for satisfying extra motives like competitive needs or sensation seeking). To reduce overestimation, they cite earlier work by Gregersen, who suggested that drivers should be put in

situations where they should not practice driving skill, but rather, should better experience their own limitations and that practical training could be developed with the purpose of surprising the learner and making them fail in driving tasks they normally believe they can handle (Gregersen, 1994, cited in Hoeschen et al., 2001). The authors also cited subsequent work by Gregersen that investigated how different educational strategies influence the drivers' overestimation of their own skill. Drivers with skill training had higher overestimation of their own ability than those with training focusing on the drivers' insight into their own limitations. Learners typically overestimated effects of advanced training programs, therefore it was suggested that the skill training may be complemented or even exchanged for insight training (Gregersen, 1996, cited in Hoeschen et al., 2001).

A study by Liu, Lenne and Williamson (2009) investigated communication skills between young male drivers and their passengers. Sixty-two provisional drivers were recruited from an Australian university and randomly assigned to pairs. Each pair was assigned to an experimental (training) or control group. The training group attended a facilitated discussion on gaps in traditional driver training, with the goal to teach drivers and passengers to view each other as part of a driving team in a bid to reduce the distractive influence of passengers on novice drivers. The pre and post-test consisted of completion of the driver behaviour questionnaire (DBQ) and a 5 minute simulator drive with one member of the pair acting as the driver and the other as the passenger. Conversations between the driver and passenger were recorded for safe and unsafe comments. A follow up was conducted several months later. Trained drivers were observed to leave a greater following distance and to approach a hazard more slowly than untrained drivers. Trained passengers also gave more safe and less unsafe comments than untrained passengers. In addition, trained participants also reported fewer mistakes and violations in the DBQ than untrained participants. It should be noted, however, that it is not clear to what extent these findings can be generalised to a broader population of drivers because the sample (university students) may have been biased in relation to the ability to communicate/articulate feedback.

Senserrick & Swinburne (2001) evaluated a driver training program that aimed to provide greater insight and awareness of potential risks when driving, thereby targeting issues of over confidence rather than traditional advanced driving skills. The Skilled Drivers of Australia driver training program was developed for those aged 18-25 years is provided free to AAMI Insurance holders and completion of the program results in reduced comprehensive insurance premiums. Questionnaires assessing attitudes, behaviours, and perceptions of enforcement and crash risk were conducted with participants upon enrolling in the course and again just before or just after participation in the course and finally, 8-9 weeks following completion of the course. A total of 149 participants completed all 3 questionnaires (35 males and 114 females). Overall, findings indicated that after participation in the program: overall confidence in driving ability did not increase (with male drivers reporting reduced confidence in their driving ability); participants reported greater discomfort driving close behind another vehicle, they were less likely to agree that driver training was a waste of time; participants' belief that they were a better driver than others became stronger; they tended to report increased confidence in their ability to manage possible hazards when driving (mostly true for females); they reported low levels of dangerous driving behaviours that did not increase over the survey period; the sensitivity of participants to the possibility of having a crash increased; and the tendency of young males to drive over the speed limit was reduced, at least to the lower level reported by females. Qualitative findings complemented these overall findings that the program saw positive changes in driving attitudes and behaviours. Due to the nature of recruitment and contact

(at three time points) with participants, anonymity was not feasible. A letter of invitation to participate was sent to participants at the time of their enrolment in the program, along with the first questionnaire. A consent form was provided with a reply paid envelope to return the completed questionnaire and consent form, if they so chose to participate. The second and third time point questionnaires were then sent out to participants and similarly returned in the same manner. The authors concluded that insight training, as provided by this AAMI training program, provides a promising road safety countermeasure, likely to result in reduced crash involvement for young drivers.

2.5.4.1 Evaluation of effectiveness

	Effectiveness	Strength of evidence	Scope of training
Insight training	**	*	C

2.5.5 Summary

There is no evidence that advanced or defensive driver training (typically offered for vehicle handling skills training for novice drivers post licence) reduces crash risk, possibly due to the short duration of training and potentially hazardous outcomes of practicing manoeuvres in real life. To date, no known studies have explored the effects of cognitive skills training on crash risk (Beanland et al., 2013). Sample sizes tend to be small due to the time consuming and costly nature of the studies, and with the exception of Carpentier et al (2013) and Liu et al (2009), post-tests tend to be completed immediately after training, therefore the potential for training effects to decrease over time is generally unknown. With few exceptions (Walker, Stanton and colleagues, 2007; 2009) evaluations of higher order cognitive skills have almost exclusively been evaluated via a simulator, so it is unknown how well these skills translate to real driving situations. Despite these limitations, higher order cognitive skills training programs are promising to the extent that they may foster safer driving attitudes and reduce overconfidence. Both of these outcomes would be expected to reduce the potential for overconfidence in novice drivers, and if so, may indirectly increase the efficacy of conventional driver skills training.

2.6 Consolidated evidence for driver education and training

Novice driver education and training is a vast area with many potential approaches and outcomes. The GDE demonstrates the importance of considering learning to drive as more than just obtaining skills to manipulate a vehicle. This report has evaluated the evidence for each of the various forms of driver education and training reviewed in terms of its effectiveness, the strength of the literature and the scope of the training as measured against the GDE. Table 1 presents the consolidated evidence for the scope of driver training and education.

Table 1: Consolidated evaluation of evidence

Education and training approach	Effectiveness	Strength of the evidence	Scope of training
GDL	*****	***	A,B,C,D
Mandatory hours	****	**	B,C,D
Time discount incentives	*	**	C,D

Professional on-road driving instruction	****	***	B,C,D
Supervised on-road driving experience	****	**	B,C,D
High school driver education	**	*	C,D
Simulators	***	**	C,D
PC Hazard perception training and education	***	**	C
Resilience training	***	**	A,B
Procedural skills training	*	*	C,D
Hazard perception education	***	**	C,D
Situation awareness	***	*	C,D
Insight training	**	*	C

As shown, most of the various forms of driver education and training focus on vehicle manoeuvring (Level D) and mastery of traffic (Level C). Such skills are essential but are not the only aspect of safe driving (they are necessary but not sufficient). Given that these skills are an essential component of safe driving, it is encouraging to note that they are taught within a range of programs. However, there are limited education and training approaches that address driving goals and context (Level B) or goals for life/skills for living (Level A).

While some forms of driver training and education address more aspects of the GDE when compared with other programs, it may not be optimal for one form of education and training to address all aspects. It may be preferable for novice drivers to complete a range of driver education and training programs that provide them with the opportunity to develop their skills and abilities in all aspects of the GDE.

2.7 Conclusion

The central aim of this literature review was to describe approaches to driver education and training in jurisdictions that are comparable to Queensland. The literature was reviewed first for pre licence training and then post licence training, in terms of both skill acquisition and potential for road safety benefits. The content of pre and post licence training differs in that pre licence training tends to focus on rudimentary driving skills associated with operating a car, whilst post licence training covers more advanced skills such as skid training or defensive driving courses. From the available literature, it is apparent that despite the large number of different approaches available to train and educate novice drivers across the span of the learning phase, there is no clear evidence to support one technique over another to provide clear road safety benefits.

The influence of GDL schemes on training is also an important and inter-related consideration in the field of novice driver training and was discussed briefly in this report in terms of 1) the mandated number of hours for supervised driving, and 2) the 'time discount' available in many jurisdictions upon completion of an approved educational program. While the evidence relating to GDL programs has produced positive results in a variety of jurisdictions, in regard to reducing exposure to the risks faced by young drivers, as they strive to gain experience in a 'controlled' manner, more work is needed to better understand how such schemes can be complemented and improved in the future. GDL will be further reviewed in Report 3 of this project.

3 Jurisdiction comparison

It is important to appreciate the context within which each novice driver training scheme is conducted. In order to assist with the appreciation of the wide range of variations that exist nationally and internationally, a flow chart detailing the process to obtain a driving licence in each Australian jurisdiction is presented along with the following international jurisdictions:

- New Zealand: closest in culture to Australia, GDL and young novice driver age
- The Netherlands: extensive use of driving simulators in training
- The UK: mandatory use of cognitive skills testing by hazard perception test
- Sweden: training used in conjunction with the licensing system
- Germany: changed from solely professional to now deregulated driver training

All information used to inform the flow charts was obtained from publically available websites. The relevant jurisdiction government website was always used as a primary source of information. In situations where the government website contained no English translation, alternative (non-government) public websites were consulted.

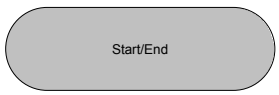
3.1 Limitations

From the review of government websites it was frequently possible to document the steps required to obtain an open licence, the requirements for assessment and the rules which a novice driver must follow. However, relatively few jurisdictions had mandatory requirements for training and even fewer provided voluntary recommendations for driver training. Further, there was a lack of consistency in the volume of information provided by each jurisdiction; consequently some types of information are presented for some jurisdictions but not others. Reliability of the information presented for English speaking jurisdictions is high. There is potential for limitations regarding the non-English speaking jurisdictions; although in many cases an English version of the government website was available. It is possible that not all of the information available in the native language was also presented in English. As such, the information presented below should be considered an accurate reflection of the publicly available English language information.

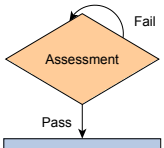
3.2 Flow chart key

All flow charts should be read from top to bottom, in the direction of the arrows. Where two arrows exit one box, novice drivers have a choice of which path they follow.

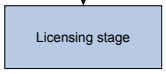
Key



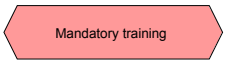
Grey oval: Start and End point (open licence). Start point includes prerequisites to commence driver training



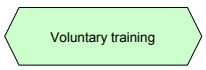
Orange diamond: Assessment. Details of the assessment provided under rules and additional information



Blue rectangle: Licensing stage



Red hexagon: mandatory step in training



Green hexagon: voluntary step in training

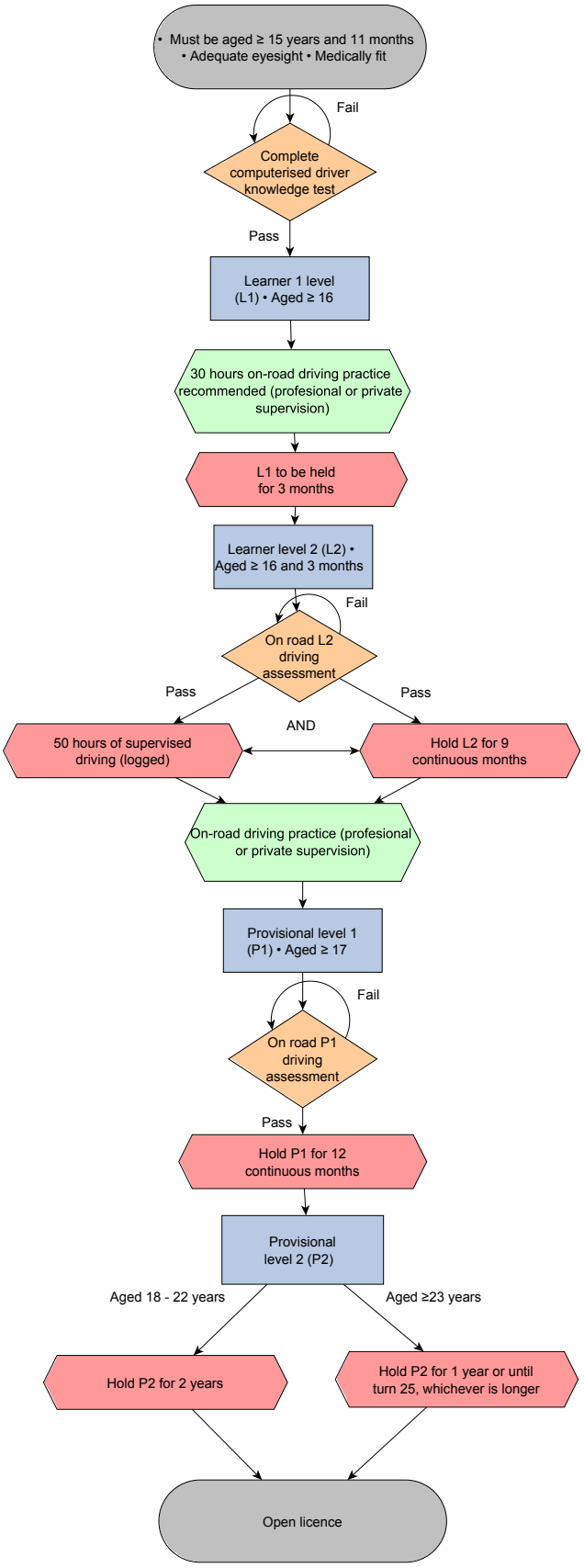
3.3 Australian jurisdictions

3.3.1 Queensland

Key source: http://www.tmr.qld.gov.au/Licensing/Getting-a-licence/Getting-a-car-driver-licence.aspx

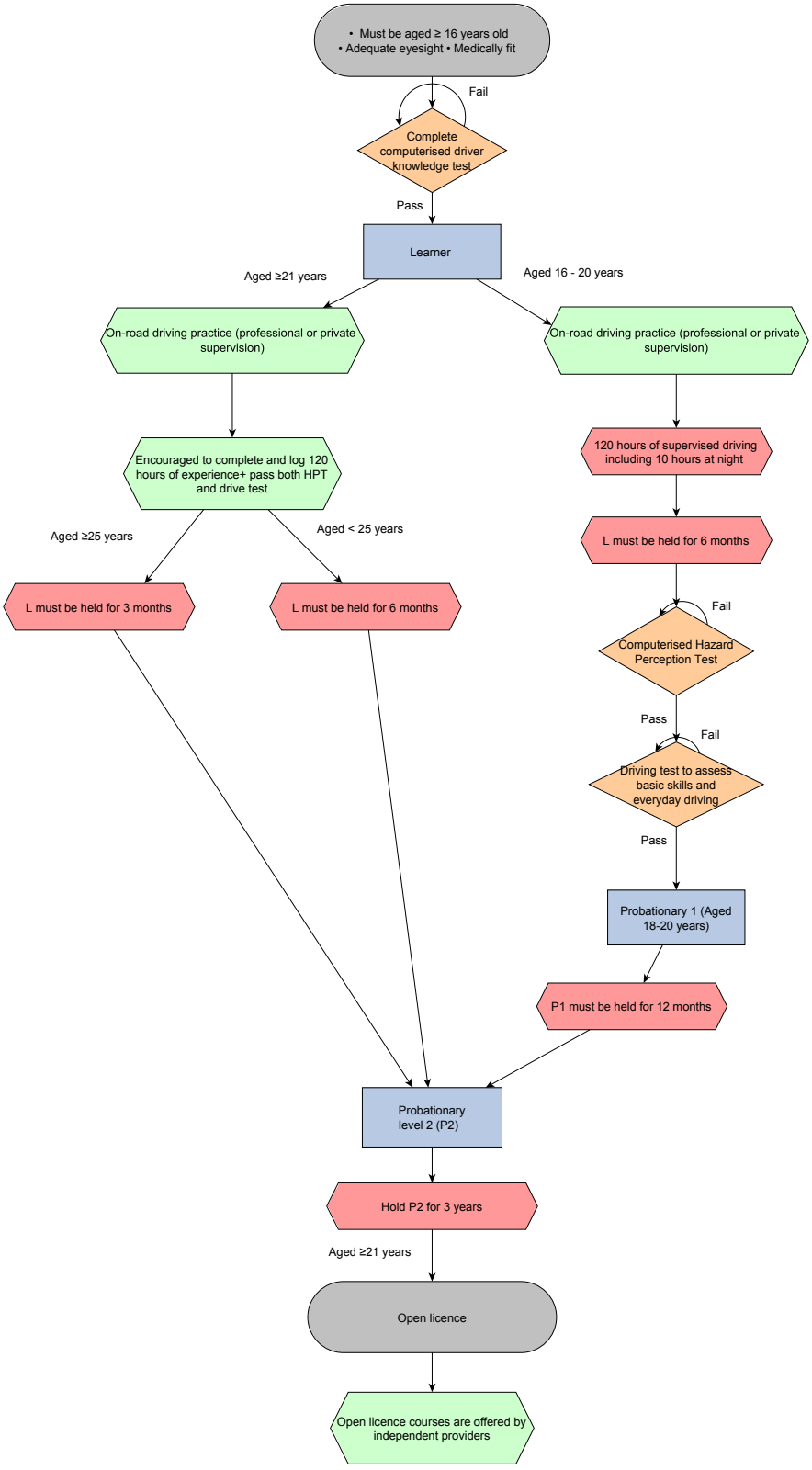
3.3.2 Tasmania

Key source: http://www.transport.tas.gov.au/licence_information



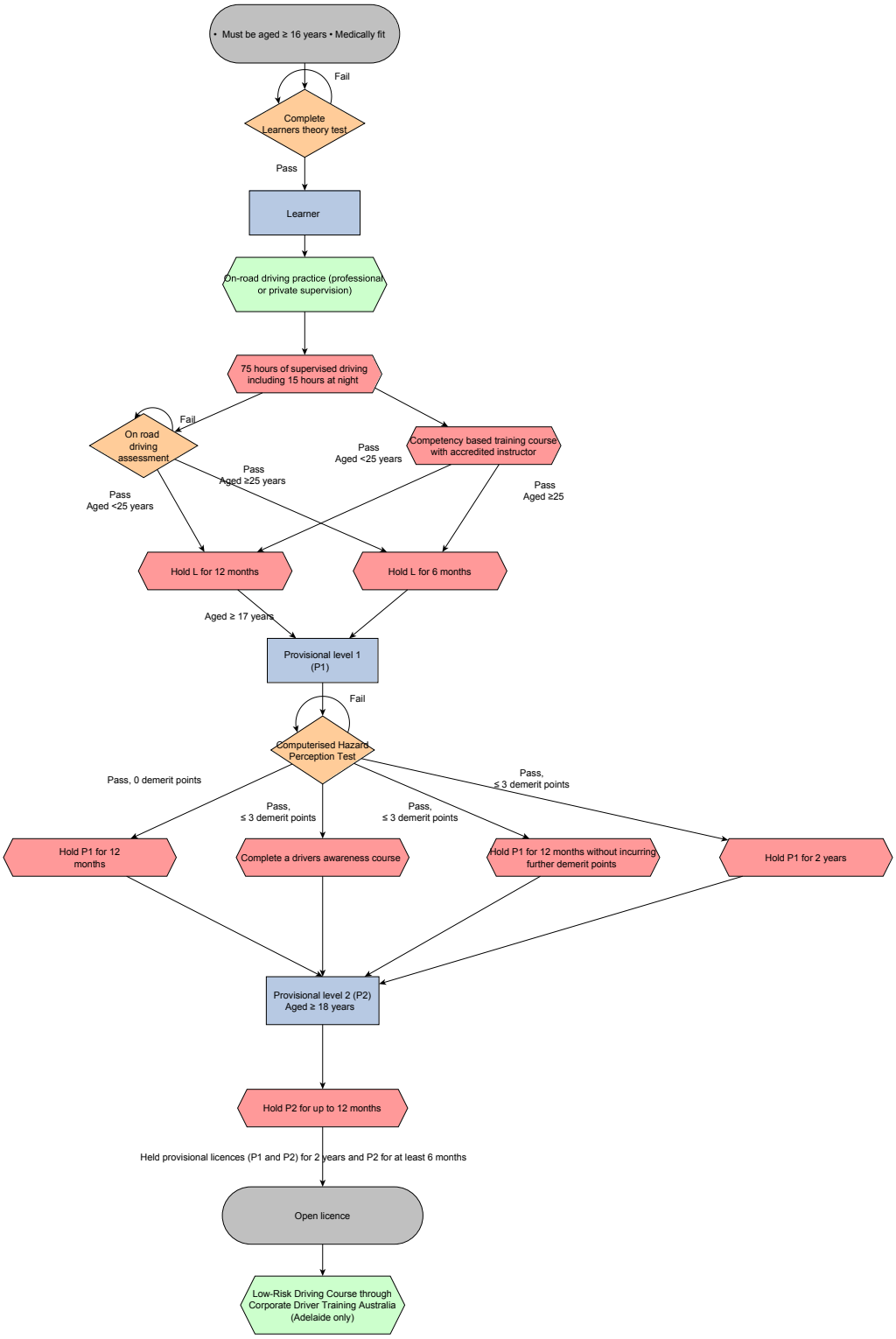
3.3.3 Victoria On-road driving practice (professional or private supervision)

Key sources:
http://www.vicroads.vic.gov.au/Home/Licences/
http://www.vicroads.vic.gov.au/Home/Licences/GetYourLs/Howtogetyourcarlearnerpermit.htm
http://www.vicroads.vic.gov.au/Home/Licences/GetYourPs/Howtogetyourprobationarycarlicence.htm



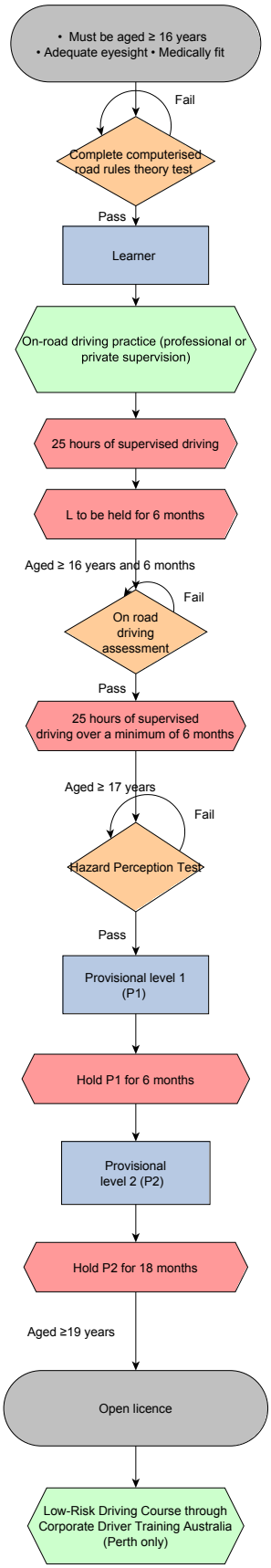
3.3.4 South Australia

Key sources:
http://www.sa.gov.au/subject/Transport,+travel+and+motoring/Motoring/New+and+young+drivers/Driving+in+South+Australia/Getting+a+driver's+licence
http://www.mylicence.sa.gov.au/my-car-licence/learners-stage
http://mylicence.sa.gov.au/the-driving-companion/step-by-step



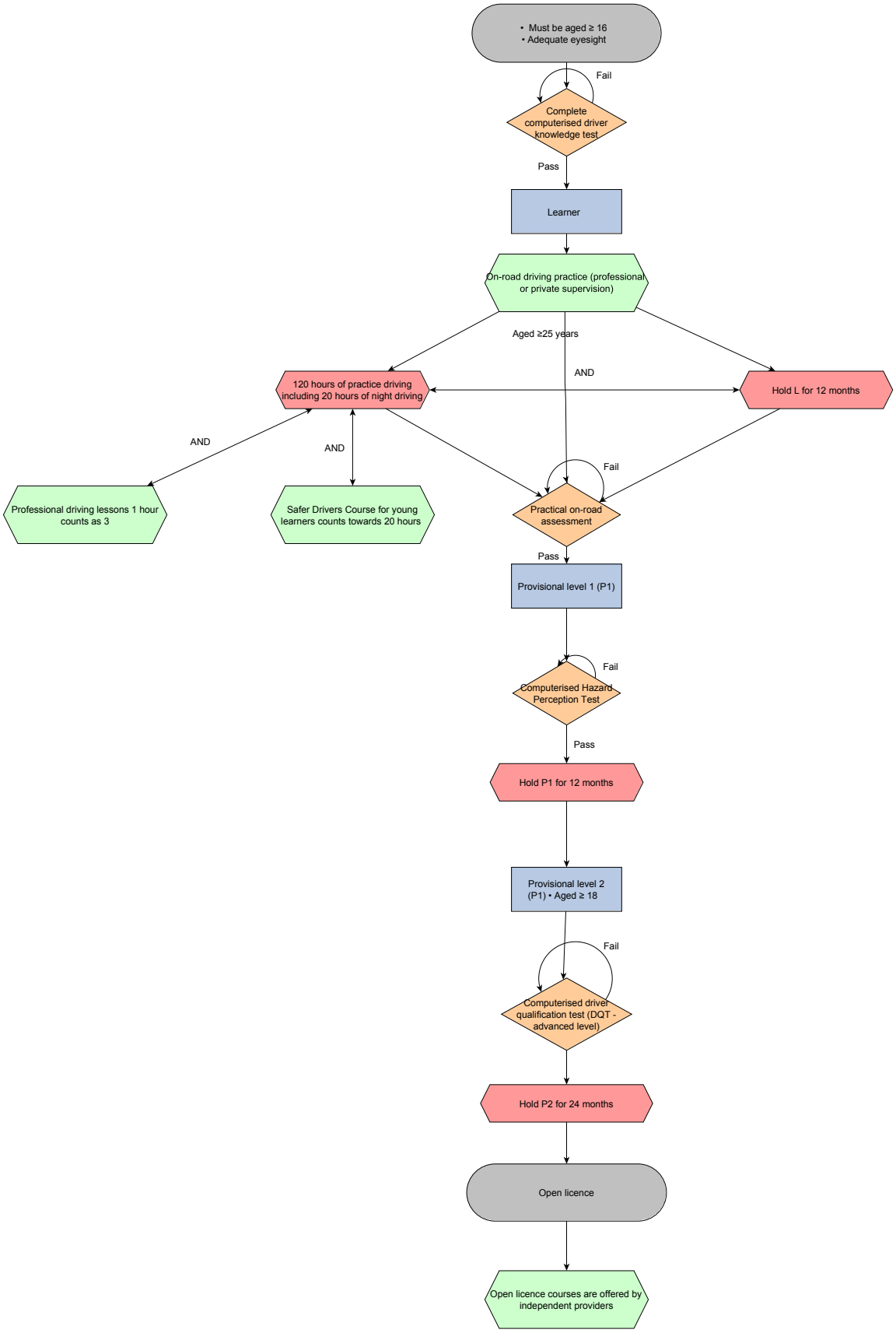
3.3.5 Western Australia

Key source: http://www.transport.wa.gov.au/licensing/20663.asp#26571



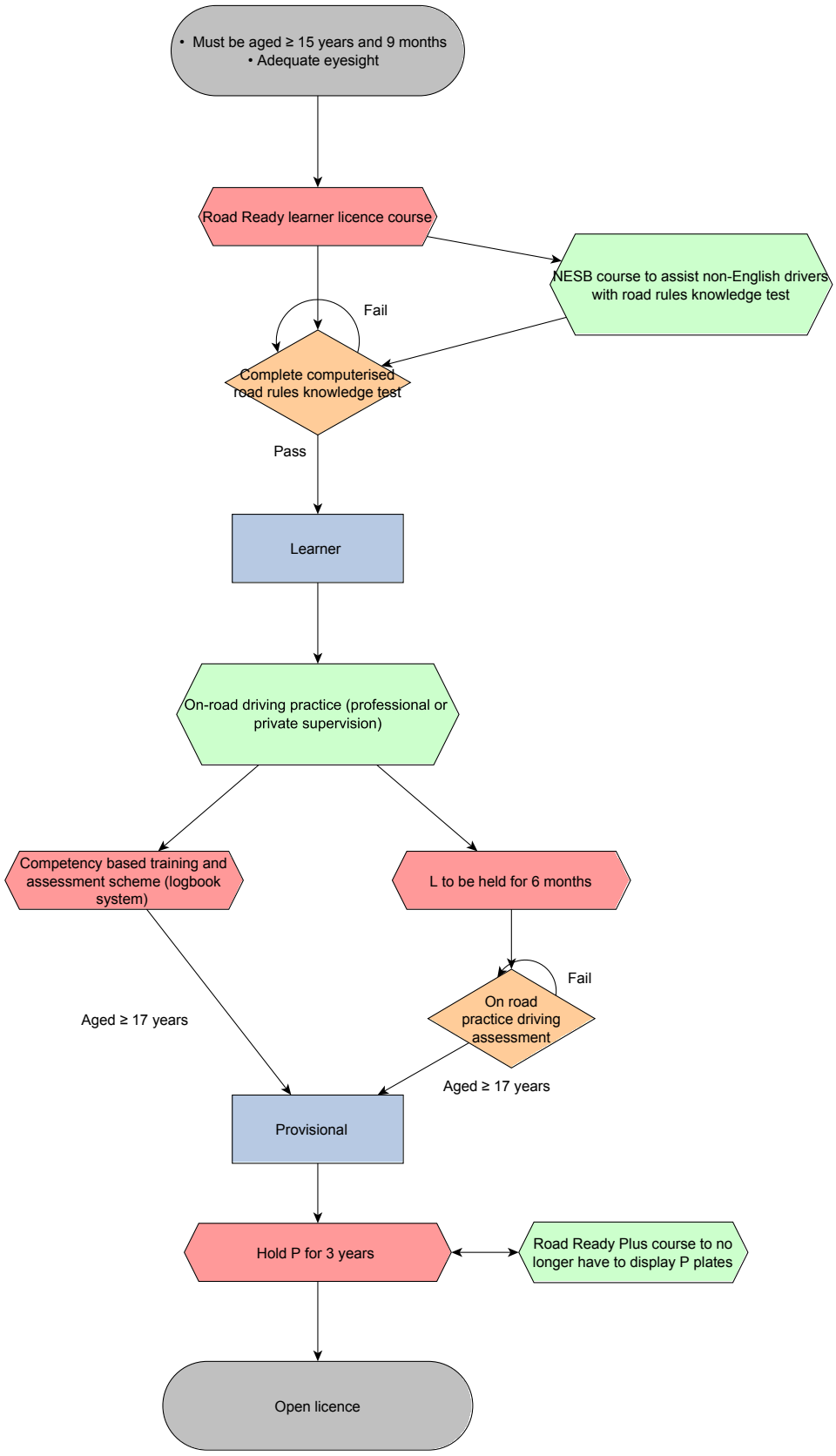
3.3.6 New South Wales

Key source: http://www.rta.nsw.gov.au/licensing/downloads/newdrivers_guide_dl1.html



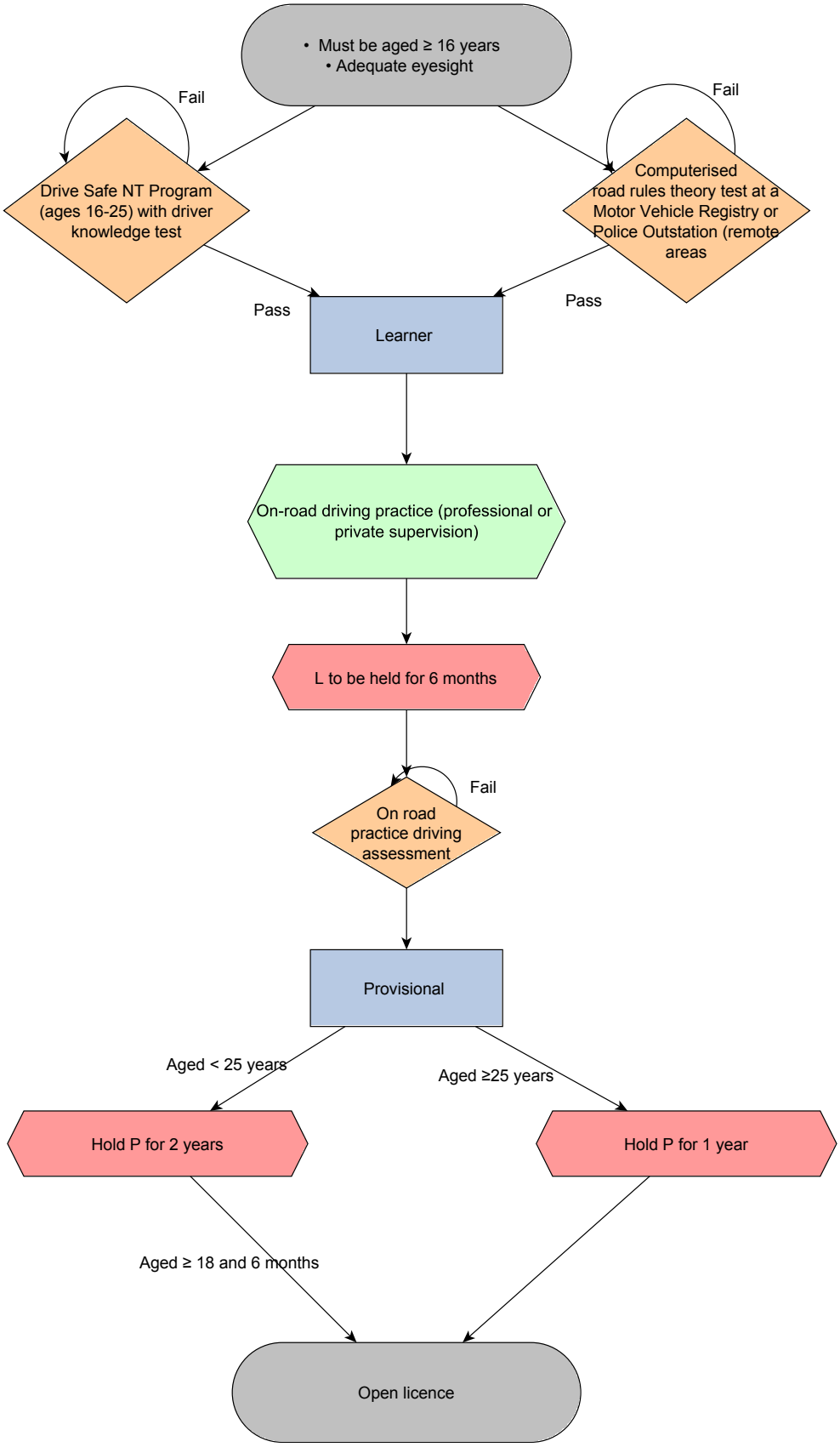
3.3.7 Australian Capital Territory

Key sources:
http://www.roadready.act.gov.au/c/roadready?a=da&did=1002908&category=2
http://www.rego.act.gov.au/licensing/licencemain.htm



3.3.8 Northern Territory

Key source: http://www.transport.nt.gov.au/mvr/driver-training-and-licensing



3.3.9 Australian rules and additional information

	TAS	VIC	SA	WA	ACT	NT	NSW	QLD
Overview of licences	3 stages • Learner (L1 & L2) • Provisional (P1 & P2) • Full licence	3 stages • Learner • Probationary (P1 & P2) • Full licence	3 stages • Learner • Provisional (P1 & P2) • Full licence	3 stages • Learner • Provisional (P1 & P2) • Full licence	3 stages • Learner • Provisional • Full licence	3 stages • Learner • Provisional • Full licence	3 stages • Learner • Provisional (P1 & P2) • Full licence	3 stages • Learner • Provisional (P1 & P2) • Open licence
Assessment components	**L 2 PDA**, 4 section test: (briefing) identify cabin controls, (1) straight drive and pull over, (2) left hand turns at, or straight drive through, intersections, (3) 3-point turn, (4) right hand turn and hazard detection). **P1 PDA**, 6 section test: (briefing) identify cabin controls, (1-6) various low and high road speed manoeuvres that reflect	**Computerised HPT** completed on site at a Service Centre. **PDA:** two-part assessment of: (pre-drive) identifying car controls, (1) less challenging situations to assess basic driving skills, (2) driving in various conditions to assess everyday driving).	**Provisional on road test** (assessment of general driving ability + 5 slow-speed manoeuvres) OR competency based training course (*recommended* option, training course with accredited instructor that involves successful performing 30 driving tasks)	**Provisional PDA** (5-section test of ability to follow directions [3 sections] and perform set exercises [2 sections]) and HPT (exemptions granted for those living outside radius of >100km from HPT location)	**Provisional driving test:** either pass government driving test OR undergone competency based training and assessment (training and continual assessment with accredited driving instructor, using logbook system) (both of which involve an assessment of 22 driver competencies)		**Provisional driving test:** assessment of 5 key performance areas: (1) speed management, (2) road positioning, (3) decision making, (4) responding to hazards, and (5) vehicle control). **DQT** assessment of advanced safe driving knowledge and advanced hazard perception required for full licence	**Provisional Q-SAFE – test** comprised of a pre-drive assessment of vehicle controls and an on-road test of a variety of procedures e.g., stopping, signalling, steering, speed + 3 of several specific manoeuvres. NB: Drivers who have sat and passed Q-SAFE at age 25 or older are exempt from the P1 stage and HPT (below). **Online HPT** is a measure of ability to respond appropriately to potentially dangerous driving situations.

	everyday driving tasks and hazard identification in final section).							
Rules	**Learner:** Carry licence, 0 BAC, display plates, max 80km/hr, never tow, supervisory driver **Provisional 1**: Carry licence, 0 BAC, display plates, max 80km/h **Provisional 2:** Carry licence, 0 BAC, do not need to display plates **Full licence:** Carry licence, <.05 BAC,	**Learner:** Carry licence, 0 BAC, display plates, never tow, do not use hands free mobile, supervisory driver **Probationary 1**: As with Learner, in addition cannot drive high powered vehicle, cannot carry more than 1 passenger <21 years, limited night driving	**Learner:** Carry licence, 0 BAC, display plates, never use any type of mobile phone function, max speed 100km/hr, never exceed speed limit by >10km/hr., supervisory driver **Provisional 1:** As learner + cannot drive high	**Learner:** Carry licence, 0 BAC, display plates, max speed 100km/hr, supervisory driver, cannot exceed speed limit, cannot drive within boundaries of Kings Park or wherever else signs prohibit L drivers **Provisional 1:** Carry licence, 0 BAC, display plates, do no drive between	**Learner:** 0 BAC, display plates, do not tow > 750kg, supervisory driver **Provisional** 0 BAC, display plates (drivers who complete the Road Ready Plus course after 6 months or more on P ["P OFF"] may remove plates) **Full Licence:** <.05 BAC, renew licence when necessary (up to 5 years)	**Learner:** Carry licence, 0 BAC, display plates, 80km/hr max, do not use hand free mobile phone, supervisory driver **Provisional** As learner (-supervisory driver) but can drive 100km/hr max **Full licence:** Carry licence, <.05 BAC, Renew licence when	**Learner:** 0 BAC, display plates, max speed 90km/hr, never tow, supervisory driver, cannot drive in certain Sydney regions (e.g., Parramatta Park), do not use any mobile phone function **Provisional 1** 0 BAC, display plates, cannot drive high performance vehicle, never two >250kg, max speed 90km/hr, drivers <21 cannot carry more than 1	**Learner**: Carry licence, 0 BAC, supervisory driver **Provisional 1:** Carry licence, 0 BAC, display plates, cannot drive performance vehicle, if <25 cannot have more than 1 passenger aged <21 (additional mobile phone conditions also apply). **Provisional 2:** As P1 with exception of the younger passenger rule **Full Licence:** Carry

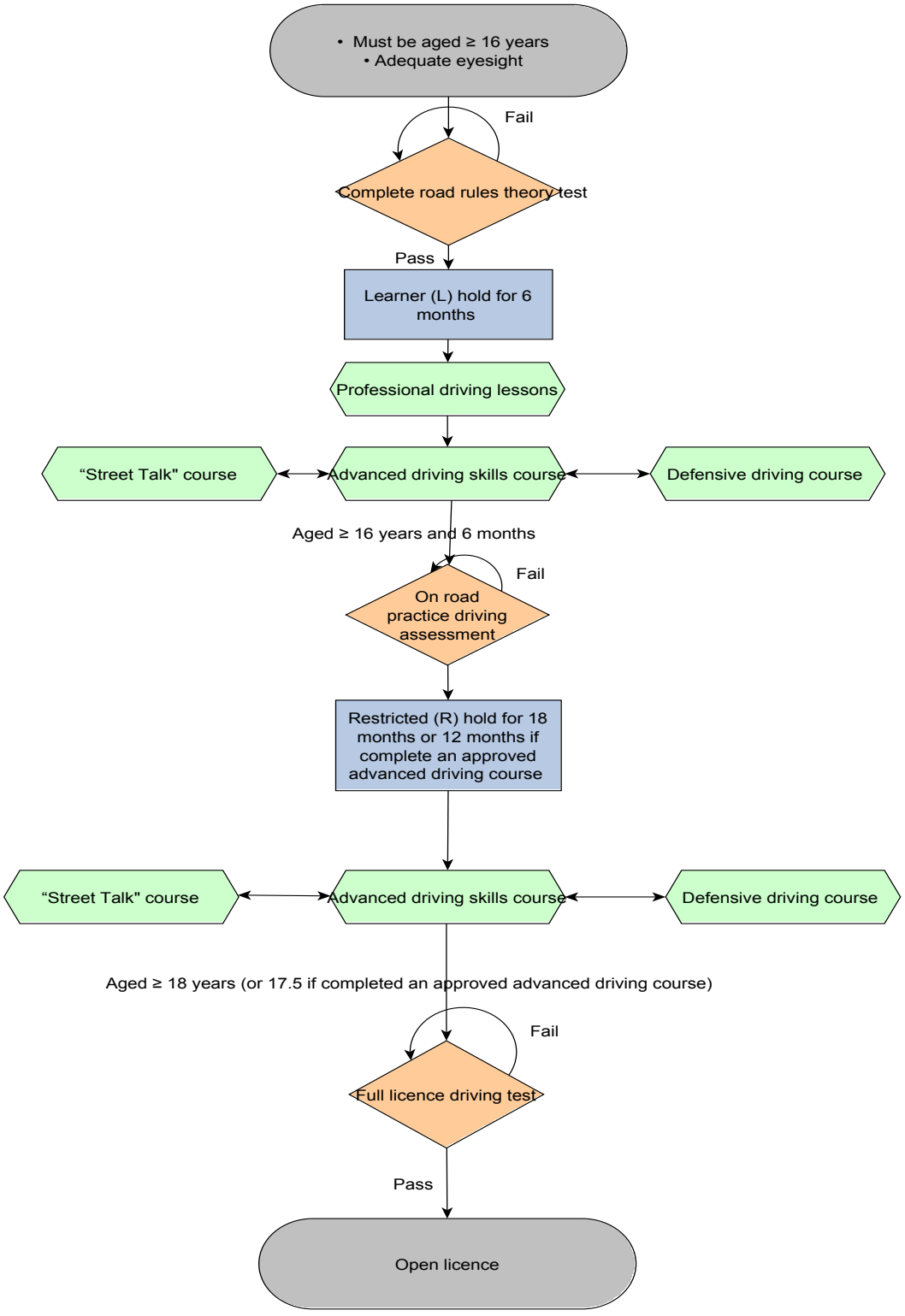
	renew licence when necessary (up to 5 years)	**Probationary 1**: As P1 with exception of young passenger and mobile phone restrictions **Full licence:** Carry licence if under 26 years of age, <.05 BAC, renew licence when necessary (up to 10 years)	powered vehicle if <25 or if obtained P1 after 04.09.10 **Provisional 2** As P1 with exception of displaying plates **Full licence**: <.05 BAC, renew licence when necessary (up to 10 years)	12am-5am, cannot exceed 110km/hr. **Provisional 2:** As P1 with exception of night time driving restrictions **Full Licence:** <.05 BAC, renew licence when necessary (up to 5 years)		necessary	passenger <21 between 11pm and 5am. **Provisional 2**As P1 but max speed 100km/hr and with exception of mobile phone and younger passenger restrictions **Full Licence:** <.05 BAC, Renew when necessary (up to 5 years)	licence, <.05 BAC, renew licence when necessary (up to 5 years)
Exemptions	Those who hold current car and/or motorcycle licences from countries recognised as having similar licencing standards to Australia are exempt from taking knowledge and on-road assessments	Those who hold a driver licence from a recognised country, and drivers aged ≥25 from an experienced driver country, are not required to undertake any tests (if <25 from an experienced driver country, however, knowledge	Drivers who hold, or have held within the past 5 years, a car or motorcycle licence from a recognised country are not required to undertake equivalent driving tests. Drivers aged ≥25 from an experienced driver	Drivers who hold a licence from a recognised country and the licence has not expired by >12 months are exempt from taking theory test and MAY be exempt from taking PDA. If licence issued by an experienced driver country, licence has not expired by >12	Drivers who have a drivers and/or motorcycle licence from an approved country or experienced driver recognised country AND are ≥25 are exempt from practical and road rules knowledge test	Drivers and/or riders licensed in a recognised country are exempt from entry level theory test and practical driving test. Drivers aged ≥25 from an experienced driver country are not required to undertake any tests, whereas	Drivers with a current NZ driver licence, or those with a current or recently expired (<5 years) overseas licence from a recognised country are exempt from licence tests (car knowledge test and practical)	Drivers and/or riders (or those who have held such licences in the past 5 years) from a prescribed/recognised country do not need to pass a written road rules test and practical driving test

		test, HPT and drive test must be completed)	country are not required to undertake any tests, whereas those <25 must pass both theory and practical tests.	months, and driver is ≥25, driver is exempt from theory and practical assessments.		those <25 must pass both theory and practical tests. Transfers		
NB: Within all Australian states, progression between licencing stages is dependent on driving record and number of offences (e.g., drivers may revert/regress to previous stage after reaching a certain number of demerit points)								

3.4 International Jurisdictions

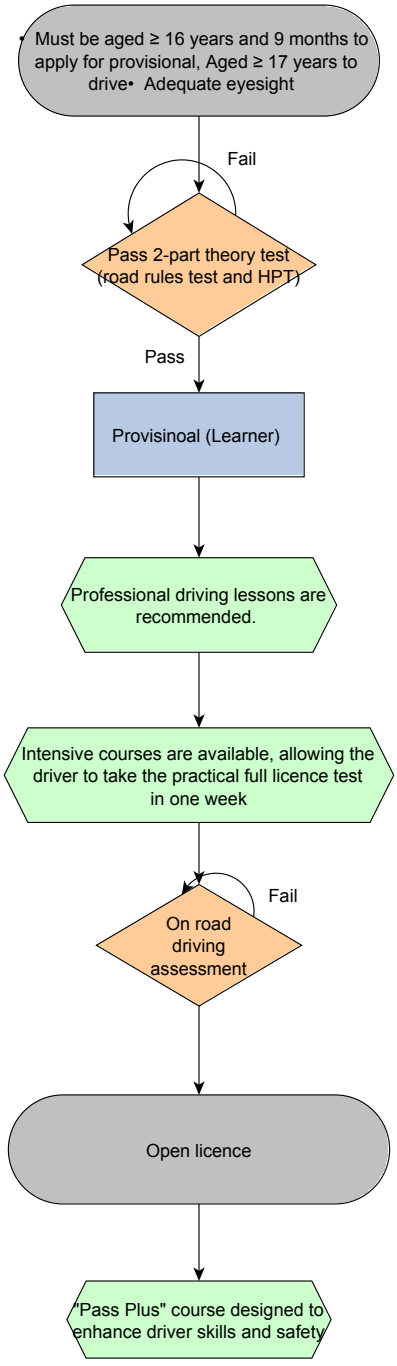
3.4.1 New Zealand

Key sources:
http://www.nzta.govt.nz/resources/roadcode/theory-test-questions/
http://www.nzta.govt.nz/resources/factsheets/45/learning-to-drive.html



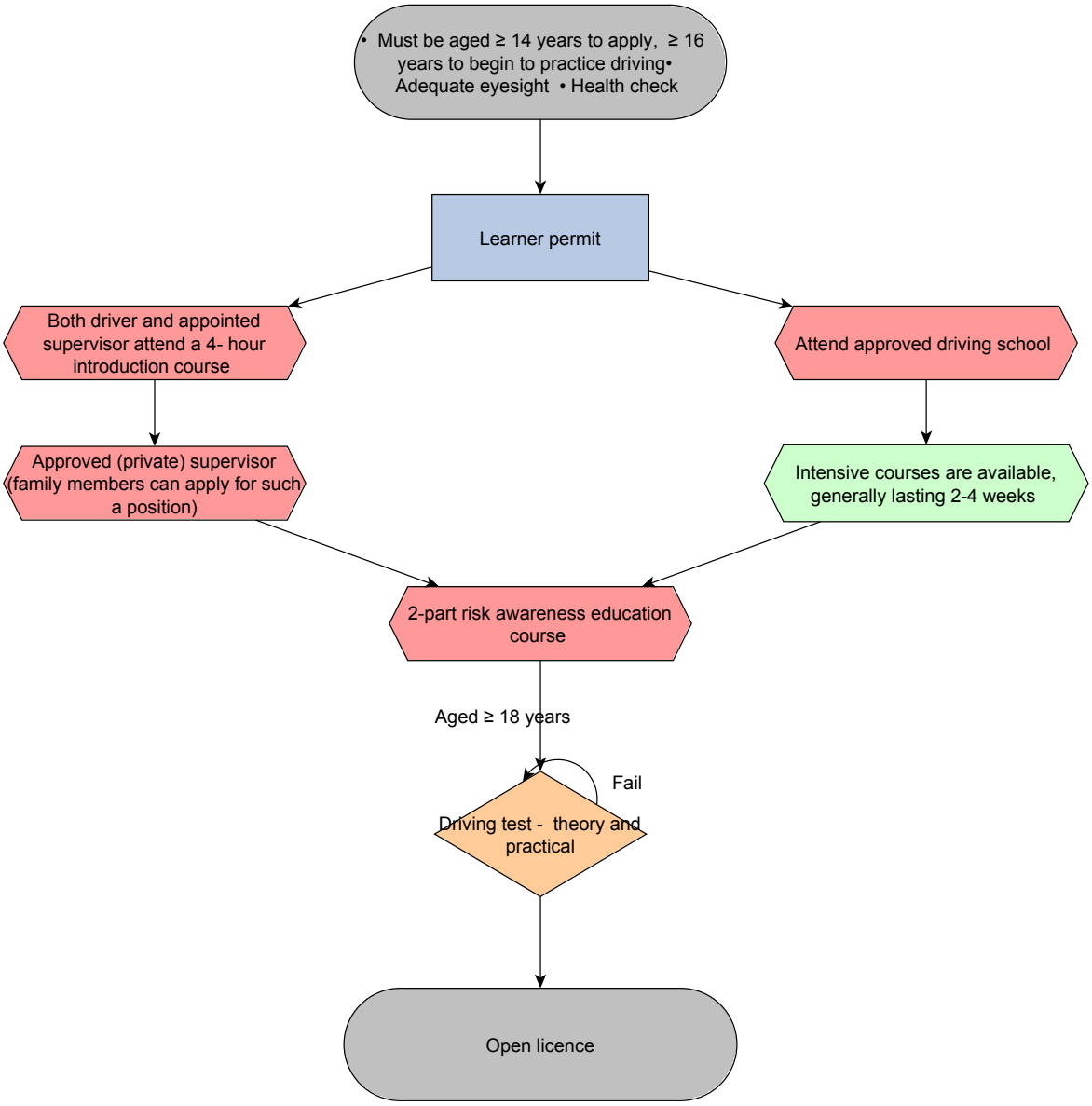
3.4.2 United Kingdom

Key sources:
https://www.gov.uk/browse/driving/learning-to-drive
https://www.gov.uk/pass-plus/how-pass-plus-training-works
https://www.gov.uk/driving-before-you-have-full-licence
https://www.gov.uk/practical-driving-test-for-cars/your-driving-test-result
https://www.gov.uk/driving



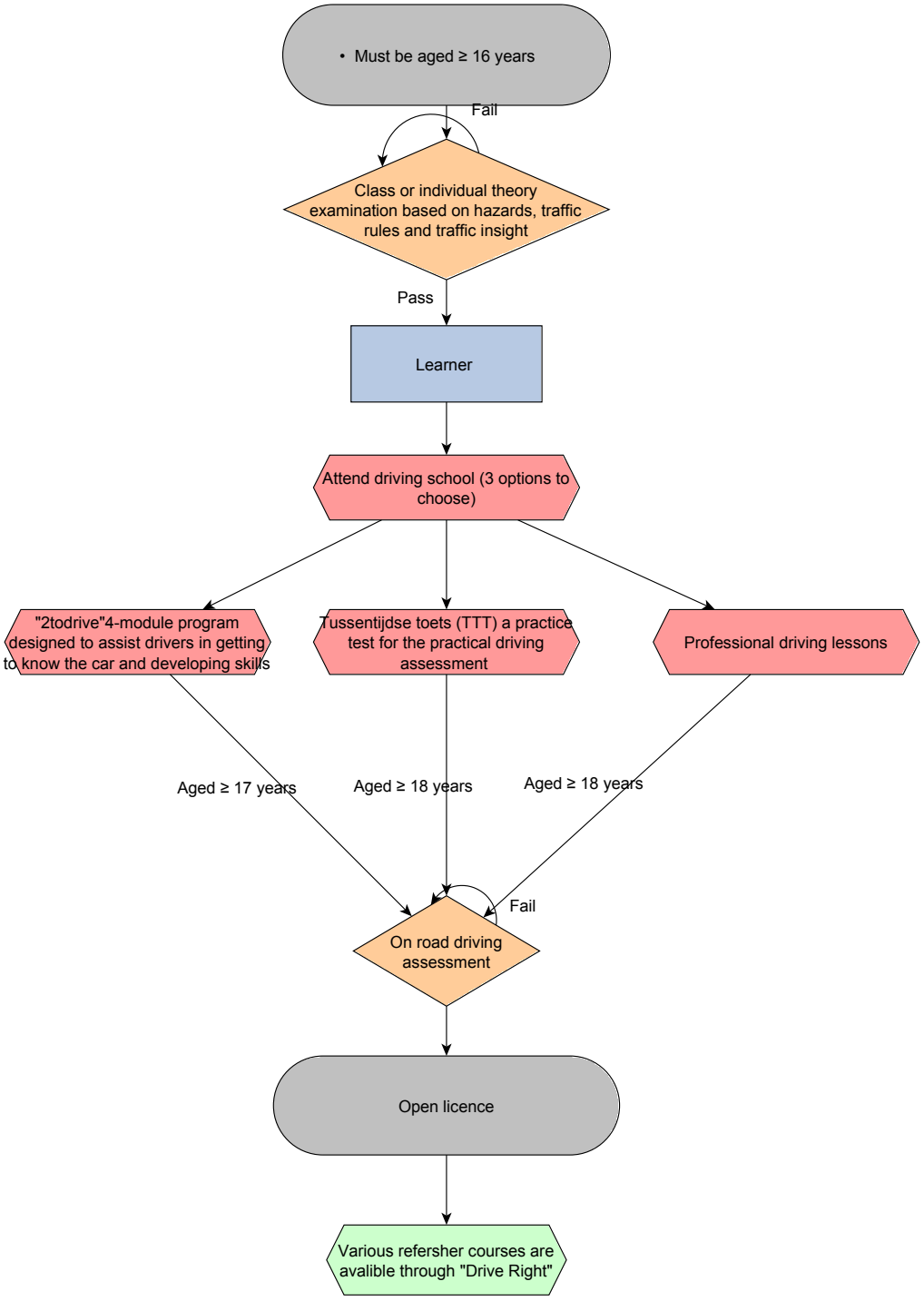
3.4.3 Sweden

Key sources:
http://www.transportstyrelsen.se/en/road/Driving-licences/
http://korkortonline.se/fakta/uppkorning/



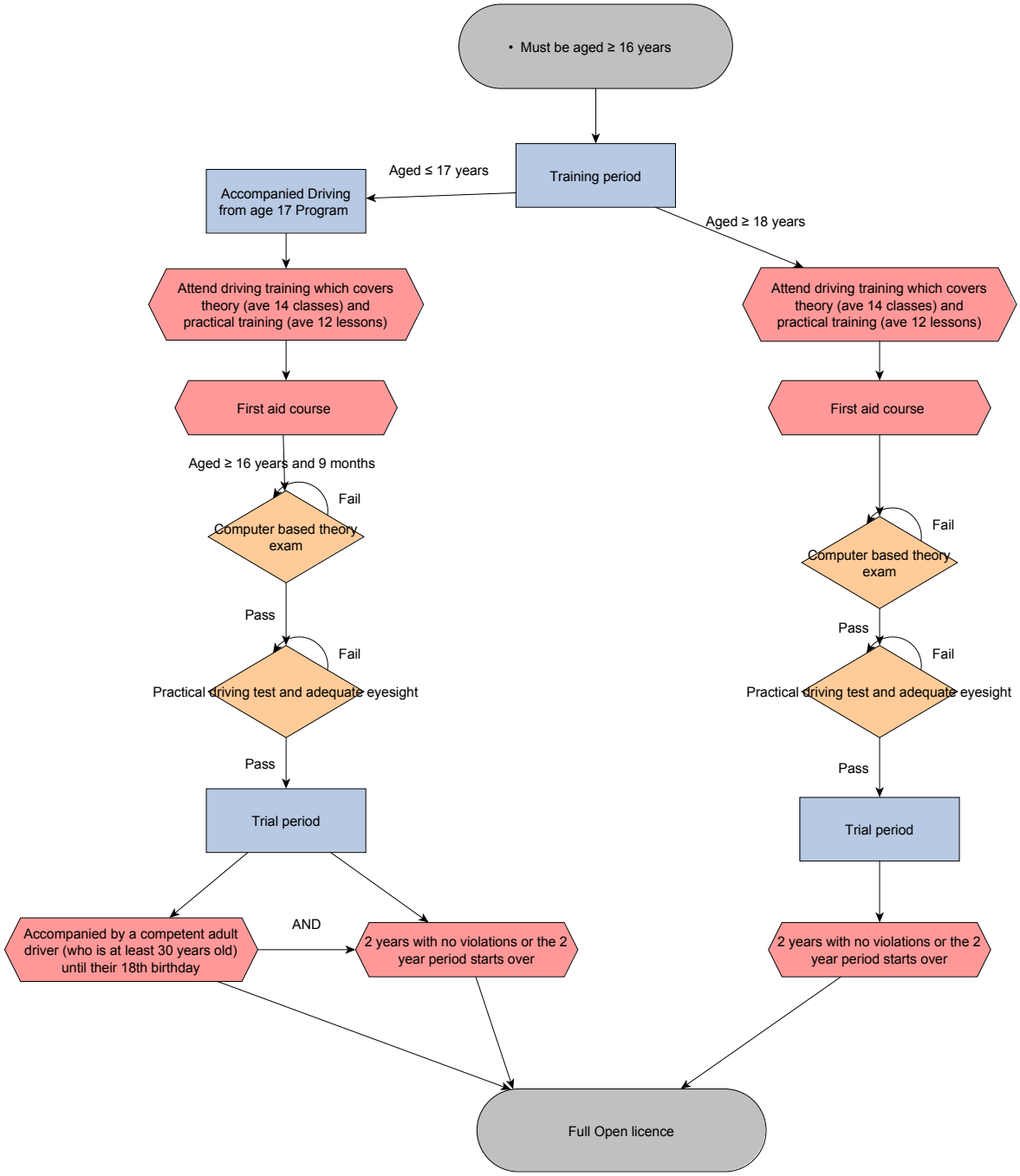
3.4.4 Netherlands

Key sources:
http://www.government.nl/issues/driving-licence/2todrive
http://www.expatica.com/nl/leisure/travel_tourism/how-to-get-a-dutch-drivers-licence-1672_9738.html
http://www.rdw.nl/englishinformation/Paginas/Features-of-the-new-driving-license-model.aspx?path=Portal/English information/Driving license



3.4.5 Germany

Key sources:
http://www.transport-research.info/web/common/fullsearch.cfm?q=probationary
http://www.moving-roadsafety.com/wp-content/uploads/2012/12/Driver-training-and-licence-acquisition-in-Germany-2013.pdf
http://www.bmvbs.de/SharedDocs/EN/Artikel/LA/novice-drivers-and-accompanied-driving-from17-scheme.html -



3.4.6 International rules and additional information

	NZ	UK	NL –difficult to obtain information in English	SE –difficult to obtain information in English	Germany –difficult to obtain information in English
Overview of licences	3 stages • Learner licence • Restricted licence • Full licence	2 stages • Provisional licence • Full licence	2 stages • Learner phase • Full licence	2 stages • Learner permit (supervised driving) • Full licence	2 main phases + transitional certificate (graduated) • Training period (this phase doesn't appear to have an official label) • Transitional 'certificate' – recognised in Germany only (to prevent premature driving abroad) • Official EU licence which includes 2-year 'trial' period
Assessment components	**Restricted practical driving assessment:** 60min test involving 45min driving, 15min for vehicle check and feedback **Full licence driving test assessment:**	**Practical driving assessment:** Eyesight check, vehicle safety questions, and 40 min driving ability assessment (including general driving ability, reversing vehicle safety, and independent driving). Passing results in obtaining full	**Practical driving assessment:** 55 min test of various skills including car control, overtaking, prioritising, driving through intersections and roundabouts etc.	**Private supervisor:** 4-hour introduction course which covers goals of driving, regulation for lessons, traffic safety importance etc **2-part risk awareness education course** must be undertaken prior to the driving test (which encompasses both a 4 hour theory class and a 4 hour group practical class) *Part 1:* Risky behaviour (e.g., alcohol, tiredness, drugs) ("*Riskettan"*) *Part 2:* On-road training about	Must complete **first aid course** ("Instruction in life support") **Learner practical driving assessment:** Eyesight check, 60 minute test involving vehicle check, car handling skills and ability to perform manoeuvres Driver receives 'certificate', valid for 3 months (must hold for min 1 month before receiving official licence)

	NZ	UK	NL –difficult to obtain information in English	SE –difficult to obtain information in English	Germany –difficult to obtain information in English
	30min test involving pre-drive safety check, a series of assessable tasks (e.g., right hand turns), and linking manoeuvres	licence		speed, safety and driving in special conditions, manoeuvres on slippery road ("*Halkbanan"* – slippery road test") It is recommended this 2-part course be undertaken just prior to obtaining full licence and not too early in learner phase **Driving test**: theory and practical test (can be completed on same day). Undertaking practical test is not dependent on successful completion of theory test, although both must be passed in a two-month period or the entire process is repeated ○ Theory test involves 5 sections covering vehicle knowledge/handling, traffic safety, environment, traffic regulations, and personal criteria ○ Practical test involves approx. 25 min test assessing 10/27 items (randomly chosen) that cover four areas of competence: 1) vehicle knowledge and handling, 2) eco-friendly and economic	

	NZ	UK	NL –difficult to obtain information in English	SE –difficult to obtain information in English	Germany –difficult to obtain information in English
				driving, 3) traffic regulations, 4) traffic safety and behaviour	
Training school details	*Voluntary* **advanced driving skills course** (two types: Defensive driving course and "Street Talk" course) which can be undertaken once learner or restricted licence has been obtained - such courses reduce time spent on R)	Intensive courses are available for drivers with P licences, allowing the driver to obtain their full licence in one week	**"*2todrive*"** - can begin driving lessons at age 16½ - similar to Germany's BF17 program re supervised driving Rijopleiding In Stappen (RIS) (Driver Training in Steps) – 4-module program designed to assist drivers in getting to "know" the car and in developing skills prior to taking practical test **Tussentijdse toets (TTT)** (Interim test) – a practice test for the practical driving assessment	**Intensive courses** (costing up to 17,000 SEK) generally lasting 2-4 weeks are available for drivers to speed up the process of obtaining a licence. These involve theory lessons, driving lessons, and completion of all stages of driving licence (although driver may still complete driver test at an external agency if they prefer) (NB not obtained from government website)	At age 16½, drivers can apply for "***Accompanied Driving from age 17 Program – BF17***" - effectively this enables them to obtain their licence at 17 provided they are accompanied by a competent adult driver (who is at least 30 years old) until their 18th birthday
Exemptions	• Drivers with a current car or motorcycl	• Drivers with a car and/or motorcycle licence from a designated	• Drivers who hold a licence from a listed European Union of European Free Trade	• Licences issues in European Economic Area, Switzerland or Japan may be exchanged for a Swedish licence if the driver is a permanent resident.	People whose driving permit was issued in a designated state or country (including Australia) are exempt from undertaking a written and practical road test.

	NZ	UK	NL –difficult to obtain information in English	SE –difficult to obtain information in English	Germany –difficult to obtain information in English
	e licence (or one that has expired within last 12 months) from a recognised country are exempt from sitting theory tests, and practical tests provided the licence has been held for >2 years.	country can exchange their licence for a Great Britain licence up to 5 years after becoming a resident.	Association state (Australia excluded) can use it for 10 years or can exchange it for a Dutch licence. Other drivers excluded from this list must undertake a theory and practical driving test	• Other drivers must undertake driving lessons, hazard training, theory and practical tests	

3.4.7 USA summary

	USA (overview only)
Overview of licensing	3 stages • Learner • Intermediate (provisional) • Full licence (this three-stage process applies to most states, with only a handful of districts lacking the intermediate stage)
Criteria and/or assessment required to obtain Learners	• Must be 16 • Adequate eyesight • Pass knowledge test on road rules, signs and signals
Learners driver training	*Voluntary:* Accredited driving school lessons *Mandatory:* (in many states) parental certification of 30-50 practice hours
Progression	To progress from learner to intermediate licence, driver must be on average 16 (depending on state) and pass the following: • Behind the wheel road test assessing general driving practices and manoeuvring skills (e.g., in Maryland this involves successfully completing a closed-course first followed by a public road test) • Driver education training (involving 3-4 days of program activities that aim to enhance knowledge, skills, safety and competency) - in many states this is *mandatory*, and sometimes lowers the age at which an intermediate licence can be obtained Driver progresses to full licence following completion of previous stage/s, at an age that depends on state
Post licence training	Training depends on state, e.g., safety, performance and custom programs are offered via Bridgestone in Colorado. Other companies such as Advanced Drivers of America offer familiarisation courses (for US visitors), defensive driving courses etc
Exemptions	Holders of car and or rider licence from a recognised country (Australia included) are generally exempt from taking theory and driving tests

Key sources:
http://www.nhtsa.gov/Driving+Safety/Teen+Drivers/Teen+Drivers+-+Graduated+Driver+Licensing
http://www.iihs.org/laws/GraduatedLicenseCompare.aspx

3.4.8 Canada summary

	Canada (overview only)
Overview of licensing	Each province/territory has specific licencing requirements, with most now implementing a graduated driver licencing program: • Learner/instruction/beginner's permit (supervised) • Intermediate/novice (which may involve 2 levels) • Full licence
Criteria to obtain Learners	• Variable ages, beginning at 15½ (dependant on experience e.g., enrolment in driver training course) • Adequate eyesight • Pass knowledge test of road rules and signs
Learners driver training	Ministry approved driver training courses, driver education courses and/or accredited driver lessons *recommended* (some of which may shorten time period required to hold a certain level of licence
Progression	To progress from Learner stage, and after holding L for approximately 12 months, driver completes some form of road test that assesses ability to scan for hazards and perform manoeuvres safely Progressing from Intermediate stage typically involves gaining experience and holding intermediate licence for anywhere up to 24 months (may involve a second, more advanced driving skills test – see Ontario)
Post licence training	None
Exemptions	If original driver's licence is from a designated country (including Australia), drivers may be exempt from undertaking knowledge exam and drivers test (applies to licences for passenger vehicles and motorcycles only)

Key sources:
http://www.youth.gc.ca/eng/life_events/drivers_license.shtml
http://www2.gnb.ca/content/gnb/en/services/services_renderer.200566.html
http://www.ontario.ca/driving-and-roads/get-g-drivers-licence-new-drivers
http://www.servicealberta.gov.ab.ca/Drivers_Licence.cfm

4 Overall conclusion

Young novice drivers are the group of drivers that are most likely to crash. One countermeasure that is used to address this crash risk is driver education and training. Driver education and training can be used either as an individual countermeasure or in conjunction with another countermeasure such as the licensing system.

Novice driver education and training is a vast area with many potential approaches and outcomes. The GDE framework is a useful tool when considering education and training approaches. This framework clearly indicates the need to consider the learning to drive process as more than just the skills to operate the vehicle. While being able to manoeuvre a vehicle and master traffic situations are essential elements for driving, it is also important for young novice drivers to learn about driving goals and context as well as incorporating their goals for life and skills for living.

This literature review considered a range of driver education and training types including professional driving instruction, private supervision, high school driver education, simulator training, PC-based hazard perception training and education, resilience training, procedural skills training, hazard perception education and training, situation awareness training and insight training. The application of the GDE framework to each of these types of education and training clearly indicates that some aspects of the framework are exceedingly well addressed by existing education and training programs. Specifically, many of the existing education and training programs tend to have a strong focus on manoeuvring a vehicle and mastering traffic situations. There are far fewer education and training programs that focus on learning about driving goals and context or goals for life and skills for living. However, there does not need to be one of type of education and training program that addresses all levels of the GDE framework. In some cases, it may be preferable to utilise a range of education and training programs to achieve this.

The jurisdictional comparisons considered a range of licensing systems in places that could be considered comparable to Queensland. They clearly demonstrate the range of pathways available for individuals to obtain a licence. Different pathways within the same jurisdiction may result from the individual's age or various education and training options chosen.

Education and training interacts with licensing systems in diverse ways depending on the jurisdiction. For instance, the Safer Driver Course in NSW provides young learner drivers 20 hours of driving towards their requirement to record 120 hours of driving practice in a log book. In the Australian Capital Territory, drivers who complete the Road Ready Plus course while on a provisional licence do not have to display P-plates. This demonstrates the important influence of the driver licensing system on driver education and training provided to novice drivers. The third report in this program of research will explore this further.

5 References

Abbott, S., & Freeth, R. (2003). From best to worst in six months - “P” off… the spectacular decline of the new driver!

Al-Balbissi, A. (2003). Role of gender in road accidents. *Traffic Injury Prevention, 4*, 64-73.

Allen, R. W., Cook, M. L., & Rosenthal, T. J. (2001). *Low cost PC simultion technology applied to novice driver training*. Paper presented at the First International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design Aspen, Colorado, US.

Allen, R. W., Park, G., & Cook, M. L. (2010). Simulator Fidelity and Validity in a Transfer-of-Training Context. *Transportation Research Record: Journal of the Transportation Research Board, 2185*, 40–47.

Allen, R. W., Park, G., Terrace, S., & Grant, J. (2011, June 27-30). *Detecting Transfer of Training Through Simulator Scenario Design: A Novice Driver Training Study.* Paper presented at the Driving Assessment Conference, Lake Tahoe, CA, US.

Allen, R. W., Park, G. D., Cook, L. K., & Fiorentino, D. (2007, September 12-14). *The Effect of Driving Simulator Fidelity on Training Effectiveness.* Paper presented at the Driving Simulator Conference (DSC) North America, Iowa City, US.

Allen, R. W., Park, G. D., Cook, L. K., Fiorentino, D. D., & Viirre, E. (2004, Sptember 20-24). *The effect of driving simulator fidelity on training effectiveness.* Paper presented at the Human Factors Ergonomics.

Allen, R. W., Park, G. D., Cook, M. L., & Fiorentino, D. (2012). Simulator training of novice drivers: a longitudinal study. *Advances in Transportation Studies: An International Journal B, 27*, 51-68.

Allen, R. W., Park, G. D., & Grant, J. (2011, June 27-30). *Detecting transfer of training through simulator scenario design: A novice driver training study.* Paper presented at the Sixth International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design, Lake Tahoe, CA, US.

Allen, R. W., Rosenthal, T. J., Aponso, B. L., & Park, G. D. (2003, October 8-10). *Scenarios produced by procedural methods for driving research, assessment and training applications.* Paper presented at the Driving Simulator Conference North America Conference, Dearborn, MI, US.

Arnett, J. J. (1994). Sensation seeking: A new conceptualization and a new scale. *Personality and Individual Differences, 16*, 289-296.

Aron, A., & Aron, E. N. (1991). *Statistics for Psychology* (2nd ed.). Upper Saddle River, NJ, US: Prentice Hall.

Bailey, T. (2003). *Differences in teaching approaches among car driving instructors*. Paper presented at the Australasian Road Safety, Policing, and Education Conference, Sydney, NSW, Australia.

Baker, S. P., Chen, L-H., & Li, G. (2006). *National Evaluation of Graduated Driver Licensing Programs.* (Report No. DOT HS 810 614). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/people/injury/NewDriver/GDLReport/images/GDLReport.pd

Bartl, G., Baughan, C., Fougere, J.-P., Gregersen, N. P., Nyberg, A., Groot, H. A. M., . . . Willmes-Lenz, G. (2002). The EU ADVANCED project: Description and analysis of post-licence driver and rider training. Final Report. Rijswijk, The Netherlands: Commission Internationale des Examens de Conduite Automobile CIECA.

Bates, L., Watson, B., & King, M. (2006). *Competing or Complementing: Driver Education and Graduated Driver Licensing.* Paper presented at the Road Safety Research, Policing and Education Conference, Gold Coast.

Bates, L., Watson, B., & King, M. (2008a, September). *The structure of the learner licence affects the type of experiences novices gain during this phase: Examples from Queensland and New South Wales.* Paper presented at the Motivating behaviour change among high risk road users: What works and what doesn't work?, Brisbane, Queensland.

Bates, L., Watson, B., & King, M. (2008b). The structure of the learner licence affects the type of experiences novices gain during this phase: Examples from Queensland and New South Wales. *Journal of the Australasian College of Road Safety, 19*(4), 36-42.

Bates, L., Watson, B., & King, M. (2009). Factors influencing learner driver experiences. Canberra: Department of Infrastructure, Transport, Regional Development and Local Government.

Bates, L., Watson, B., & King, M. (2009). Driving and licensing experiences of learner drivers in two Australian states prior to changes in the licensing laws. *Journal of the Australasian College of Road Safety, 20*(3), 51-55.

Bates, L., Watson, B., & King, M. (2010a). Mobility and safety are conflicting goals for transport policy makers when making decisions about graduated driver licensing. *International Journal of Health Promotion and Education, 48*(2), 46-51.

Bates, L., Watson, B., & King, M. (2010b). Required hours of practice for learner drivers: A comparison between two Australian jurisdictions. *Journal of Safety Research, 41*, 93-97.

Bates, L. (2012). *The experiences of learner drivers, provisional drivers and supervisors with graduated driver licensing in two Australian jurisdictions.* (PhD), Queensland Univesity of Technology, Brisbane, QLD, Australia.

Bates, L., Watson, B., & King, M. (2013, August 28-30). *Mothers Vs Fathers As Learner Driver Supervisors: Time Commitment, Driving Activities And Perceptions Of Risk.* Paper presented at the 2013 Australasian Road Safety Research, Policing & Education Conference, Brisbane, QLD, Australia.

Bates, L., Watson, B., & King, M. (2014a). Parental perceptions of the learner driver log book system in two Australian states. *Traffic Injury Prevention*, *15*(8), 809-16.

Bates, L., Watson, B., & King, M. (2014b). The role of parents and non-parents in the supervision of learner drivers in Australia. *Accident Analysis & Prevention*, *70*, 40-45.

Beanland, V., Goode, N., Salmon, P., & Lenne, M. G. (2013). Is there a case for driver training? A review of the efficacy of pre- and post-licence driver training. *Safety Science, 51*, 127-137.

Beanland, V., Goode, N., Salmon, P. M., & Lenné, M. G. (2011). The Efficacy of Advanced Driver Training: A Targeted Literature Review. Melbourne, VIC, Australia: Curtin–Monash Accident Research Centre.

Begg, D. J., Langley, J. D., & Stephenson, S. (2003). Identifying factors that predict persistent driving after drinking, unsafe driving after drinking and driving after using cannabis among young adults. *Accident Analysis & Prevention, 35*(5), 669-675.

Begg D, & Stephenson S.(2003). Graduated driver licensing: the New Zealand experience. *Journal of Safety Research,34*(1),99-105.

Begg, D. J., Stephenson, S., Alsop, J., & Langley, J. (2001). Impact of graduated driver licensing restrictions on crashes involving young drivers in New Zealand. *Injury Prevention, 7*(4), 292-297.

Berg, H. (2006). Reducing crashes and injuries among young drivers: what kind of prevention should we be focusing on? *Injury Prevention, 12*(suppl_1), i15-18.

Bingham, C. R., & Hockanson, H. M. (2008). M-CASTL 2008 synthesis report: Volume 2, teen driver safety. Michigan, US: Michigan Department of Community Health, Injury and Violence Prevention Section.

Boufous, S., Ivers, R., Senserrick, T. M., Stevenson, M., Norton, R., & Williamson, A. (2010). Accuracy of self-report of on-road crashes and traffic offences in a cohort of young drivers: the DRIVE study. *Injury Prevention, 16*, 275-277.

Braunstein, R., Nordyke, S. A., Benson, N., & Peterson, D. (2011). Evaluation of driver education in South Dakota. South Dakota: Government Research Bureau, University of South Dakota.

Brezillon, J., & Tijus, C. (2007, September 12-14). *New representation of GADGET's matrix for a driver typology.* Paper presented at the Driving Simulator Conference (DSC), Iowa City, US.

Brookland, R., Begg, D., Langley, J., & Ameratunga, S. (2008, 9-12 November). *Parent and adolescent risky driving behaviours: New Zealand Drivers Study.* Paper presented at the Australasian Road Safety Research, Policing and Education Conference, Adelaide, SA, Australia.

Caird, J. K., & Horrey, W. J. (2011). *Twelve practical and useful questions about driving simulation.* Published in: Fisher, D. L., Rizzo, M., Caird, J., & Lee, J. D. (Eds.). (2011). *Handbook of driving simulation for engineering, medicine, and psychology*. CRC Press.

Cantwell, S. J., Isler, R. B., & Starkey, N. J. (2013, 28-30 August). *The effects of road commentary training on novice drivers' visual search behaviour: A preliminary investigation* Paper presented at the Road Safety Research, Policing and Education Conference, Brisbane, QLD, Australia.

Carpentier, A., Wang, W., Jongen, E. M. M., Hermans, E., & Brijs, T. (2012, January 22-26). *Training hazard perception of young novice drivers - A driving simulator study.* Paper presented at the Transport Research Board (TRB) Annual Meeting Washington, DC, US.

Carpentier, A., Wang, W., Jongen, E. M. M., Hermans, E., & Brijs, T. (2013, January 13-17). *Training hazard perception of young novice drivers - a driving simulator study* Paper presented at the 92nd Annual Meeting of the Transportation Research Board, Washington DC, US.

Carstensen, G. (2002). The effect on accident risk of a change in driver education in Denmark. *Accident Analysis and Prevention, 34*, 111-121.

Cazzulino, F., Burke, R., Muller, V., Arbogast, H., & Upperman, J. (in press). Cell phones and young drivers: a systematic review regarding the association between psychological factors and prevention. *Traffic Injury Prevention*. doi: 10.1080/15389588.2013.822075

Chapman, R., Buckley, L., & Sheehan, M. (2009, 10-12 November). *The potential for a web based intervention to improve young adult passenger safety.* Paper presented at the 2009 Australasian Road Safety Research, Policing and Education Conference, Sydney, Australia.

Chapman, R., Buckley, L., & Sheehan, M. (2012). Developing safer passengers through a school-based injury prevention program. *Safety Science, 50*(9), 1857-1861.

Choy, S. C., & Delahaye, B. (2007). Attending to a new 'species' of learners: Principles for facilitating youth learning. *Quest, 7*, 6-9.

Christie, R. (2001, August 23-24). *The effectiveness of driver training as a road safety measure: An international review of the literature.* Paper presented at the Road Safety Research, Policing and Education Conference, Adelaide, SA, Australia.

Crundall, D., Andrews, B., van Loon, E., & Chapman, P. (2010). Commentary training improves responsiveness to hazards in a driving simulator. *Accident Analysis and Prevention, 42*, 2117–2124.

Curry, A., Mirman, J., Kallan, M., Winston, F. K., & Durbin, D. (2012). Peer Passengers: How Do They Affect Teen Crashes? *Journal of Adolescent Health, 50*, 588–594.

Davis, C. S. (1990). The DeKalb County, Georgia, Driver Education Demonstration Project: Analysis of its Longer Term Effect. Iowa City, IA, US: University of Iowa, Department of Preventive Medicine.

de Winter, J. C. F., de Groot, S., Mulder, M., Wieringa, P. A., Dankelman, J., & Mulder, J. A. (2009). Relationships between driving simulator performance and driving test results. *Ergonomics, 52*(2), 137-153.

de Winter, J. C. F., Wieringa, P. A., Dankelman, J., Mulder, M., van Paassen, M. M., & de Groot, S. (2007, June 20-22). *Driving simulator fidelity and training effectiveness.* Paper presented at the 26th European Annual Conference on Human Decision Making and Manual Control, Lyngby, Denmark.

Deery, H. A., & Fildes, B. N. (1999). Young novice driver subtypes: relationship to high-risk behavior, traffic accident record, and simulator driving performance. *Human Factors, 41*, 628–643.

Delahaye, B. L. (2005). *Human resource development: Adult learning and knowledge management* (2nd ed.). Brisbane: QLD, Australia: Wiley & Sons.

Dorn, L., & Barker, D. (2005). The effects of driver training on simulated driving performance. *Accident Analysis & Prevention, 37*, 63-69.

Elvik, R. (2010). Why some road safety problems are more difficult to solve than others. *Accident Analysis & Prevention, 42*, 1089-1096.

Engstrom, H., Gregersen, N. P., Hernetkoski, K., Keskinen, E., & Nyberg, A. (2003). Young Novice Driver Education and Training, Literature review, VTI Report 491A. Linköping, Sweden: Swedish National Road and Transport Research Institute.

Faulks, I., Irwin, J., & Morphett, A. (2010). *Enhanced training and structured lesson planning for young drivers in New South Wales*. Paper presented at the 2010 Australasian Road Safety Research, Policing and Education Conference, Canberra, Australia.

Fisher, D. L. (2008). Evaluation of PC-based novice drivr risk awareness. Washington, DC, US: National Highway Traffic Safety Administration.

Fisher, D. L., Laurie, N. E., Glaer, R., Connerney, K., Pollatsek, A., Duffy, S. A., & Brock, J. (2002). Use of a Fixed-Base Driving Simulator to Evaluate the Effects of Experience and PC-Based Risk Awareness Training on Drivers' Decisions. *Human Factors, 44*(2), 287-302.

Fisher, D. L., Narayanaan, V., Pradhan, A. K., & Pollatsek, A. (2004, September 20-24). *Using eye movements in driving simulators to evaluate effects of PC-based risk awareness training.* Paper presented at the The Human Factors and Ergonomics Society 48th Annual Meeting.

Fisher, D. L., Pollatsek, A. P., & Pradhan, A. K. (2006). Can novice drivers be trained to scan for information that will reduce their likelihood of a crash? *Injury Prevention, 12*(Supplement 1), i25-29.

Foss, R. (2007). Improving graduated driver licensing systems: A conceptual approach and its implications. *Journal of Safety Research, 38*(2), 185-192.

Foss, R., Masten, S. V., Goodwin, A., & O'Brien, N. (2012). The role of supervised driving requirements in graduated driver licensing programs. Washington, DC, US: National Highway Traffic Safety Administration.

Funk, W. (2012). Accompanied Driving from Age 17 – A new scheme for young novice drivers in Germany I Driver Bheaviour and Training. In L. Dorn (Ed.), *Human Factors in Road and Rail Transport* (pp. 25-37). Surrey, UK: Ashgate Publishing.

Goodwin, A., Kirley, B., Sandt, L., Hall, W., Thomas, L., O'Brien, N., & Summerlin, D. (2013). *Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices, 2013* (No. DOT HS 811 727).

Goodwin, A. H., Foss, R., Margolis, L. H., & Waller, M. (2010). Parents, teens and the learner stage of graduated driver licensing. Washington, DC, US: AAA Foundation for Traffic Safety.

Gregersen, N. P. (1994). Systematic cooperation between driving schools and parents in driver education, an experiment. *Accident Analysis and Prevention, 26*(4), 453-461.

Gregersen, N. P. (1996). Young drivers' overestimation of their own skill - An experiment on the relation between training strategy and skill. *Accident Analysis and Prevention, 28*(2), 243-250.

Gregersen, N. P. (1997). Evaluation of 16-years Age Limit for Driver Training. Sweden: Swedish National Road and Transport Research Institute.

Gregersen, N. P., Berg, H.-Y., Engstrom, I., Nolen, S., Nyberg, A., & Rimmo, P. A. (2000). Sixteen years age limit for learner drivers in Sweden - An evaluation of safety effects. *Accident Analysis and Prevention, 32*, 25-35.

Gregersen, N. P., & Bjurulf, P. (1996). Young novice drivers: Towards a model of their accident involvement. *Accident Analysis and Prevention, 28*(2), 229-241.

Gregersen, N. P., Nyberg, A., & Berg, H.-Y. (2003). Accident involvement among learner drivers - An analysis of the consequences of supervised practice. *Accident Analysis and Prevention, 35*, 725-730.

Groeger, J. A., & Brady, S. J. (2004). Differential effects of formal and informal driver training, Road Safety Research Report No. 42. UK: Department for Transport.

Harmsen, A., Allen, R. W., Rosenthal, T. J., Aponso, B. L., & Markham, S. (2002, August 27-30). *A PC system for measuring driver behavior* Paper presented at the Measuring Behavior 2002 , 4th International Conference on Methods and Techniques in Behavioral Research, Amsterdam, The Netherlands.

Harrison, W. A. (2004). Investigation of the driving experience of a sample of Victorian learner drivers. *Accident Analysis and Prevention, 36*, 885-891.

Hatakka, M., Keskinen, C., Baughan, C., Goldenbeld, N. P., Gregersen, H., Groot, S., . . . Winkelbauer, M. (2003). BASIC – Driver Training: New Models, Final Report. Finland: University of Turku.

Hatakka, M., Keskinen, E., Gregersen, N. P., Glad, A., & Hernetkoski, K. (2002). From control of the vehicle to personal self-control: Broadening the perspectives to driver education. *Transportation Research Part F: Traffic Psychology and Behaviour, 5*(3), 201-215.

Haworth, N., Kowadlo, N., & Tingvall, C. (2000). Evaluation of pre-driver education program. Melbourne: Monash University Accident Research Centre.

Helman, S. (2008). Situational judgement in driver training and assessment: a literature review. Report PPR312. UK Transport Research Laboratory.

Hirsch, P., Maag, U., & Laberge-Nadeau, C. (2006). The role of driver education in the licensing process in Quebec. *Traffic Injury Prevention, 7*, 130-142.

Hoeschen, A., Verwey, W., Bekiaris, e., Knoll, C., Widlroither, H., de Ward, D., . . . Schelin, H. (2001). Trainer: System for driver Training and Assessment using Interactive Evaluation tools and Reliable methodologies. Brussels, Belgium: European Commission Competitive and Sustainable Growth Programme Directorate General for Energy and Transport.

Isler, R. B., & Starkey, N. M. (2011, November 6-9). *Free Online Training in Hazard Perception and Risk Management for Learner Drivers in New Zealand.* Paper presented at the Australasian Road Safety Research, Policing and Education, Perth, WA, Australia.

Isler, R. B., & Starkey, N. J. (2012, October 4-6). *Driver Education and Training as evidence-based road safety, interventions paper.* Paper presented at the Australasian Road Safety Research, Policing and Education Conference, Wellington, New Zealand.

Isler, R. B., Starkey, N. J., & Sheppard, P. (2011). Effects of higher-order driving skilltraining on young, inexperienced drivers' on-road driving performance. *Accident; analysis and prevention, 43*, 1818–1827.

Isler, R. B., Starkey, N. J., & Williamson, A. (2009). Video-based road commentary training improves hazard perception of young drivers in a dual task. *Accident Analysis and Prevention, 41*, 445-452.

Ivers, R., Senserrick, T. M., Boufous, S., Stevenson, M., Chen, H.-Y., & Woodward, M. (2009). Novice drivers' risky driving behavior, risk perception and crash risk: Findings from the DRIVE study. *American Journal of Public Health, 99*(9), 1638-1644.

Jonah, B. (1997). Sensation seeking and risky driving: A review and synthesis of the literature. *Accident Analysis & Prevention, 29*(5), 651-665.

Jonah, B., Thiessen, R., & Au-Yeung, E. (2001). Sensation seeking, risky driving and behavioral adaptation. *Accident Analysis & Prevention, 33*(5), 679-684.

Kappe, B., & van Emmerik, M. (2005). The use of driving simulators for initial driver training and testing. Mogelijkheden van rijsimulatoren in de rijopleiding en het rijexamen. Soesterberg: TNO Defensie en Veiligheid [Management summary in English].

Kappé, B., van Emmerik, M., van Winsum, W., & Rozendom, A. (2003, October 8-10). *Virtual instruction in driving simulators.* Paper presented at the Driving Simulator Conference: North America, Dearborn, Michigan, US.

Kelly, M. J. (2005). Effects of Defensive Vehicle Handling Training on Novice DriverSafety: Phase 1. Preparation for Advanced Driver Training. Bozeman, MT, US: WesternTransportation Institute.

Keskinen, E., Hatakka, M., Katila, A., Laapotti, S., & Peraaho, M. (1999). Driver training in Finland. *IATSS Research, 23*(1), 78-84.

King, K., Vidourek, R., Love, J., Wegley, S., & Alles-White, M. (2008). Teaching adolescents safe driving and passenger behaviours: Effectiveness of the *You Hold the Key* teen driving countermeasure. *Journal of Safety Research, 39*, 19-24.

Knight, P., Iverson, D., & Harris, M. (2012). Early driving experience and influence on risk perception in young rural people. *Accident Analysis & Prevention, 45*, 775-781.

Lam, L. T., Norton, R., Woodward, M., Connor, J., & Ameratunga, S. (2003). Passenger carriage and car crash injury: A comparison between younger and older drivers. *Journal of Safety Research, 35*, 861-867.

Langford, J. (2002). Using the research to reduce novice driver crashes *Proceedings of the Developing Safer Drivers and Riders Conference*. Brisbane: ACRS and Travelsafe Committee.

Lewis-Evans, B. (2006). An examination of what the currently available data can tell us about the effects on offence and crash history of two driver education programs. Adelaide, SA: Centre for Automotive Safety Research: University of Adelaide.

Lewis-Evans, B. (2010). Crash involvement during the different phases of the New Zealand Graduated Driver Licensing System (GDLS). *Journal of Safety Research, 41*, 359-365.

Lidestam, B., Lundqvist, A., & Ronnberg, J. (2010). Concepts from research literature and practical assessment of risk awareness: The Swedish driving test from the perspective of cognitive psychology. *Transportation Research Part F - Traffic psychology and behaviour, 13*(6), 409-425. doi: http://dx.doi.org/10.1016/j.trf.2010.06.004

Liu, C. C., Lenne, M. G., & Williamson, A. R. (2009). Development and evaluation of a young driver training program. Melbourne, VIC, Australia: Monash University Accident Research Centre.

Lonero, L. P. (2008). Trends in Driver Education and Training. *American Journal of Preventive Medicine, 35*(3, Supplement 1), S316-S323.

Lonero, L. P., & Clinton, K. M. (2006). Evaluating Driver Education Programs. Washington: Foundation for Traffic Safety.

Lonero, L. P., & Mayhew, D. (2010). Large-Scale Evaluation of Driver Education: Review of the Literature on Driver Education Evaluation. Washington: AAA Foundation for Traffic Safety.

Lund, A., Williams, A., & Zador, P. (1986). High school driver education: Further evaluation of the DeKalb County study. *Accident Analysis & Prevention, 18*(349-357).

Lyon, J. D., Pan, R., & Li, J. (2012). National evaluation of the effect of graduated licensing laws on teenager fatality and injury crashes. *Journal of Safety Research*, *43*, 29-37.

Malik, H., Rakotonirainy, A., Larue, G., & Maire, F. D. (2011, 6-8 June). *How consistent are drivers in their driving? A driver training perspective.* Paper presented at the 17th International Conference on Urban Transport and Environment, Pisa, Italy.

Mann, H. N., & Lansdown, T. (2009). Pre-driving adolescent attitudes: Can they change? *Transportation Research Part F, 12*, 395-403.

Marcotte, T., Bekman, N., Meyer, R., & Brown, S. (2012). High-Risk Driving Behaviors among Adolescent Binge Drinkers. *The American Journal of Drug and Alcohol Abuse, 38*(4), 322-327.

Mayhew, D. (2003). The learner's permit. *Journal of Safety Research, 34*, 35-43.

Mayhew, D., Simpson, H. M., & Pak, A. (2003). Changes in collision rates among novice drivers during the first months of driving. *Accident Analysis & Prevention, 35*(5), 683-691.

Mayhew, D., Simpson, H. M., & Singhal, D. (2005). Best practices for graduated driver licensing in Canada. Ottawa, ON, Canada: Traffic Injury Research Foundation.

McCartt, A., Shabanova, V. I., & Leaf, W. A. (2003). Driving experience, crashes and traffic citations of teenage beginning drivers. *Accident Analysis and Prevention, 35*, 311-320.

McCartt, A., Teoh, E. R., Fields, M., Braitman, K. A., & Hellinga, L. A. (2010). Graduated Licensing Laws and Fatal Crashes of Teenage Drivers: A National Study. *Traffic Injury Prevention, 11*(3), 240-248.

McKenna, F. P., Alexander, J. L., & Horswill, M. S. (2006). Does anticipation training affect drivers' risk taking? *Journal of Experimental Psychology – Applied, 12*(1), 1-10.

Molina, J. G., Sanmartin, J., & Keskinen, E. (2013). Driver training interests of a Spanish sample of young drivers and its relationship with their self-assessment skills concerning risky driving behavior. *Accident Analysis & Prevention, 52*, 118-124.

Naylor, B. (2010). L-Plates, Logbooks and Losing-out: Regulating for safety - or creating new criminals? *Alternative Law Journal, 35*(2), 94-98.

Nemme, H., & White, K. (2010). Texting while driving: Psychosocial influences on young people's texting intentions and behaviour. *Accident Analysis & Prevention, 42*, 1257-1265.

Newstead, S., & Scully, M. (2013, August 28-30). *Crash effects of the new Queensland Graduated Licensing System: A preliminary evaluation.* Paper presented at the Australasian Road Safety Research, Policing & Education Conference, Brisbane, QLD, Australia.

Nyberg, A. (2007). *The Potential of Driver Education to Reduce Traffic Crashes Involving Young Drivers.* (Medical Dissertation), Linköping University Sweden.

Nyberg, A., & Engstrom, I. (1999). "Insight" - An evaluation. Sweden: VTI Report

Nyberg, A., Gregersen, N. P., & Wiklund, M. (2007). Practicing in relation to the outcome of the driving test. *Accident Analysis & Prevention, 39*, 159-168.

O'Brien, N., Foss, R., Goodwin, A., & Masten, S. V. (2013). Supervised hours requirements in graduated driver licensing: Effectiveness and parental awareness. *Accident Analysis & Prevention, 50*, 330-335.

OECD/ECMT. (2006). Young drivers: The road to safety: Report prepared by the Joint Transport Research Centre, ISBN 92-821-1334-5.

Park, G. D., Allen, R. W., Rosenthal, T. J., & Fiorentino, D. (2005, Septermber 26-30). *Training effectiveness: How does driving simulator fidelity influence driver performance?* Paper presented at the Human Factors and Ergonomics Socieity 49th Annual Meeting, Orlando, Florida, US.

Peck, R. (2011). Do driver training programs reduce crashes and traffic violations? A critical examination of the literature. *IATSS Research, 34*(2), 63-71.

Petersen, A., & Barrett, R. (2009). Postural stability and vehicle kinematics during anevasive lane change manoeuvre: a driver training study. *Ergonomics, 52*, 560–568.

Petersen, A., Barrett, R., & Morrison, S. (2006). Driver-training and emergencybrake performance in cars with antilock braking systems. *Safety Science, 44*, 905–917.

Petersen, A., Barrett, R., & Morrison, S. (2008). Enhanced postural stability followingdriver training is associated with positive effects in vehicle kinematics duringcornering. *Human Factors, 50*, 159–172.

Petzoldt, T., Weiss, T., Franke, T., Krems, J., & Bannert, M. (2013). Can driver education be improved by computer based training of cognitive skills? *Accident Analysis and Prevention*(50), 1185-1192. doi: dx.doi.org/10.1016/j.aap.2012.09.016

Petzoldt, T., Weiss, T., Krems, J., & Bannert, M. (2013, July 17-20). *The development of a cognitive skills training to support driver education - comparing performance of experienced and trained learner drivers.* Paper presented at the Seventh International Driving Symposium on Human Factors in Driver Assessment, Training, and Vehicle Design, New York, US.

Pollatsek, A., Fisher, D. L., & Pradhan, A. K. (2006). Identifying and Remedying Failures of Selective Attention in Younger Drivers. *Current Directions in Psychological Science, 5*(5), 255-259.

Pradhan, A. K., Fisher, D. L., & Pollatsek, A. (2005, August 14-17). *The effects of PC-based training on novice drivers' risk awareness in a driving simulator.* Paper presented at the The third International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design, Aspen, Collorado, US.

Pradhan, A. K., Pollatsek, A., & Fisher, D. L. (2007). Comparison of Trained and Untrained Novice Drivers' Gaze Behavior in Risky and Non-Risky Scenarios *Proceedings of the Fourth International Driving Symposium on Human Factors in Driver Assessment, Training, and Vehicle Design* (pp. 328-334). Iowa City, US: University of Iowa Press.

Prato, C., Toledo, T., Lotan, T., & Taubman-Ben-Ari, O. (2010). Modeling the behavior of novice young drivers during the first year after licensure. *Accident Analysis & Prevention, 42*, 480-486.

Preusser, D., Ferguson, S. A., & Williams, A. (1998). The effect of teenage passengers on the fatal crash risk of teenage drivers. *Accident Analysis and Prevention, 30*(2), 217-222.

Roelofs, E., Vissers, J., van Onna, M., & Kern, G. (2012). Coaching Young Drivers in a Second Phase Training Programme Driver Behaviour and Training,: Human Factors in Road and Rail Transport. In L. Dorn (Ed.), (pp. 3-24). Surrey, UK: Ashgate Publishing.

Roenker, D., Cissell, G., Ball, K., Wadley, V., & Edwards, J. (2003). Speed-of-Processing and Driving Simulator Training Result in Improved Driving Performance. *Human Factors: The Journal of the Human Factors and Ergonomics Society, 45*(2), 218-233. doi: 10.1518/hfes.45.2.218.27241

Rowden, P. (2012). *Development and Formative Evaluation of a Motorcycle Rider Training Intervention to Address Risk Taking* (PhD), Queensland University of Technology, Brisbane, QLD, Australia.

Sagberg, F., & Bjornskau, T. (2006). Hazard perception and driving experience among novice drivers. *Accident Analysis & Prevention, 38*, 407-414.

Sagberg, F., & Bjørnskau, T. (2003). Uerfaren bak rattet. Hva forklarer nye føreres ulykkesreduksjon de første månedene med førerkort? (Inexperienced at the wheel. Errors, driving behaviour, and hazard perception among novice drivers). Oslo, Norway: The Institute of Transport Economics.

Sanders, N., & Keskinen, E. (2004). EU NovEV project; Evaluation of post-licence training schemes for novice drivers. Final Report. Rijswijk, The Netherlands: International Commission of Driver Testing Authorities CIECA.

Scott-Parker, B., Bates, L., Watson, B., King, M., & Hyde, M. (2011). The impact of changes to the graduated driver licensing program in Queensland, Australia on the experiences of learner drivers. *Accident Analysis & Prevention, 43*, 1301-1308.

Scott-Parker, B., Watson, B., King, M., & Hyde, M. (2012). ‘‘They’re lunatics on the road’’: Exploring the normative influences of parents, friends, and police on young novices’ risky driving decisions. *Safety Science, 50*, 1917-1928.

Scott-Parker, B., Hyde, M., Watson, B., & King, M. (2013). Speeding by young novice drivers: What can personal characteristics and psychosocial theory add to our understanding? *Accident Analysis and Prevention, 50*, 242-250.

Senserrick, T., Ivers, R., Boufous, S., Chen, H.-Y., Norton, R., Stevenson, M., . . . Zask, A. (2009). Young driver education programs that build resilience have potential to reduce road crashes. *Pediatrics, 124*, 1287-1292.

Senserrick, T., & Swinburne, G. C. (2001). Evaluation of an Insight Driver-Training Program for Young Drivers. Melbourne, VIC, Australia: Monash University Accident Research Centre.

Schade, F.D & Heinzmann, H.J. (2013). Summative Evaluation of “Accompanied Driving from Age 17”, German Federal Motor Transport Authority, http://bast.opus.hbz-nrw.de/volltexte/2013/621/pdf/M218b_en.pdf.

Simons-Morton, B. (2007). Parent involvement in novice teen driving: Rationale, evidence of effects, and potential for enhancing graduated driver licensing effectiveness. *Journal of Safety Research, 38*(2), 193-202.

Simons-Morton, B., & Ouimet, M. C. (2006). Parent involvement in novice teen driving: a review of the literature. *Injury Prevention, 12*(Supplement 1), i30-i37.

Solomon, G., King, M., & Moore, R. (2006). *Queensland young driver community engagement process.* Paper presented at the 2006 Australasian Road Safety Research, Policing and Education Conference, Surfers Paradise, Australia

Stanley, L. M., & Mueller, J. (2010). Effects of defensive vehicle handling training on novice driver safety: Phase 3. Data analysis and results.

Stanton, N. A., Walker, G. H., Young, M. S., Kazi, T., & Salmon, P. M. (2007). Changing drivers' minds: the evaluation of an advanced driver coaching system. *Ergonomics, 50(8), 50*(8), 1209-1234.

SWOV Fact sheet. (2012). Young novice drivers (pp. 1-8). Leidschendam, the Netherlands: SWOV, Institute for Road Safety Research.

Taubman-Ben-Ari, O. (2011). The contribution of perceived parental and familial characteristics to attitudes toward accompanied driving among young drivers. *Accident Analysis & Prevention, 43*(1720-1729).

Thomas, F. D., Blomberg, R. D., & Fisher, D. L. (2008). On developing a new generation of driver education (pp. 1–79). Washington, DC, US: National Highway Traffic Safety Administration.

Thomas, F. D., Blomberg, R. D., & Fisher, D. L. (2012). A fresh look at driver education in America. Washington, DC: National Highway Traffic Safety Administration (NHTSA).

Thomas, F. D., Pollatsek, S., Pradhan, A. K., Divekar, G., Blomberg, R. D., Reagan, I., & Fisher, D. (2011a). Field and simulator evaluations of a PC-based attention maintenance training program. Washington, DC: National Highway Traffic Safety Administration (NHTSA).

Thomas, F. D., Pollatsek, S., Pradhan, A. K., Divekar, G., Blomberg, R. D., Reagan, I., & Fisher, D. (2011b). TRAINER: System for driver Training and Assessment using Interactive Evaluation tools and Reliable methodologies: Deliverable No 2.1:Inventory of driver training needs and major gaps in the relevant training procedures. Belguim: European Commission Competitive and Sustainable Growth Programme: Directorate General for Energy and Transport.

Tronsmoen, T. (2010). Associations between driver training, determinants of risky behaviour and crash involvement. *Safety Science, 48*, 35-45.

Underwood, G., Crundall, D., & Chapman, P. (2011). Driving simulator validation with hazard perception. *Transportation Research Part F - Traffic psychology and behaviour, 14*(6), 435-446.

Vaa, T., Fyhri, A., & Sorensen, M. W. J. (2012). Traffic education in Denmark: from cradle to wheel (Vol. Report 1232/ 2012). Norway: TOI: Institute of Transport Economics, Norwegian Centre for Transport Research.

Vachal, K., & Malchose, D. (2009). What can we learn about North Dakota's youngest drivers from their crashes? *Accident Analysis & Prevention, 41*, 617-623.

Vassallo, S., Smart, D., Sanson, A., Harrison, W. A., Harris, A., Cockfield, S., & McIntyre, A. (2007). Risky driving among young Australian drivers: Trends, precursors and correlates. *Accident Analysis & Prevention, 39*, 444-458.

Vernick, J. S., Li, G., Ogaitis, S., MacKenzie, E. J., Baker, S. P., & Gielen, A. C. (1999). Effects of high school driver education on motor vehicle crashes, violations, and licensure. *American Journal of Preventive Medicine, 16*(1, Supplement 1), 40-46.

Vlakveld, W. (2011). *Hazard anticipation of young novice drivers: Assessing and enhancing the capabilities of young novice drivers to anticipate latent hazards in road and traffic situations.* (PhD), Universiteit van Massachusetts, Geelong, VIC, Australia.

Walker, G. H., Stanton, N. A., Kazi, T. A., Salmon, P. M., & Jenkins, D. P. (2009). Does advanced driver training improve situation awareness? *Applied Ergonomics, 40*(4), 678-687.

Waller, P. F., Olk, M. L., & Shope, J. T. (2000). Parental views of and experience with Michigan's graduated licensing program. *Journal of Safety Research, 31*(1), 9-15.

Wallis, S., & Horswill, M. (2007). Using fuzzy signal detection theory to determine whye experienced and trained drivers respond faster than novice drivers in a hazard perception test. *Accident Analysis & Prevention, 39*, 1177-1185.

Wang, Y., Zhang, W., Reimer, B., Lavalliere, M., Lesch, M. F., Horrey, J., & Wu, S. (2010). The Effect of Feedback on Attitudes Toward Cellular Phone Use While Driving: A Comparison Between Novice and Experienced Drivers. *Traffic Injury Prevention, 11*(5), 471-477. doi: 10.1080/15389588.2010.495761

Watson, B., Fresta, J., Whan, H., McDonald, J., Dray, R., Bauermann, C., & Churchward, R. (1996). *Enhancing driver management in Queensland*. Brisbane: Queensland Transport.

Weiss, T., Petzolt, T., Bannert, M., & Krems, J. (2013). Calibration as side effect? Computer-based learning in driver education and the adequacy of driving task related self assessment. *Transportation Research Part F - Traffic psychology and behaviour, 17*, 63-74.

Whelan, M., & Senserrick, T. (2003). Review of graduated licensing systems and the effectiveness of specific components *2003 Road Safety Research, Policing and Education Conference*. Sydney.

Whelan, M., Senserrick, T., Groeger, J., Triggs, T., & Hosking, S. (2004). Learner Driver Experience Project. Melbourne: Monash University Accident Research Centre.

White, K., Walsh, S., Hyde, M., & Watson, B. (2012). Connection without caution? The role of mobile phone involvement in predicting young people's intentions to use a mobile phone while driving. *Journal of the Australasian College of Road Safety, 23*(1), 16-21.

Wiggins, S. (2004). Graduated Licensing Program: Interim Evaluation Report – Year 3. Victoria, BC, Canada: Insurance Corporation of British Columbia.

Williams, A. (2003). Teenage drivers: Patterns of risk. *Journal of Safety Research, 34*, 5-15.

Williams, A. (2009). Licensing age and teenage driver crashes: A review of the evidence. *Traffic Injury Prevention, 10*(1), 9-15.

Williams, A., Leaf, W. A., Simons-Morton, B., & Hartos, J. L. (2006). Vehicles driven by teenagers in their first year of licensure. *Traffic Injury Prevention, 7*, 23-30.

Williams, A. (2007). Contribution of the components of graduated licensing to crash reductions. *Journal of Safety Research, 38*(2), 177-184.

Williams, A., Preusser, D. F., & Ledingham, K. A. (2009). Feasibility Study on Evaluating Driver Education Curriculum. US: US. Department of Transportation National Highway Traffic Safety Administration.

Williams, A., & Shults, R. A. (2010). Graduated driver licensing research, 2007-present: A review and commentary. *Journal of Safety Research, 41*(2), 77-84.

Williamson, A. (2008). *Effect of video based road commentary training on the hazard perception skills of teenage novice drivers.* (Master of Social Sciences in Psychology Masters), University of Waikato, Hamilton, New Zealand.

Willmes-Lenz, G., Prucher, F., & Groemann, U. (2010). Evaluation of the novice driver training models "Accompanied driving from 17" and "Voluntary further training seminars for holders of probationary driving licences". Results up to November 2009 Third report on AP project F1100-4408016 "Evaluation of novice driver training models". Bergisch Gladbach, Germany: Federal Highway Research Institute.

Zhao, J., Mann, R. E., Chipman, M., Adlaf, E., Stoduto, G., & Smart, R. G. (2006). The impact of driver education on self-reported collisions among young drivers with a graduated license. *Accident Analysis & Prevention, 38*(1), 35-42.