




## Article

# What, Who, and When? The Perceptions That Young Drivers and Parents Have of Driving Simulators for Use in Driver Education

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**Abstract:** Driver education providers may utilise technologies such as driving simulators to augment their existing courses. Understanding the perceptions that young drivers and parents have of simulators may help to make simulator-based driver education more accepted and more likely to be effective. Young drivers and parents completed an online questionnaire that included a “simulator invention” visualisation task. Items based on the Goals for Driver Education framework investigated perceptions of the most appropriate skill type, while others examined the most suitable target group for simulator training, and timing in relation to completing a formal driver education course for simulator training to occur. Both groups perceived that simulators were most appropriate for training a combination of physical, traffic, psychological, and social driving skills with learner drivers during attendance at a novice driver education program. Young drivers and parents had similar perceptions regarding the amount that each skill type should be trained using a simulator. Understanding the perceptions of young drivers and parents, and especially those who are somewhat naïve to the use of driving simulators, may aid in the introduction and administration of simulator training and may increase the effectiveness of driver education as a crash countermeasure.

**Keywords:** driver training; novice drivers; teen drivers; driving simulator; perceptions

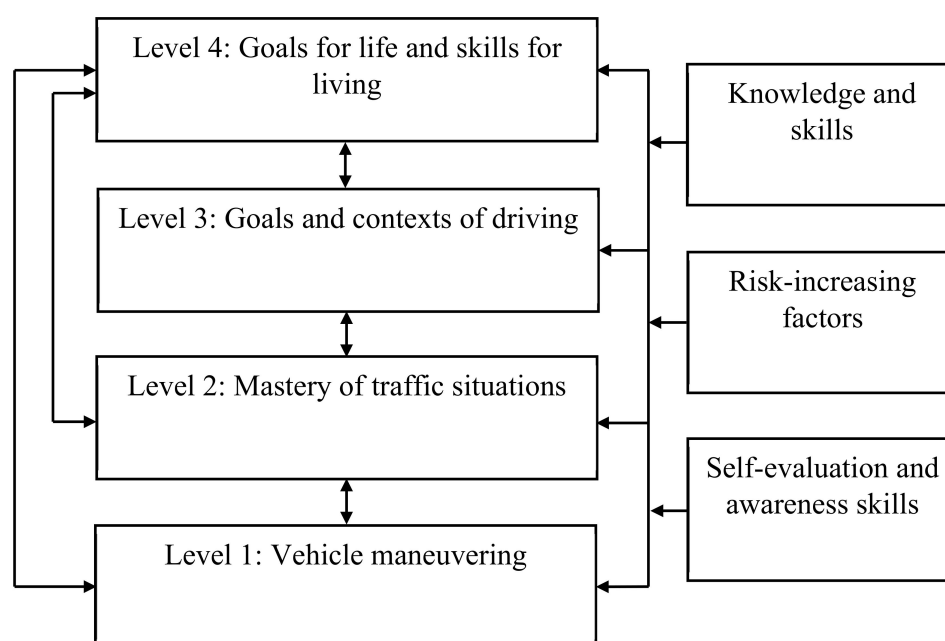
## 1. Introduction

Young people in many countries are over-represented in motor vehicle crashes despite the development of interventions designed to reduce their crash involvement [1]. Studies suggest that young driver at-fault fatal crashes are primarily the result of human error rather than nonhuman factors such as issues with tyres [2]. Novice driver education is a method to increase young people’s driving skills [3], and there are a wide variety of pre-and-post licensure approaches to driver education [4,5]. However, despite having face-validity as a safety measure and general support from parents, the public, and governments [6], no consistent link between professional driver education and reductions in young driver crashes has been demonstrated [3,5,7–10].

There may be several reasons why driver education has not, overall, reduced young driver crash rates. For example, Mayhew and Simpson [11] suggest that professional driver education may not teach critical safe driving skills; may not motivate the use of these skills once trained; may increase or fail to reduce young driver overconfidence in driving ability; may not address contextual and lifestyle influences on driving; or may fail to target individual student needs appropriately. These potential reasons are not necessarily singular or exclusive.

### 1.1. Goals for Driver Education

The Goals for Driver Education (GDE) [12] was developed to increase the efficacy of driver education as a young driver crash countermeasure. The GDE is a wide-ranging framework consisting of four hierarchical levels that organises the disparate influences on young driver education and considers the influence of three person-specific factors on each of these levels [13]. The levels in the GDE range in abstraction from driving-focused (e.g., vehicle manoeuvring skills such as braking) to macro-contextual (e.g., cultural values related to authority), and the person-specific factors span knowledge and skills, individualised risk-increasing factors, and self-evaluation and awareness skills [14]. Each level may exert influence on other levels, either directly or indirectly, and each of the person-specific factors may influence each of the levels. The GDE is depicted in Figure 1.



**Figure 1.** The Goals for Driver Education (adapted from Hatakka et al. [12]).

### 1.2. Driving Simulators

Many injury prevention behavioural interventions utilise technology [15]. Potentially, the effectiveness of driver education as a crash countermeasure could be increased by augmenting traditional programs with advanced technology such as driving simulators. A review of randomised clinical trials suggests that improvements in a range of procedural, higher-order cognitive, and psychosocial driving outcomes could be the result of young driver education delivered using driving simulators, although these authors made some criticisms related to the methodology used in many of the studies [16]. On balance, current simulator technology seems better suited to the training of higher-order cognitive skills (e.g., hazard perception) rather than procedural or physical driving skills (e.g., braking) [17]. It is possible, however, given the adaptability of driving simulators [18], that they could be used to train aspects of driving that may fall at the intersection of each of the hierarchical levels and person-specific factors in the GDE.

Simulator training that is combined with real-world training may have beneficial effects for young driver safety [19], although the amount of research examining this is limited, and some seemingly contradictory findings have emerged. For example, one study found that after training, young Israeli drivers who received simulator-plus-traditional training had riskier driving attitudes but drove more safely than those who received traditional training only [20]. Parkes and Reed [21] noted that research has not investigated when simulator training should best be positioned in driver education courses

or the most effective blend of simulator and in vivo training. Despite some promising longitudinal results [19], it is currently unclear how much transfer of driving simulator training to real-world contexts occurs, and more research is needed [22].

### 1.3. The Current Study

The current research expands upon, but is separate from, previous studies investigating professional driver education and the GDE [13] and the views that professional driver educators and young people have of driving simulators [23]. The current study concentrates on the perceptions that young people and parents, rather than professional driver educators, have of driving simulators using a quantitative methodology rather than a qualitative methodology. Based on an adaption of the GDE, the first aim of the current study was to investigate the basic perceptions that these groups have of the types of skills simulators could be used to train. In response to Parkes and Reed [21], the current study also aimed to examine perceptions of “who” should be taught with a driving simulator and “when” in the licensing process simulator-based driver education should occur. In line with Rodwell and Hawkins [23], a “simulator invention” visualisation task was used to increase the cognitive engagement of participants in the study.

## 2. Materials and Methods

### 2.1. Context

The study was conducted in Queensland, Australia, where a Graduated Driver Licensing (GDL) program was in operation [24]. GDL programs focus on reducing risks to young people in the initial period of their driving, allowing them to develop skills in a safer overall environment [25]. GDL programs work by dividing the early portion of an individual’s driving career into a series of stages, where different conditions are imposed on the young driver [26]. The Queensland GDL program was made up of Learner (L; minimum age of 16 years; 12 months duration), Provisional 1 (P1; minimum age of 17 years; 12 months duration), Provisional 2 (P2; minimum age of 18 years; 24 months duration) and Open (minimum age of 20 years; ongoing duration) licence stages.

Individuals obtained a learner licence by passing a road rules test. To obtain a P1 licence, learner drivers had to complete at least 100 h of driving practice with a supervising open licence holder and pass an on-road driving test. Following this, young people were required to complete an online hazard perception test administered by the licensing authority to obtain a P2 licence. Both provisional stages allowed independent driving without supervision. After two years of driving on a P2 licence, a young person moved to an Open licence.

Learner and Provisional drivers could accrue a smaller number of demerit points for driving infractions before receiving a licence sanction; they had to display licence plates on the front and rear of their car indicating the type of licence they had; they had a zero-BAC limit; and they had restrictions on driving high-powered vehicles. Learner and P1 drivers had restrictions on all mobile phone use including hands-free use; P2 drivers were allowed hands-free mobile phone use. P1 drivers were also subject to a late-night peer passenger restriction, while this restriction was relaxed for P2 drivers. All restrictions were removed when a young person obtained an Open licence.

Evaluation studies suggest that the Queensland GDL, which was improved in 2007 [27], was effective at reducing young driver crashes, fatalities, and serious injuries [28]. Research indicates that parental engagement in GDL programs, especially parental regulation of young people’s driving, rather than that of police or other regulatory agencies, is important for the success of GDL programs [29,30].

At the time of the study, there was no requirement for young people in Queensland to obtain professional driver education or training, although research suggests that most receive some professional instruction [31]. Most non-professional driving instruction in Queensland was provided by parents, and in most cases by the young driver’s mother [31]. Parents are also likely to be responsible for the

cost of professional driver education for their child and hence are important decision-makers in terms of the amount and type of instruction their child receives.

It is likely that simulator-based driver education was not widespread in Queensland when the study was conducted [32]. Thus, the young drivers and parents in the current study would have had limited experience with driving simulators. However, the perceptions of individuals such as these may be valuable for jurisdictions that do not currently use driving simulators. For example, this knowledge may aid policy makers in introducing driving simulators into driver education and licensing processes by providing an indication of their initial likely level of public acceptance.

## 2.2. Participants

Young drivers ( $n = 272$ ;  $M = 18.8$ ,  $SD = 0.7$ ; 76% female) with provisional (intermediate) driving licenses (P1 = 40%) and parents of young drivers and pre-drivers ( $n = 460$ ;  $M = 48.8$ ,  $SD = 4.9$ ; 87% female) from Queensland, Australia, participated in the study. Young drivers were required to have a current Provisional licence (P1 or P2) and be 17–20 years. Parents were required to have an Open licence and have a child with a learner or provisional licence, or who would obtain a licence in the next 6–12 months. Most parents had children with a learner licence (50%) followed by a P1 licence (29%) or P2 licence (14%). Participants were recruited using university research participation pools, social media and email lists, recruitment flyers, and word-of-mouth. The young drivers and parents were not family dyads but instead represented two groups of key stakeholders intimately involved in the process of learning to drive. University students received course credit (0.05%) for participation while other young driver participants could enter a prize draw for a \$100 gift voucher for a department store. Parents could enter a similar but separate prize draw.

## 2.3. Design and Procedure

This study was part of a larger project investigating young driver education and technology [13,23,33,34]. Participants completed a young driver or parent version of an online questionnaire. Initially, the webpage provided participants with participant information, and informed consent was gained when participants acknowledged that they had read and understood the information and wished to continue. Participants were directed out of the questionnaire if they did not consent and could not continue with the questionnaire without responding to the consent question.

The total survey took around 40 min to complete. However, this paper focuses on a subset of items included in both versions of the questionnaire. Demographic questions were completed before several standardised instruments and items based on previously validated scales. Answers to some demographic questions were used to further screen participants, and skip logic ensured that participants only answered items relevant to them. Sections of the survey following the demographics were presented in random order to address issues of response fatigue. The study was granted ethical approval prior to data collection (QUT approval Numbers: 1700000220/1700000720), which occurred from July to November 2017 for the young drivers and November 2017 to April 2018 for the parents.

### “Simulator Invention” Visualisation Task

To deepen the cognitive engagement of participants and minimise simplistic responding, participants were asked to complete a “simulator invention” visualisation task immediately prior to responding to the items examined in this study. This task was based on a qualitative draw-and-talk methodology employed by Rodwell and Hawkins [23] but adapted to suit an online questionnaire. Participants had to imagine an “ideal” driving simulator for use in driver education and consider what it would be used for, who it would be used with, and when it would be used in the driver education process. Participants were asked to provide a written description of the simulator they imagined in a free-text box. Participants were given the following instructions:

Please imagine it is the near future and driving simulators have become available to be used as part of learning to drive. Please take some time to imagine what your ideal simulator would be.

There are no financial or technology constraints on what you can imagine. While you are designing your simulator in your mind, please take into consideration what specific things the simulator would be used for, with who, and where and when you would use it in a professional driver education program? Please describe your simulator briefly.

## 2.4. Measures

### 2.4.1. Demographics

Questions for both young drivers and parents included age (years), gender (male, female, other), and licence details (Unlicensed, Learner, P1, P2, Open). Parents also provided the licence category of a focal child (Learner, P1, P2, Pre-driver, Unsure).

### 2.4.2. Perceptions about Driving Simulators

Three items referred to the imagined driving simulator that participants had created in the simulator invention task. The participants were first asked “what would you use your simulator for” and were given the following response options: (1) physical driving skills (operating the car, e.g., braking, accelerating); (2) traffic skills (interacting with other road users and the road environment, e.g., negotiating roundabouts, driving in peak hour); (3) psychological driving skills (the thinking aspects of driving, e.g., anticipating hazards, dealing with boredom); (4) social driving skills (learning about the influence of other people on your driving, e.g., being responsible as the designated driver); or (5) “a combination of these skills”. The skill options were devised with the intent of succinctly capturing all elements of the GDE [13]. If participants nominated the final option, they were asked to advise the percentage that the simulator would be used for each of the four skill types, ensuring that the total added to 100%.

Participants were asked two further questions. One item asked “who would be trained with your driving simulator”, with the following response options: (1) unlicensed teenagers; (2) learners; (3) P1 drivers; (4) P2 drivers; or (5) open licence holders. The final item asked was “when would your simulator be used in a formal driver education program”, with the following response options: (1) in the 6 months before a driver education program; (2) just before (e.g., two weeks) a driver education program; (3) while completing a formal driver education program (e.g., as a part of the course); (4) just after (e.g., two weeks) completing a driver education program; or (5) as a follow up after a driver education program (e.g., 6 months after). In both questions, parents only were also provided an “other (please specify)” response option.

## 2.5. Statistical Analyses

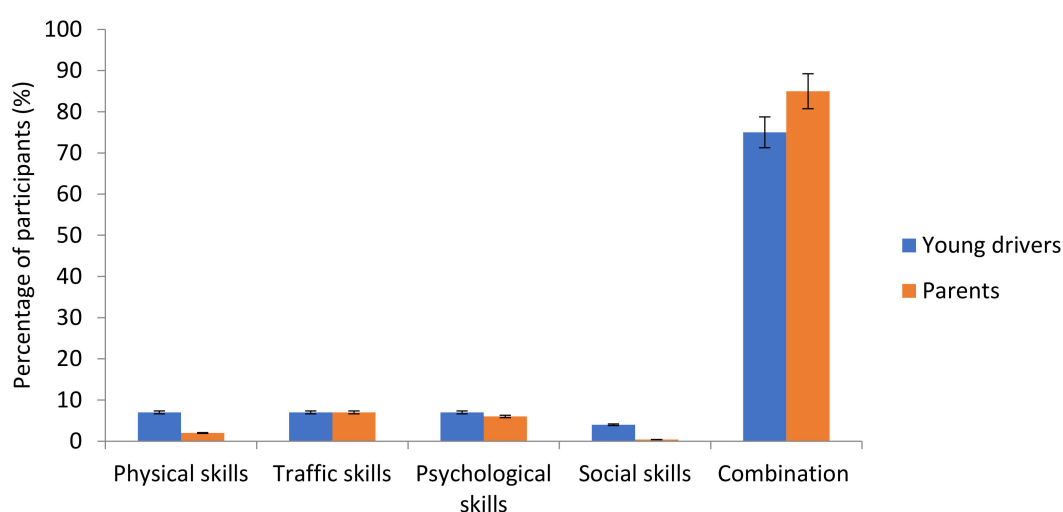
Due to the nature of many of the questionnaire items, which required categorical responses from participants, most analyses were non-parametric. The tests included both chi square and, if expected cell sizes were lower than 5 [35], Fisher’s exact tests. Significant chi square and Fisher’s exact tests were followed up using z-tests of column proportions. Friedman’s ANOVA, Kruskal–Wallis, and Mann–Whitney U tests were also applied to the data. Statistically significant omnibus Friedman’s ANOVA analyses were followed up with Wilcoxon signed-rank tests. All analyses were assessed using an  $\alpha$  of 0.05. When multiple tests were performed, the type 1 error rate was controlled using the Bonferroni correction [35]. In many of the analyses, z scores were converted to Pearson’s  $r$ , which is used as a measure of effect size. Statistics were calculated using IBM SPSS (version 23).

## 3. Results

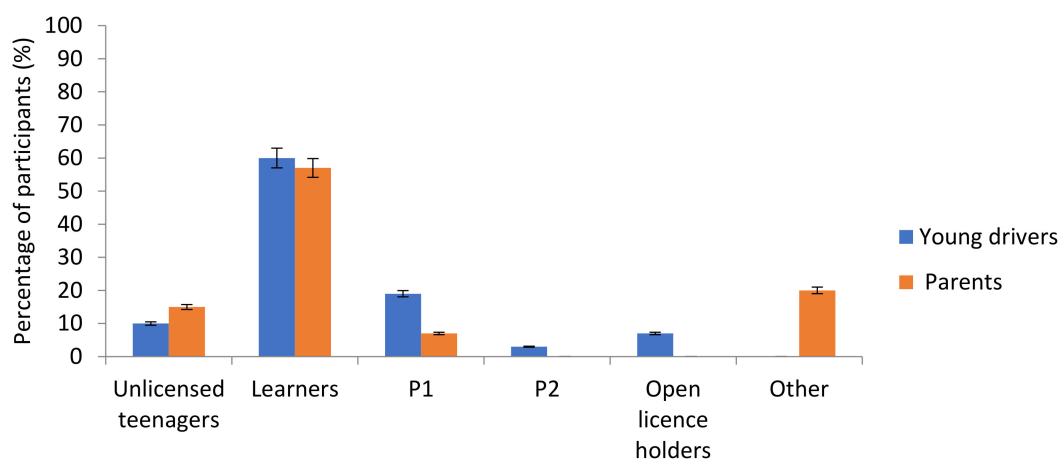
### 3.1. Descriptive Statistics

The percentages of young drivers and parents that nominated each of the skills (“what”), target groups (“who”), and possible timing options (“when”) for driving simulator training were

calculated. Most young drivers and parents perceived that simulators could be used to train “a combination of driving skills” (Figure 2). Similar numbers of young drivers and parents thought that driving simulators could be used to train traffic skills and psychological skills, while more young drivers thought physical skills and social skills could be trained using simulators. Both young drivers and parents perceived that learner drivers were the most appropriate target group for simulator training (Figure 3). Parents and young drivers thought that unlicensed teenagers and P1 licence holders were appropriate training groups, but only young drivers thought that simulator training would be beneficial for P2 and open licence holders. Again, both young drivers and parents thought the optimal time for driving simulator training was while young people attended a driver education course (Figure 4). Both groups had similar perceptions about the timing of simulator-based training, except for simulator training just after attendance of a driver education course. In this instance, a comparatively larger percentage of young drivers than parents thought it would be appropriate.

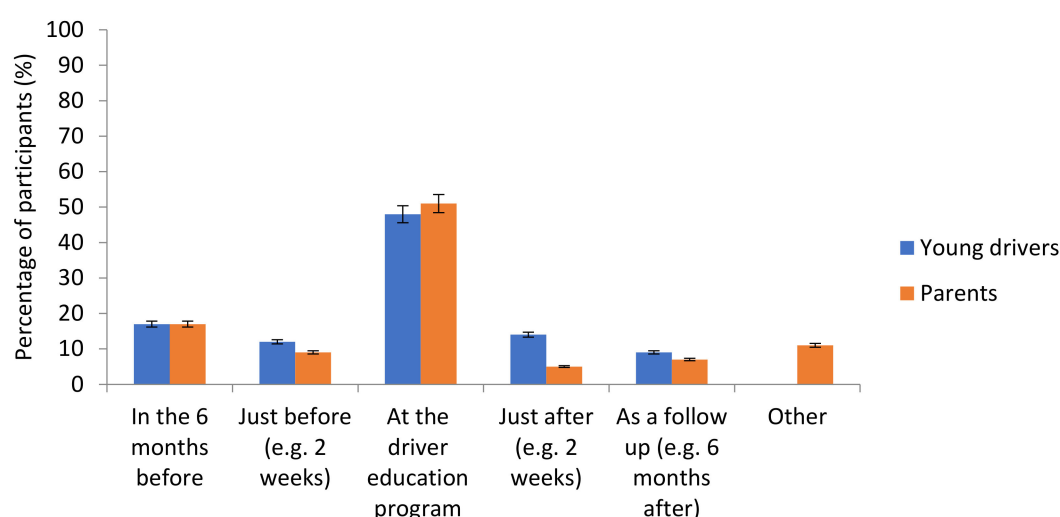


**Figure 2.** Percentage of young driver and parent responses indicating the type of skill that should be trained using a driving simulator.



**Figure 3.** Percentage of young driver and parent responses indicating the target group that should be trained using a driving simulator.





**Figure 4.** Percentage of young driver and parent responses indicating the optimal timing for training using a driving simulator.

Comparatively large proportions of parents nominated the “other” option in response to the questions examining “who” a simulator should be used to train and “when” driving simulator training should occur. Most parents who responded this way indicated that simulators could be used to train all or some combination (e.g., learners and P1 drivers) of the target groups that were already provided. A minority of respondents suggested simulators may be used to train “the elderly”, “new residents”, or people with “medical conditions”. Similarly, driving simulators could be used at “all of the above” times, although some parents also indicated that simulator training could be “... an ongoing component” of an individual’s driving career.

Two hundred and five young drivers and 309 parents responded that simulators should be used to train “a combination of these skills”. Descriptive statistics for the percentages that participants nominated for each of the skill types are presented in Table 1. The young drivers assigned higher percentages on average to physical skills than each of the other skills, while social driving skills were assigned the lowest average percentages. Parents assigned the highest average percentage to traffic skills, while social driving skills had the lowest. For both groups, there was a similar amount of variability in the percentages of each of the skills, although the most variability was demonstrated in percentages applied to physical driving skills.

**Table 1.** Mean percentage amounts that young drivers and parents nominated that each skill type should be taught using a driving simulator.

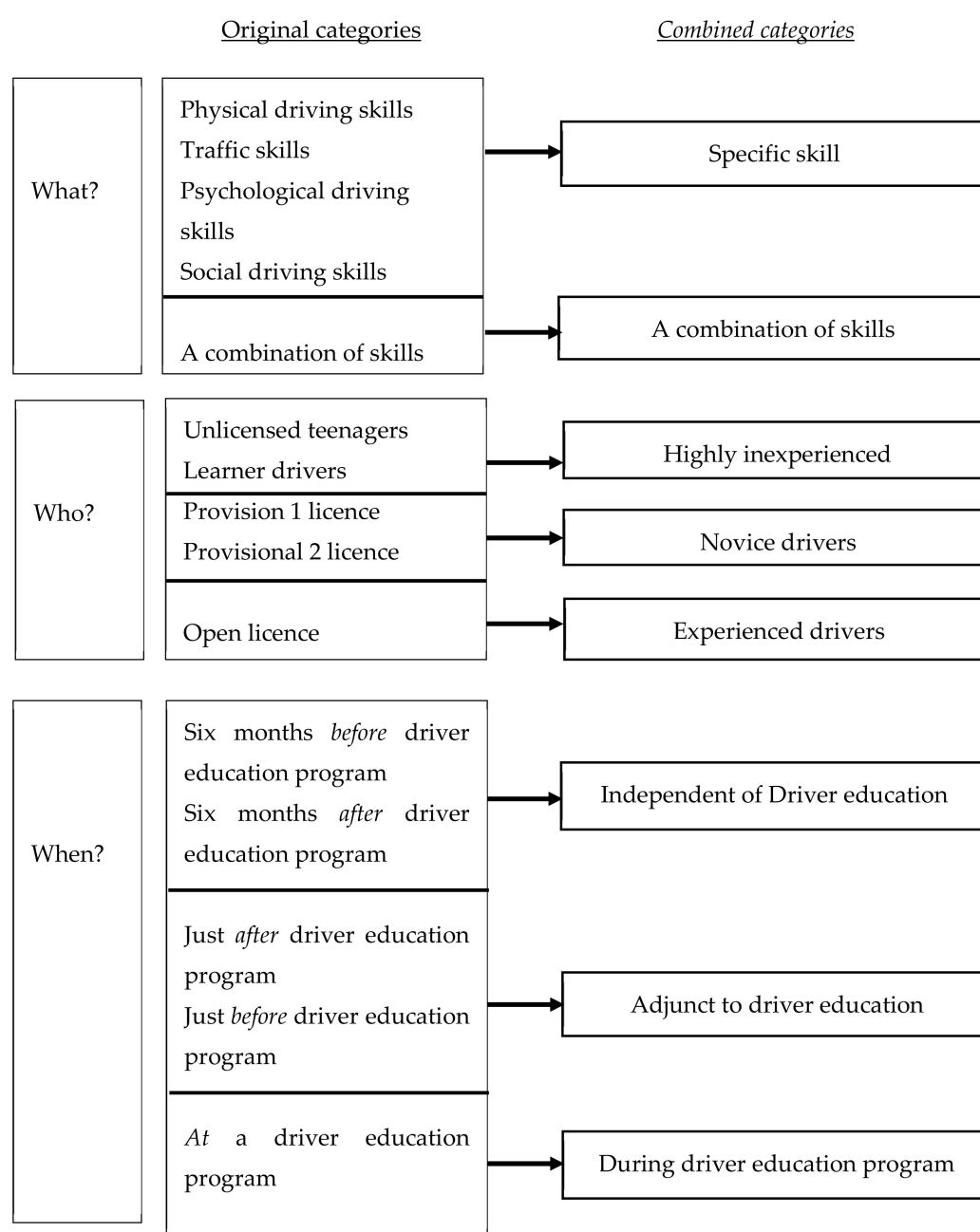
Type of Skill	Young Drivers (N = 205)			Parents (N = 390)		
	M (SD)	Mode	Min–Max	M (SD)	Mode	Min–Max
Physical skills	29.4 (13.9)	25	0–80	26.3 (14.0)	25	0–80
Traffic skills	27.3 (8.9)	25	0–50	30.6 (12.0)	25	0–80
Psychological skills	23.6 (9.9)	20	0–60	23.8 (10.7)	25	0–70
Social skills	19.6 (9.2)	20	0–50	19.2 (10.5)	10	0–80

Note. Scores refer to percentage amounts. M = mean; SD = standard deviation; Min = minimum score; Max = maximum score.

### 3.2. Main Analyses

Due to small expected cell counts, and as depicted in Figure 5, further statistical analysis was enabled by combining participant responses into subcategories of “what” (“specific skills” and “a combination of skills”); “who” (“highly inexperienced drivers”, “novice drivers”, and “experienced

drivers"); and "when" ("independent of driver education", "adjunct to driver education", and "during driver education"). The demographic makeup of the newly created subcategories was examined.



**Figure 5.** The combined "what", "who", and "when" subcategories. Percentage of young driver and parent responses indicating the target group that should be trained using a driving simulator.

A significantly greater proportion,  $p < 0.001$ , of young drivers that perceived simulators should be used for a specific skill (18%), rather than for a combination of skills (4%), also perceived that they should be used with experienced drivers. There were no significant differences regarding when a simulator should be used based on the overall skill type dichotomy. Looking more closely at the young driver percentages attached to individual skills, a significantly larger proportion of young drivers that perceived driving simulators should be used to train a combination of skills also perceived they should be used with highly inexperienced drivers (75%) rather than teaching social driving skills to this group (36%). A significantly larger proportion of young drivers perceived that simulators should be used



to train social driving skills to novice drivers (54%) compared to those who perceived simulators should be used to train traffic skills to novice drivers (6%). The proportion of participants who thought simulators should be used to train physical skills to experienced drivers (28%) was significantly larger than that which perceived experienced drivers should be trained a combination of skills with a driving simulator (4%). There were no significant differences in proportions of individual skills that simulators should be used to train based on the combined “when” subcategories.

Overall, the proportion of parents who perceived that simulators are appropriate to train a specific skill (87%), rather than a combination of skills (70%), also thought that highly inexperienced drivers would be the most appropriate target group for simulator training ( $p = 0.007$ ). A smaller proportion of those advocating for simulator training of a specific skill perceived that simulators could be used for “other” groups (9%) than those who advocated for a combination of these skills (21%). No significant differences in parent perceptions of the most appropriate timing for simulator training were found based on the dichotomised skill variable. Regarding the individual skill types, a significantly greater proportion of parents perceived simulators should be used to train traffic skills to highly inexperienced drivers (97%) than psychological driving skills (73%) or “a combination of skills” (70%) to this group ( $p = 0.009$ ). A greater proportion of parents perceived simulators should be used to train physical skills to experienced drivers (11%) than “a combination of skills” (0.5%) to this group. No significant differences were found in relation to the combined “when” subcategories.

As most young drivers and parents nominated “a combination of skills”, further statistical analysis concentrated on the average percentages that were assigned by each group to the individual skill types. Age was not significantly associated with the percentages assigned to a particular skill by the young drivers. However, for parents, weak negative significant correlations were found between age and psychological driving skills ( $r = -0.1$ ,  $p = 0.03$ ) and age and social driving skills ( $r = -0.1$ ,  $p = 0.02$ ). No significant differences were found in percentages based on the licence type of the young drivers.

Female young drivers ( $mdn = 20$ ) assigned significantly higher percentages to social driving skills than male young drivers ( $mdn = 15$ ,  $U = 2541.00$ ,  $z = -3.11$ ,  $p = 0.02$ ,  $r = -0.2$ ). Similarly, mothers ( $mdn = 20$ ) assigned higher percentages to social driving skills than fathers ( $mdn = 10$ ,  $U = 5912.50$ ,  $z = -2.41$ ,  $p = 0.02$ ,  $r = -0.1$ ). Conversely, fathers ( $mdn = 30$ ) assigned significantly higher percentages to traffic driving skills compared to mothers ( $mdn = 30$ ,  $U = 5985.00$ ,  $z = -2.30$ ,  $p = 0.02$ ,  $r = -0.1$ ). A Kruskal–Wallis test revealed that a significant difference existed in the percentages that parents applied to social driving skills according to the type of licence a parent’s child had ( $H(3) = 10.26$ ,  $p = 0.02$ ). Follow up Bonferroni-adjusted Mann–Whitney U tests indicated that parents of P1 licensed children ( $mdn = 20$ ) assigned significantly higher percentages to social driving skills than parents of learner drivers ( $mdn = 20$ ,  $U = 535.00$ ,  $z = -1.61$ ,  $p = 0.007$ ,  $r = 0.1$ ).

Friedman’s ANOVA was used to investigate differences in the skill type mean percentage amounts. Significant results were returned for both the young drivers ( $Q(3) = 69.82$ ,  $p < 0.001$ ) and the parents ( $Q(3) < 153.49$ ,  $p = 0.001$ ). Follow up Bonferroni-adjusted Wilcoxon signed-rank tests comparing each of the different skill types are presented in Table 2. Young drivers assigned significantly higher percentages to physical driving skills than all other skill types except traffic skills. Social driving skills had significantly lower percentages when compared to each of the other driving skills. Traffic skills had significantly higher percentages than psychological driving skills, while the percentages applied to psychological driving skills were only significantly higher than social driving skills. Parents applied significantly higher percentages to traffic skills compared to the other skills. There was no significant difference between physical driving skills and psychological driving skills. Simulator training of social driving skills received significantly lower percentages, on average by the parents, than all the other skill types. The results for both young drivers and parents had small to medium effect sizes.

**Table 2.** Wilcoxon signed-rank tests comparing percentage amounts assigned by young drivers and parents to skill types that could be trained with driving.

Initial Skill Type	Comparison Skill Type	Young Drivers		Parents	
		<i>z</i>	<i>r</i>	<i>z</i>	<i>r</i>
Physical skills	Traffic skills	−1.44	−	−4.12 *	−0.2
Physical skills	Psychological skills	−3.63 *	−0.2	−1.93	−
Physical skills	Social skills	−6.01 *	−0.4	−6.11 *	−0.3
Traffic skills	Psychological skills	−3.54 *	−0.2	−6.69 *	−0.3
Traffic skills	Social skills	−6.53 *	−0.4	−10.43 *	−0.5
Psychological skills	Social skills	−4.54 *	−0.3	−7.33 *	−0.4

Note. \*  $p < 0.001$  with Bonferroni-adjustment;  $z$  =  $z$  score;  $r$  = Pearson's correlation (effect size).

Finally, the young driver and parent data sets were combined, and the percentages applied by each group to each of the skill types were compared directly using Bonferroni-adjusted Mann–Whitney  $U$  tests. Young drivers assigned significantly higher percentages to physical skills than parents ( $U = 34,149$ ,  $z = -2.96$ ,  $p = 0.003$ ,  $r = -0.1$ ). Alternatively, parents assigned significantly higher percentages to traffic skills than young drivers ( $U = 33,973.500$ ,  $z = -3.06$ ,  $p = 0.002$ ,  $r = -0.1$ ). However, the effect sizes suggest that the differences found are not of substantial importance.

It is also noted that, while included here for completeness, the interpretation of the comparative analyses between parents and young drivers should be treated with some caution. There are theoretical and practical reasons to indicate that the young driver and parent groups are not comparable in a strict statistical sense. For example, the young drivers are highly constrained in age and driving experience, while the parents are not; the young drivers and parents are not family members; and the groups are engaged in related but different behaviours (i.e., “learning to drive” vs. “driving instruction”) and may have very different motivations for engaging in the behaviours. As such, the direct statistical comparison of these groups has not been a primary focus in the study.

#### 4. Discussion

This exploratory study sought to provide an initial understanding about how young drivers and parents think driving simulators should be used in driver education. Overall, the results of this study indicate that both young drivers and parents believe that driving simulators should most appropriately be used to train a combination of physical, traffic, psychological, and social driving skills with learner drivers while attending a professional driver education course. These results help inform how driving simulator training and in vivo driver education can be most effectively blended. This issue has not received much research attention [21].

Within the perception that simulators could train a combination of skills, both the young drivers and parents were significantly more likely to perceive that simulators should be used for physical and traffic skills. There was no statistical difference in the young drivers' perceptions of simulator training of physical and traffic skills, while, alternatively, there was no statistical difference in parents' perceptions of physical skills and psychological skills. This divergence could reflect that parents, who are experienced drivers, are more likely to understand that overall psychological aspects of driving may be of equal importance as physical skills for driving and thus should be a focus for driver education in the long-term [12]. Of all the skills, it appeared that both young people and parents were most divided about the role of simulators in relation to training social driving skills. However, very small effect sizes were evident, and therefore these findings are not likely to be meaningful in practice.

It appears that both the young drivers and parents grouped together simulator training of physical and traffic skills, which had close mean percentages, and psychological and social skills, which also appeared to be grouped together. When compared directly, the young drivers perceived simulators should be used more to train physical skills while the parents perceived simulators should be used more to train traffic skills. This suggests there is some agreement in the use of driving simulators to

train elements of driving included in the lower hierarchical levels of the GDE, which are specifically related to basic vehicle manoeuvring and ability to manage traffic interactions [14]. However, there is misalignment regarding whether priority should be placed on Level 1—vehicle manoeuvring or Level 2—mastery of traffic situations. This finding is congruent with other research, based on the GDE, that found the perceptions that young drivers and driver educators had of a traditional driver education course were misaligned [13].

A number of benefits have been identified in relation to the use of driving simulators [18] with some of the primary ones being the flexibility of what they can be used to train and their level of control and repeatability of the training [36]. Conceivably, a driving simulator could be used for the issues that Mayhew and Simpson [11] suggest limit the effectiveness of driver education and to train aspects of driving located on each level of the GDE [12]. Most research on the effectiveness of driving simulator education indicates they are currently more effective for training higher-order cognitive skills [17,22]. Given this, it is notable that the parent and young driver participants suggested that simulators were most appropriate for the training of skills related to physical vehicle operation or driving in traffic. As such, there may be need for some awareness-raising or education of the general public regarding the flexibility of driving simulators if they are to be introduced with the intent of training aspects of driving related to the higher and more abstract GDE levels. Concurrently, creative design of simulator tasks and scenarios that focus on skills and abilities located at higher GDE levels is needed.

There are some similarities and differences in the perceptions of the young people and parents in relation to what and who could be trained using a simulator. Overall, both the young drivers and parents thought that simulators would be most appropriate for training learner drivers and least appropriate for older independently driving novices (e.g., those with P2 licenses). These perceptions may be connected to the participants' understanding that simulators are best for educating physical or traffic skills. For very inexperienced novices, the physical operation of the car is a major objective, and skills for this are obtained relatively quickly [37]. For P1 drivers who have acquired some vehicle operation skills, the ability to negotiate traffic without the aid of a supervising adult becomes paramount. Most of the young drivers in the study had P2 licenses and therefore would have acquired basic vehicle operation skills.

Looking at the “what” and “who” combinations in more depth, young drivers were more likely to perceive that experienced drivers should be trained a specific skill rather than a combination of skills in a simulator. Alternatively, parents thought that highly inexperienced drivers should receive specific training in a single skill. Both groups thought that simulator training of physical driving skills to experienced drivers was more appropriate than training of a combination of skills. The young drivers thought that simulator training of social driving skills was more appropriate than traffic skills for novice drivers. This suggests that the young people in the study had some insight into the effect of social influences on their driving behaviour [38]. Parents thought simulator training of traffic skills should be prioritised over “a combination of skills” and the specific skill of psychological driving skills for highly inexperienced drivers. This is perhaps indicative that parents perceive that very new drivers concentrate on a single aspect of driving, and that this should be how to interact with other drivers.

Most of the young drivers and parents in this study thought driving simulator-based education was most appropriate during attendance at a driver education course. This may indicate that these groups believe that professional guidance by a driver educator is required for them to benefit from simulator training. Because of this, there may be a need for driver education organisations to address this when designing and implementing courses that intend to use simulators independently of in-person training. This may also have wider implications. For example, the simulators used in driver education in the Netherlands include a “virtual instructor” that removes the need for a human presence in the process and therefore reduces the financial cost of driver education [39]. The current study suggests that this may not be the best strategy to gain acceptance of driving simulators for driver education, although more research is needed to confirm this proposition. More broadly, this finding might also have some implications related to the design and deployment of other technologies being used in

driver education, such as online and PC-based training programs, e.g., teenSMART [40], which are also generally completed without the physical guidance of a driver education professional.

Some limitations to this study should be noted. While the current study investigated perceptions regarding simulator training in relation to attendance at a driver education course, it did not investigate perceptions of simulator training within an overall GDL system. For example, it did not seek answers to questions about the benefits (or not) of simulator training for learner drivers compared to those more advanced in the novice period, or whether it should be recognised in some way in learner driver log books. One key consideration concerns the “simulator invention” task. This task was intended to increase the robustness of participant responses. However, not all individuals provided a written response to the visualisation task, and it is unclear how much, or if, these individuals engaged in it before completing the remaining questions. There were unequal gender proportions in both the young driver and parent samples, with young female drivers and mothers making up the bulk of participants. It is unclear why the sample of respondents was biased towards females. While a lower response from males could have been motivated by less interest in engaging with simulator training, it is also possible that the lower male representation in the sample is simply a matter of the convenience sampling approach and recruitment strategies employed by the researchers (i.e., the university participant pool may have simply had higher numbers of female students). Gender-based attitudes towards driving simulator-augmented driver education may be a future research question to explore. It should also be noted that the proportions of male and female young drivers that participated in the study differ from the overall males and females with P1 (female = 48%) and P2 (female = 51%) in the Queensland population [41]. Nevertheless, the absolute numbers of males in each of these subsamples were substantial, and thus views of young male drivers and fathers were represented in the findings. It is also the case that the influence of participant education level and other demographics such as income level were not investigated in this study. It is conceivable that characteristics such as these may affect perceptions about simulator technology and its use in driver education. Therefore, it may be of benefit for future studies to investigate demographic characteristics in addition to age, gender, and license category. The study used an online survey format that may have been subject to biases in self-reporting. However, care was taken to ensure that participant bias was avoided as much as possible through design elements built into the online questionnaire. Self-reporting is often used in young driver research, and evidence suggests it is a reliable and valid research method in this field [42]. One final limitation is that a baseline measurement of experience with driving simulators was not collected from participants. Future research should ensure that an indicator of experience with simulators is included so that this information can be incorporated in statistical analyses providing a more detailed understanding of young drivers’ and parents’ perceptions of driving simulators for driver education.

## 5. Conclusions

It is very likely that professional driver education will include technology in the future [43], and one technological tool that may be used for a range of young driver education and training is driving simulators [44]. It appears that both young drivers and parents perceive that simulators are a flexible driver education tool, applicable for use in training physical, traffic, psychological, and social driving skills, and that they have some relatively strong preconceptions regarding the most appropriate training group and the optimal timing vis-à-vis professional traditional driver education that simulator training should occur. Driving simulator training is utilised in some countries as a method to enable greater access to professional driver education for young people, e.g., the Netherlands [39] and may readily be included in GDL systems administered to young drivers in many jurisdictions [17]. It is important from a human factors standpoint to obtain knowledge about how key stakeholders in the process of learning to drive, such as young people and parents, think driving simulators could be used in driver education. Ultimately, a greater understanding of how these groups are likely to accept and engage with driving simulators may be used to direct the more effective use of these devices in

educating young drivers. This, in turn, may help to lessen the burden placed on society because of the crash involvements of young people.

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