Towards Standardizing Simulators in Teen Driver Training – Lessons Learned

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ABSTRACT

Drivers aged 16-24 represent 12% of the total driving population, yet account for 20% of all road vehicle accidents. Teen driver/passenger deaths account for 25% of total teen deaths from any cause – more than cancer, homicide, and suicide. It is clear that roadway safety has been, and continues to be a major public health concern – and one which lacks standardization of training and education practices at the State/National level. The present study aims to build upon past research involving the expanded use of driving simulators to supplement existing driver training curricula. The eventual goal is to develop, validate, and standardize a state-level and nationally accepted revision to existing driver training policies – including simulation as a core component. Subsequent to our preliminary pilot study in 2012, numerous revisions have been made in an effort to improve the program, including enhancements to module content, modifications to the simulator itself, and revised data collection and analysis methods. The updated module content of the training program will focus on the statistically documented Top 5 causes of teen driver accidents (in New York State): unsafe speed, failure to yield right of way, driver inattention or distraction, driver inexperience, and following too closely. In this paper, these revisions will be described in detail, along with future recommendations for quantifying the success of using simulators by analyzing teen driving performance data longitudinally over time. Although the focus of this paper is on refinement of module content (and data collection/analysis methods), in an effort to quantify the improvement of the simulation-based framework, we have recruited a small cohort of participants to experience our revised program whose results are analyzed and reported. This process will help to ensure the continued evolution of our program towards achieving our long-term goal: widespread deployment and standardization of simulators at a National level.

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INTRODUCTION

Driver education and traffic safety continue to be major public health concerns. Motor vehicle crashes remain the leading cause of death for teenagers (aged 16-19) in the United States (CDC, 2013a), with average daily morbidity of seven teenagers. Per mile driven, teen drivers are three times more likely (than drivers aged 20 and older) to be in a fatal crash (IIHS, 2012). Young people (ages 15-24) represent only 14% of the total U.S. population, yet account for 30% ($19 billion) of the total costs of motor vehicle injuries among males, and 28% ($7 billion) among females (Finkelstein et al., 2006). One logical solution to this ongoing problem is to assure that new drivers receive improved driver training – both in terms of quality and quantity - in advance of licensure. Conventional methods for driver training, which have included a lecture (in-class) and a practical (in-vehicle) component do not provide teenagers with enough advance hands-on exposure to the many challenges of driving, which can be visual, manual, and/or cognitive in nature. As the I/ITSEC community is well-aware, simulation can provide a framework for driver training and education that is safe, authentic, controllable, and repeatable. Supplemental simulation-based training can provide young drivers with additional "seat time" that could, over time, help to reverse these tragic trends.

This paper describes the ongoing development and refinement of such a training program. Subsequent to our preliminary pilot study, numerous revisions have been made to improve the training program, including changes to the simulator, to module content, and revised data analysis methods. In this paper, these revisions will be described and demonstrated by way of a pilot study test cohort. This process will help to ensure the continued evolution of our program towards achieving our long-term goal: widespread deployment and standardization of simulator training.

LITERATURE OVERVIEW

Typically, formal driver training programs have been found to be effective for procedural skill acquisition. Although such training programs are popular, recent evidence suggests that traditional driver training programs have not appreciably reduced young drivers' crash risk (Beanland et al., 2013). Current data trends indicate that some forms of training have been effective for procedural skill acquisition, and other programs have been found to improve drivers' perception of dangers and hazards.

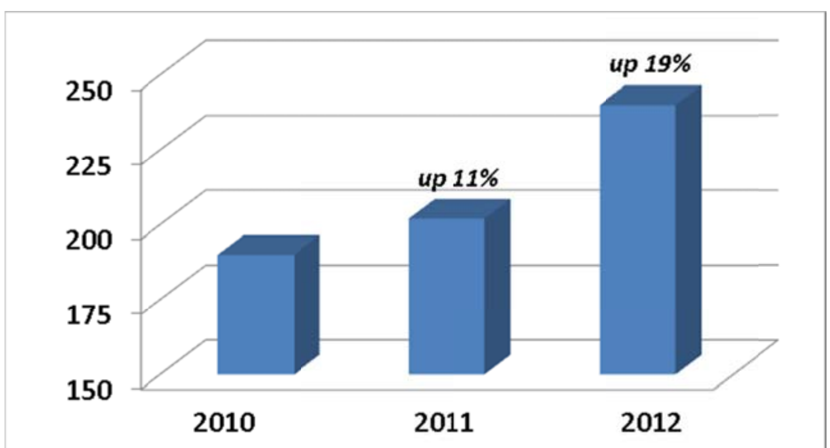


Figure 1 - Driver Deaths of 16- and 17-Year-olds (Jan-June, 2010-2012)

According to the Governors Highway Safety Association (GHSA, 2012), vehicle driver deaths of 16-17 year olds is on the rise, with increases of 11% from 2010-2011, and 19% from 2011 to 2012. See Figure 1.

Most educators agree that improved training could help to reverse these trends. Current classroom-based programs are characterized by some (or all) of the following implementation deficiencies:

- Antiquated training materials and techniques (e.g., outdated VHS/DVD videos & "chalk and talk" instruction).
- Instructional techniques that promote passive rather than active (e.g., hands-on, "seat time" style) learning.
- Instructors cull from a wide body of training materials, many outdated, without any structure or uniformity.
- Simulators are typically only ever implemented as a novelty rather than as a serious, sustained training resource.
- No standardization of training protocols at the State (or National) level.

Although an artificial driving environment is not as authentic as actual driving, a simulation system can be used primarily to build and maintain good driving habits. Within a simulator, students can be safely exposed to urban congestion, unpredictable pedestrians, highways, heavy-traffic merging, aggressive drivers, and rubbernecking scenarios. All the while, students will learn to maintain their attention and awareness, anticipate hazards, and always look for an "out" in any detrimental situation. (Vanderwerp, 2010). While simulation and gaming-inspired approaches have been employed for a number of previous mental health, rehabilitation, distraction, and performance applications within driving-based research (e.g., McDonald et al., 2013; Zhao and Wu, 2012; Fabiano et al., 2011; Underwood et al., 2011; Chan et al., 2010), they have not yet been adopted for sustained and widespread use in young driver training programs. In this ongoing research effort, our primary goal is to verify and validate the need for simulation as a core and standardized component in all future young driver training programs, nationwide.

BROADER IMPACTS

A primary disadvantage of many existing commercial driving simulation utilities is cost. To a large degree, the current research is aimed at justifying the expense of incorporating simulation as a standard, core component to all driver training programs nationwide, but in a manner that can be cost-effective for all training institutions depending on their available resources. In other words, the training software vignettes can be standardized, while the hardware upon which the software can vary from simple to sophisticated. Understandably, many training centers and agencies are resistant to investing their monetary resources required for suitable simulation-based training hardware. We suggest that for every large-group training setting, even if **<u>one accident is prevented</u>** by incorporating simulation-based training to improve young driver skill, then one can reasonably argue that the expense will have been justified.

Through this ongoing study, we hope to demonstrate that sustained simulation-based driver training, offered prior to licensure and sustained through the formative years of driving education, can serve as an engaging educational tool that will result in safer driving practices. What percentage of novice drivers tend to "roll" through a stop sign? What is the most common mistake of unlicensed pre-teen drivers, who are brand new to the mindset of driving? How inclined are driving-aged teenagers to obey the posted speed limit? These and other questions can be observed, calculated, analyzed, and documented using accurate simulation-based tools in a convenient and repeatable manner.

As suggested by previous literature, simulators have successfully been applied in a variety of research applications with young drivers. Although training simulators have been increasingly used by school districts, the field requires empirical studies, as is being attempted here, to determine the long-term efficacy of such approaches. Because there is an absence of such longitudinal comparison data, the hope is that based on these and similar published reports, widespread adjustments will be made to existing training programs in an effort to improve teenage driving practice.

DESCRIPTION OF SIMULATORS

As a portion of this study, we will demonstrate the utility of training reinforcement upon simulators of varying fidelity. Accordingly, we have implemented two primary simulator hardware arrangements that will be used for the ongoing study. An overview of our training simulators is provided here.

<u>0-DOF (fixed-based) Simulator</u>

Our fixed-base training simulator (Figure 2) consists of a Simulator Chair in which the driver controls the simulation using: a steering unit with 240 degrees of angular rotation, paddle shifters, and foot pedals. Our visualization is provided by way of three 32" monitors arranged in a half-hexagon, thus providing a full-surround (forward) field-of-view. Finally, the system also includes a basic stereo 2.0 channel sound system.

<u>6-DOF (motion-based) Simulator</u>

Our motion simulator (Figure 3) consists of a 6 DOF motion platform, a passenger cabin that includes 2 front seats w/ seat belts, a steering wheel and 3 foot pedals, a full front vehicle console, rear and side-view mirrors, and an emergency stop switch. Our steering unit features 900 degrees of angular rotation, a mechanical force-feedback capability, and rear-wheel paddle shifters. Our visualization system consists of four 8' x 6' screens (3 front, 1 rear). A stereo 2.1 channel sound system is employed. The simulation system is powered by a tower graphics workstation that has dual-core 2.16 GHz Intel Xeon processors, 12 GB Memory, and a state-of-the-art graphics processor.

Figure 2 – 0-DOF Simulator

Figure 3 – 6-DOF Simulator

REFINEMENT OF SIMULATORS: EFFECTIVE BRAKING

One of the most common technical complaints among drivers of simulators is that the brake pedal does not "feel right." It is important that the simulator be as realistic as possible so that participants can gain proper experience to improve their driving capabilities in an actual vehicle. One way to assess the validity of a simulator is to associate the performance measures obtained in the simulator with those obtained in reality (de Groot et al., 2011). This is accomplished by comparing real vehicle brake pedal data with measurements taken from the simulator's brakes.

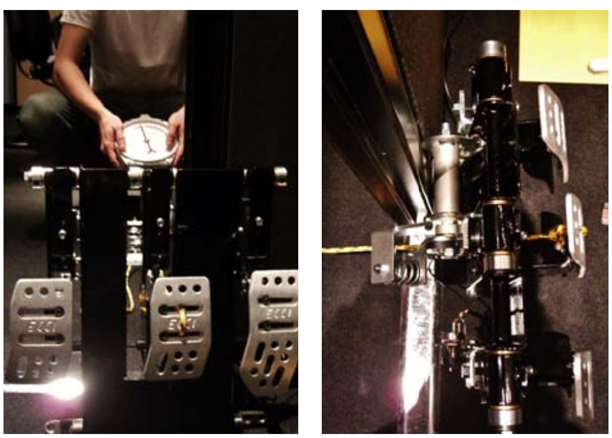


Figure 4 – Experimental Setup (brake pedal)

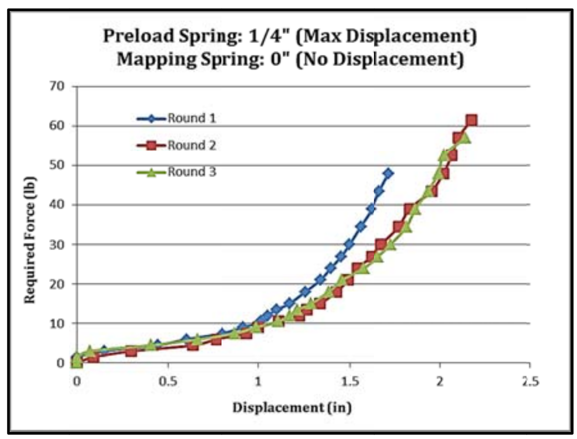


Figure 5 – Simulator brake pedal data

The applied force vs. pedal displacement curve produced by a simulator pedal should resemble that produced by a real vehicle, containing a degree of idle travel before the required force to displace the pedal further increases. After the idle period, the pedal force rises at a faster rate than the pedal travel (i.e., more pedal resistance with more displacement) (Edgar, 2008). Our experimental setup, employed to calibrate the pedal to "match" real-vehicle brake force, is shown in Figure 4. Figure 5 is an experimental plot resulting from preliminary testing, and was encouraging based on its resemblance to previously published real-vehicle analyses of brake pedal performance (e.g., NHTSA, 2011); Figure 6. To validate this data, the simulator brake system underwent an additional twelve rounds of force-displacement testing, and a third degree polynomial equation was fit to the data, now employed as the accepted functional relationship to convert simulator pedal displacement to pedal force. Refer to Figure 7.

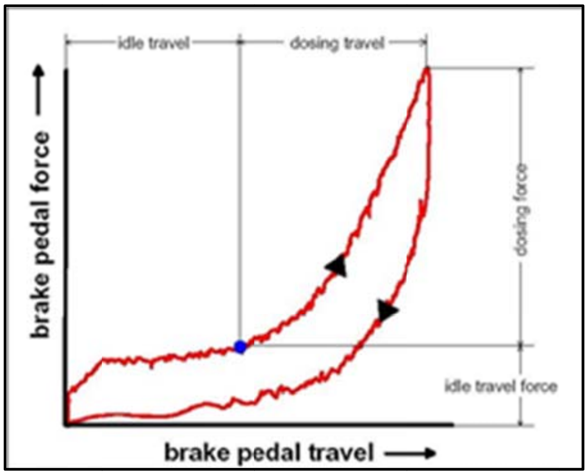


Figure 6 – Previously published pedal data

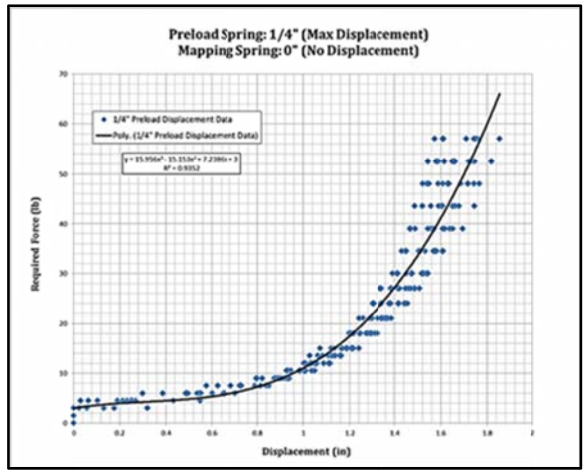


Figure 7 – Polynomial fit (simulator data)

REFINEMENT OF TRAINING MODULES

Our original pilot study (Hulme et al., 2012) focused on the preliminary development of a simulation-based driver training program to help us better understand how motion fidelity plays a role in teen driver training. At the time, a total of seven training modules were developed to allow groups of teens to practice safe diving skills using one of two simulators of varying fidelity. Each training session consisted of pre-simulation surveys, video briefings, driving (and observing as a passenger) each of the simulator modules, a post-simulation driving review, and post-simulation surveys. Various quantitative and qualitative methods were employed to analyze the key differences in training effectiveness with respect to simulator features and fidelity. The numerous shortcomings of that Pilot study served as a motivation to improve the content and focus of the training program, as described in this section.

Refined training focus (2013)

Upon completion of the original study, we decided to re-design our training modules to be more explicitly targeted towards specific driving skills, namely – the Top 5 contributors of teen accidents in New York State (GTSC, 2009): **1) following too closely, 2) driver inexperience, 3) driver inattention or distraction, 4) failure to yield right of way, and 5) unsafe speed**. Each of the revised training modules has a definitive focus to more effectively train students in a progressive manner. See Table 1 for a summary of our revised module content, along with the associated training goals, and the primary Top 5 accident contributors addressed by each listed training goal. This curriculum emphasis was the primary motivation for the re-design of our training modules. In the paragraphs that follow, each of our five revised training modules, and culminating graduation module, are described in more detail.

Table 1 – Summary of revised module content

Module Content	**Primary Training Goals**	**Top 5 Contributors:**
Closed course track	Understand how speed effects vehicle control	**2, 5**
Intersections	Observe driver response to traffic light states and stop signs	**2, 4, 5**
Rain/Snow	Observe how weather affects vehicle performance and roads	**1, 2, 5**
Deer Crossing	Monitor driver response to moving road obstructions	**1, 2, 5**
Slippery Road	Monitor response to hazardous road conditions	**1, 2, 3, 5**
Tailgater	Monitor response and reaction to an impatient driver	**1, 2, 3, 4, 5**
Construction Zone	Monitor behavior amongst lane hazards and construction vehicles	**2, 3, 4, 5**
Speed Bump Zone	Observe driver modulation of speed over roadway bumps	**2, 3, 5**
School Zone	Assure that driver slows down amidst school vicinity and signs	**2, 3, 4, 5**

Modules 1-5

In the **first module**, students learn how to operate the foot pedals smoothly for braking and accelerating, and how to control the steering wheel to turn smoothly and accurately. There are many traffic accidents due to unsafe speed. The main objective for the **second module** is to maintain speed in relation to the environment. Participants are expected to maintain proper lane position, change lanes smoothly, and scan for signs on the road. This module also provides inclement weather effects, which will have an impact on speed and vehicle control, particularly when turning. The primary goals of the **third module** are for students to learn how to maintain appropriate following distance from other cars, apply braking in a timely fashion, and change lanes amidst traffic. These activities aim to minimize driver distraction and excessive speeding. Ultimately, driver awareness is critical for driving at a proper speed amidst challenges on the road. In the **fourth module**, students will learn how to react to common hazards encountered on the roadway, such as construction zone trucks, a school zone crossing, and various deer crossings. Teens will also learn how to drive smoothly in a roundabout to practice yielding the right-of-way in the presence of traffic. Teens will subsequently learn how to control a vehicle on a "closed course" track at various speeds with varying weather conditions. In the **fifth module**, teens will learn how to merge onto and exit from a highway, to drive appropriately and calmly in the presence of a tailgater (i.e., a "road rage" scenario), modulate speed amidst a road sector populated with speed bumps, and obey associated hazard signs.

Graduation Module

In the graduation module, students will have the opportunity to apply what they have learned on the simulator within a final training course that serves as a culmination of the previous five training modules. A variety of hazards are present along this road course, including: a deer crossing, a tailgater, slippery road conditions, a construction zone, a school zone and a speed bump zone. Such hazards depict real life driving situations that challenge the student to multi-task, and have full awareness of their surroundings at all times. For example, the deer crossing helps the student to rapidly identify and react appropriately to an obstruction; the tailgater induces the student to drive defensively and perform an evasive action (e.g. change lanes) to mitigate danger; the construction zone zones forces the student to use visual search techniques, maintain their speed and identify and react (in a timely manner) to roadway signage. These challenges provide much needed exposure to the documented Top 5 causes of accidents, most notably: driver inattention, unsafe speed, and failure to yield the right of way.

REFINEMENT OF DATA MEASURES

In our original pilot study, data was collected by way of numerous mechanisms. Surveys were used both to assess knowledge retention, to gain program feedback (i.e. on simulator hardware and software) from participants, and to solicit anecdotal data from both the participant and from their parents. We also collected vehicle performance information (as captured numerically by the simulator) such as vehicle position and velocity, and data relating to traffic interactions such as driver behavior at stop signs and traffic lights. A major component of our review process with teens (and their parents) was a quantitative measure of driving performance. A scoring algorithm was developed to ensure that students are focused on practicing sound driving principals, and avoiding negative driving habits. The original scoring algorithm employed "0" as the optimal score, with positive penalty points assessed for any incorrect or otherwise non-optimal vehicle maneuver. It was easier to program the simulator to tabulate "points" this way, but these results were counter-intuitive for teens/parents to interpret.

Re-defined measures (2013)

Our initial methods for scoring and recording data required changes moving forward. With relatively large amounts of data associated per participant in our previous study, and having employed antiquated and tedious (manual) methods for collecting and subsequently data, we wanted to streamline various components of the overall process. Our revised approaches, outlined and described here, made data collection, review, storage, analysis and interpretation easier both for the research team and for the research participants.

Surveys

Surveys for the revised program include the Session Based Questionnaires (SBQ), which are employed to determine if the student is learning from the current simulation module content, and is used to assess which simulator fidelity level is most effective for each student to understand specific training techniques. As motion sickness (and associated symptoms) is a common and unfortunate side effect of simulators (for some), the Motion Sickness Assessment Questionnaire (MSAQ) (Gianaros et al., 2010) is employed to query how each student feels (e.g., nausea, dizziness, headache, thirst, dry mouth, etc.) before and after they drive the simulator. Finally, a participant satisfaction form is issued, upon program exit, to solicit overall program rating, comments, and suggestions. Previously, all surveys were completed by hand by participants and had to be analyzed by transferring that "paper and pencil" data to "software". This took place for each participant, for each survey (pre- and post- simulator), for each training session, and for each simulator fidelity level. As a result, we decided to digitize all surveys (using Google Forms) to allow for much more efficient entry (using a hand-held Amazon Kindle), and analysis of the data.

In this way, each participant's information is automatically collected, stored, and analyzed upon entry. The information collected is updated to reflect the changes made in the respective driving sessions.

Evaluator Feedback (qualitative)

At the end of each driving session, there are score and performance reports that advise how they performed during each driving module. While the students are driving the simulator modules, the instructor is completing an instructor evaluation checklist and writing down other qualitative remarks based on the student driving performance. As a portion of the "human-in-the-loop" analysis, the instructor leverages this data to discuss with each teen how they can improve their driving, and emphasizes the driving techniques upon which they performed well.

Simulator data (quantitative)

Our scoring method now employs metrics whereby students are scored separately for stop signs, traffic light interaction, traffic collisions, hazard interactions, and speed modulation, as appropriate, in each training module. This mechanism informs students on areas of improvement, and also allows for easier data analysis. Scoring is now based on a 0-100 scale, (with a "100" being a perfect score), deducting points for inappropriate behavior relative to each driving module. This scale will help students to assess their performance using a familiar metric. Our method for illustrating vehicle performance data for participant review, developed in-house (using Matlab), has been improved to increase detail. Individual lane makers have been added to allow the student to view their lane position with greater detail. Refer to Figure 8.

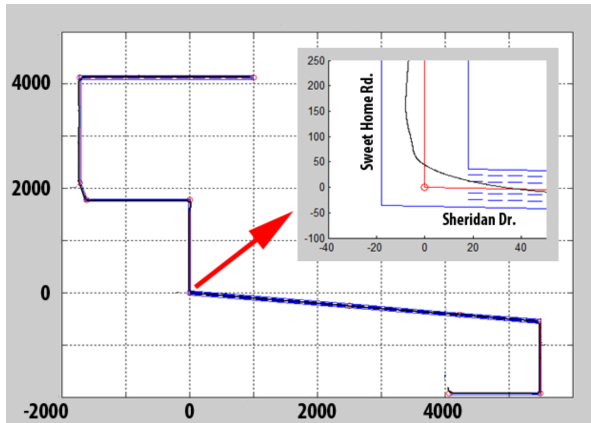


Figure 8 – revised feedback plot (sample)

PILOT STUDY TEST COHORT AND RECRUITMENT

As with the preliminary training program, we recruited ONLY teenagers who had little or no driving experience (learner's permit acceptable), so that the training principals would be the most impactful, and not tarnished by pre-existing bad habits. Members of this cohort were minimally compensated for their time (a $50 gift card) after completing all five of the 2-hour training modules. Future cohorts (summer, 2013, and beyond) of teenagers will be recruited to receive free simulation-based driver training, but once the program has been suitably tested, refined, and "validated", will do so without any auxiliary compensation. Ultimately, 7 teenagers participated in our pilot study test cohort, which took place in May-June of 2013. **Note: the primary intention of conducting this test cohort was to introduce, revise, finalize, and ultimately, disseminate details of our revised training program content in advance of its "official" deployment later this year**. Teens were recruited from a variety of sources, including digital mailings, posted flyers, and a community newspaper (The Bee Group).

SAMPLE RESULTS AND DISCUSSION

The primary motivation for this cohort study was to demonstrate the enhanced training materials highlighted in this paper. These enhancements include training module content (i.e., better aligned with the Top 5 causes of collisions), and refinements to our primary data measures: surveys, qualitative (evaluator) and quantitative (simulator). Accordingly, for the analysis of results, we offer an example each of the above, specially noting how our improved data collection methods have demonstrated their benefit for measuring driver performance within a simulator.

Data Analysis I: Surveys

During our initial (2012) pilot study, participant surveys were completed by hand and manually transferred into database software (e.g. MS Excel) for analysis purposes. For large amounts of data, this was a tedious process. In an effort to minimize human error and unnecessary effort, all surveys were converted to digital format, which has improved our ability to collect and interpret results from our driving trials. Note that we not only offered participant (teen) surveys to gain feedback, but we also required parents to complete an exit survey, which was also digital and available on-line. With digital surveys, the data becomes automatically post-processed once entered by the participants. Figure 9 demonstrates the flow of information within our revised survey-based data collection system.

Teen participants first enter data into our digitized survey system, which is then transferred to a spreadsheet, where the data is sorted and stored. From there, various analyses are performed to calculate up-to-date grading averages per participant, average scores per survey question (with standard deviation), and per module, etc. Figure 10 presents a representative analysis from our survey data. In this case, plotted as a pie graph, a PRE session survey question is analyzed. The survey question is in regards to appropriate speed behavior as a stop sign is approached. Generally speaking, and not surprisingly, survey scores tend to increase for the corresponding POST module survey data, once collected.

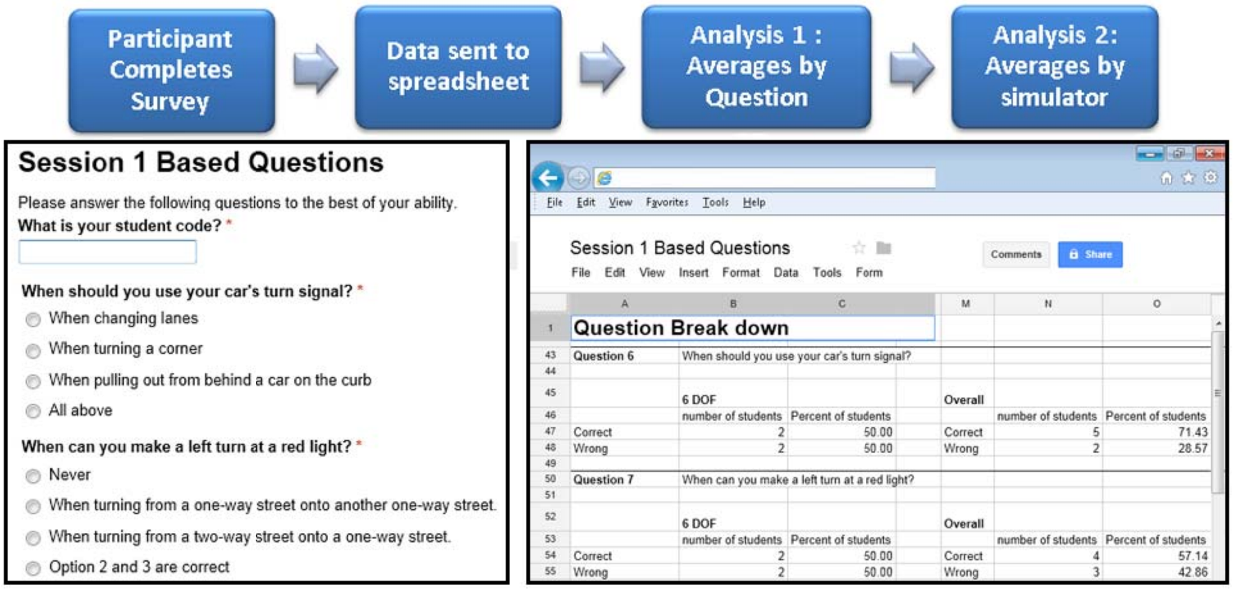


Figure 9 – Information pipeline on revised Surveys

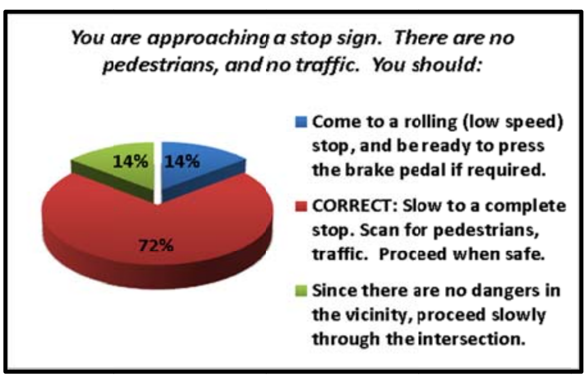
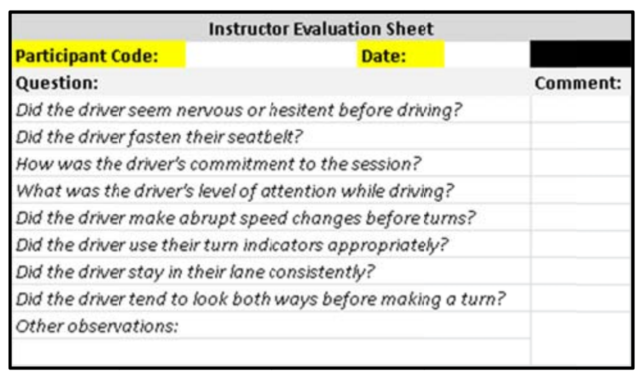


Figure 10 – Participant survey data (sample)



Instructor Evaluation Sheet		
Participant Code:	Date:	
Question:		Comment:
Did the driver seem nervous or hesitent before driving?		
Did the driver fasten their seatbelt?		
How was the driver's commitment to the session?		
What was the driver's level of attention while driving?		
Did the driver make abrupt speed changes before turns?		
Did the driver use their turn indicators appropriately?		
Did the driver stay in their lane consistently?		
Did the driver tend to look both ways before making a turn?		
Other observations:		

Figure 11 – Evaluator Feedback (sample revised form)

<u>Data Analysis II: Evaluator Feedback (qualitative)</u>

To enhance our qualitative measures, improvements to our evaluation sheets were likewise made. Previously, instructors would answer pre-made questions/comments on paper. As with teen participant data entry, instructor evaluations are now conducted digitally using an Amazon Kindle. To attain a better sense of how well the students performed during simulator driving, we added a section where instructors write down detailed notes about the driver's performance. These notes allow the evaluator to verify student progress, and serve to navigate the conversation between the instructor and student in the post-session de-briefing. While the simulator and other engineering tools (e.g., Matlab) are used to measure, for example, exact speed behaviors, these tools cannot easily be programmed to "see" the improvements that each driver has made. This "human-in-the-loop" component is therefore essential in simulation-based driver evaluation. Refer to Figure 11, which demonstrates a revised evaluation sheet. Figure 12 is a representative graph attained through the use of our re-designed evaluator metrics. Here, we are plotting evaluator response for three categories: lane maintenance, use of turn indicators, and speed fluctuations while turning. For each module, instructors note driver performance, in various categories, as: "none of the time", "some of the time", "most of the time", or "all of the time", which for the purposes of our graph, are denoted on a 1-4 Likert-type scale, respectively. As demonstrated by the horizontal bar graph, for all three performance categories, the general trend is that the cohort average score tends to increase as the modules progress. Not surprisingly, this is indicative of noted driver improvement with additional time and exposure on the simulator.

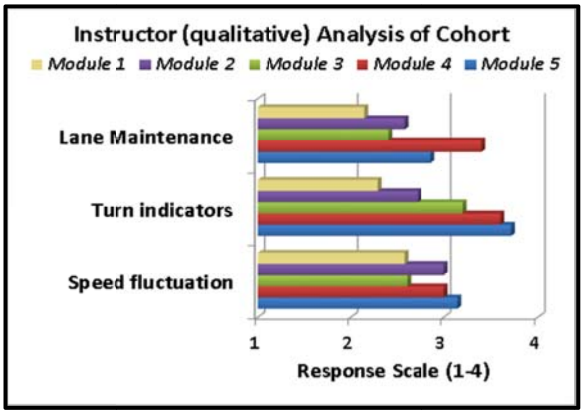


Figure 12 – Instructor analysis data (sample)

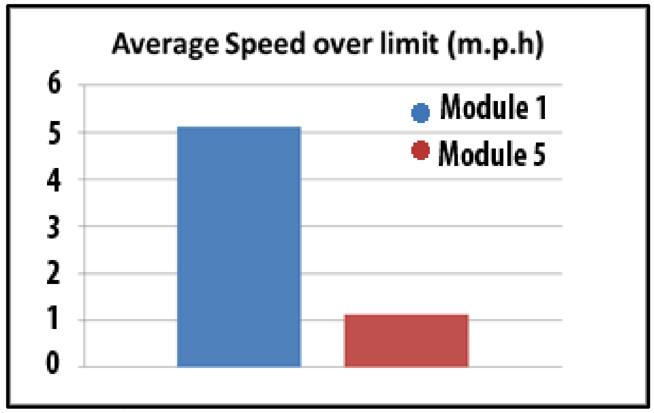
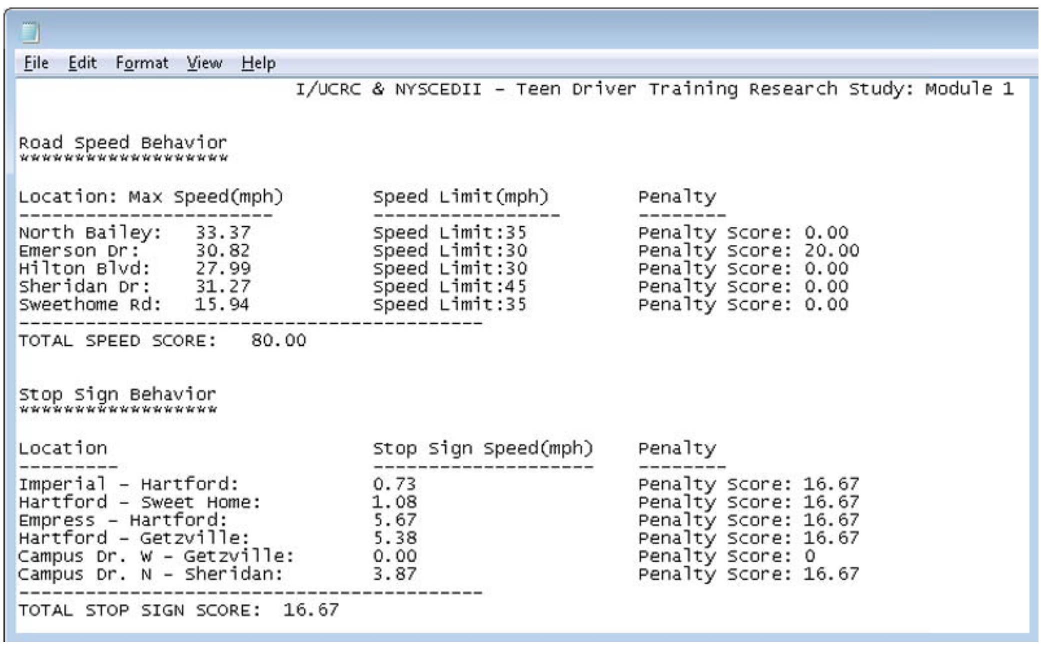


Figure 13 – Simulator Data (average speed overage)



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                         I/UCRC & NYSCEDII - Teen Driver Training Research Study: Module 1

Road Speed Behavior
*******************

Location: Max Speed(mph)         Speed Limit(mph)        Penalty
-----------------------          -----------------       --------
North Bailey:    33.37           Speed Limit:35          Penalty Score: 0.00
Emerson Dr:      30.82           Speed Limit:30          Penalty Score: 20.00
Hilton Blvd:     27.99           Speed Limit:30          Penalty Score: 0.00
Sheridan Dr:     31.27           Speed Limit:45          Penalty Score: 0.00
Sweethome Rd:    15.94           Speed Limit:35          Penalty Score: 0.00
------------------------------------------
TOTAL SPEED SCORE:    80.00


Stop Sign Behavior
******************

Location                         Stop Sign Speed(mph)    Penalty
---------                        --------------------    --------
Imperial - Hartford:             0.73                    Penalty Score: 16.67
Hartford - Sweet Home:           1.08                    Penalty Score: 16.67
Empress - Hartford:              5.67                    Penalty Score: 16.67
Hartford - Getzville:            5.38                    Penalty Score: 16.67
Campus Dr. W - Getzville:        0.00                    Penalty Score: 0
Campus Dr. N - Sheridan:         3.87                    Penalty Score: 16.67
------------------------------------------
TOTAL STOP SIGN SCORE:   16.67
```

Figure 14 – Revised Score Sheet (sample data)

<u>**Data Analysis III: Simulator-scored Data (quantitative)**</u>

Improvements to the simulator-generated score sheets have also assisted with teen driver performance evaluation. The score sheets have been re-purposed to tabulate a variety of quantitative performance metrics. Refer to Figure 14. As shown, the score sheet is formatted in an easy-to-interpret manner, and displays roadway speeds, speeds at stop sign zones (and associated penalties) for each segment encountered. In this sample case, a teen participant remained below the speed limit on 4 of the 5 roads, and thus earned an 80/100. For this participant, behavior at stop signs was not as favorable. The teen "rolled" through 5 of the 6 stop signs, only once coming to a complete stop (i.e., 0.0 speed). Accordingly, their total score was a 16.67/100. Figure 13 illustrates a corresponding sample plot that showcases this simulator data, as it demonstrates student improvement (<u>entire cohort average</u>) in speed handling within the simulator from the beginning of the program (Module 1) to the end of the program (Module 5). In this case, we are plotting average speed overages per module, which are shown to reduce from ~ 5 mph to 1 mph.

CONCLUSIONS

Documented statistics have shown that the greatest lifetime chance of being involved in a motor vehicle crash occurs in the first six months after licensure (Mayhew et al., 2003). Yet in spite of these negative outcomes, typical driver education approaches remain largely similar to those used 50 years ago. According to Dr. Thomas Frieden, Director of the CDC, Motor vehicle safety is one of the agency's most “winnable battles”, a problem that can be solved if evidence-based strategies are implemented across the U.S. (CDC, 2013b). One logical solution to this ongoing problem is to assure that new drivers receive improved driver training – both in terms of quality and quantity. Accordingly, our research team is continuing to improve a suite of standardized advanced technological training resources for high school-aged teenagers that will make them better prepared for the challenges of driving.

In this paper, we have recommended essential modifications for such an environment, including a modified set of training modules (i.e., influenced by the Top 5 causes of accidents among the teen demographic), improved data measures (i.e., designed to be easier to tabulate by trainees, and to interpret by trainees), and modifications to the simulator itself (e.g., systematic modifications to brake pedal behavior to improve functionality and realism). The major updates featured in this paper were sampled upon a small pilot cohort, whose results were collected and analyzed. With newly revised training modules and data collection methods, we have emphasized the potential for employing a diverse set of **quantitative and qualitative measures** (e.g., simulator-measured driving performance, pre- and post- surveys and questionnaires, and instructor feedback) to evaluate teen driving performance upon a variety of core driving skills. The improvements highlighted in this paper will help us to ensure the continued evolution of our program for future training and longitudinal data analysis, as will be outlined next.

FUTURE WORK

The deployment of the described training program can best be viewed as a three-stage process. The first stage was the deployment of the initial training program. The second stage is described in this paper, and serves as the revision of the preliminary program in response to **lessons learned** during the first stage, primarily in terms of program content and structure. The final stage of program deployment will begin in late 2013, and continue indefinitely thereafter. Our long-term goal is simple, but ambitious – with the support of empirical evidence, prove the value of using simulation as a required, supplementary component to all teen driver training.

A major portion of the ongoing effort will be the collection of cohort driving records. Subsequent to obtaining parent/teen consent, the MV-15 report (DMV, 2013) will provide valuable information regarding any traffic accidents, moving violations, and other negative driving outcomes. Once a statistically significant number of teens have encountered our program, we will compare drivers from our 10-hour simulation-based training program to State and National averages (most of whom have received little or no simulator training). Such empirical data – presently unavailable - will have the appropriate impact to influence stakeholders and policymakers to embrace simulation technology for future driver training protocols, with the goal of steadily improving roadway safety.

Finally, to aid in the process of the evolutionary deployment of technology-driven and simulation-based driver training programs, first throughout the State of New York, NYSCEDII will continue to expand the scope of its recent collaborations with two critical entities. First, to assist with driver training, we will partner with the Center for Children and Families (CCF) at the University at Buffalo, who specialize in public health-based treatments and training with teenagers, and have federally funded research experience working with simulator-based interventions. Likewise, we will leverage the ongoing support of the Driver Education Research and Innovation Center (DERIC), a collaboration between the New York State Departments of Health, Motor Vehicles, and Education, whose mission is to implement programs education-based that reduce the risk of crashes, injuries and deaths among young drivers.

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