Chapter

# A Multitiered Holistic Approach to Traffic Safety: Educating Children, Novice Teen Drivers and Parents, and Crash Investigators to Reduce Roadway Crashes - An Eight-Year Introspective Project

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## Abstract

The Strategic Prevention Framework (SPF), developed by the Substance Abuse and Mental Health Services Administration (SAMHSA), was adopted as an effective injury reduction model for reducing driver injury crashes on community roadways. Kean University and the New Jersey Division of Highway Traffic Safety (NJDHTS) adopted crash prevention strategies involving education and enforcement outreach. First, an effective K-12 traffic safety program was established for supporting driver education training and then crash investigation training, and a statewide traffic safety specialist certification was promoted within the law enforcement community. This successful outreach initiative also involves community representation, including law enforcement personnel and parents of novice drivers. Best practices have been established in New Jersey by four traffic safety specialist (TSS)-Level 2 leaders, with over 100 more TSS officers waiting to qualify for this second tier. Future plans involve an outreach program for officers to develop traffic safety programs in their communities while qualifying for the TSS-Level 2 designation.

**Keywords:** traffic safety, novice driver, crash investigation

## 1. Introduction

The Haddon matrix is a public safety model that was developed in 1980 to further standardize safety analysis. The matrix is a two-dimensional model that adapts principles of public health to crash injuries and fatalities. The first domain of the model involves rows that are divided into pre-crash, crash, and post-crash phases. The second domain is known as influencing factors of injury: human, vehicle/equipment, physical environment, and socioeconomic. The Matrix has been successfully adopted to evaluate crash sites and/or related conditions. Results often provide information on safety issues and potential solutions. This planning tool is effective for establishing countermeasures based on crash-related data collection and collaborations with involved agencies. The countermeasures offer a variety of solutions addressed through education, enforcement, engineering, and emergency response solutions (the 4 Es of Safety) [1].

In 2005, John Hopkins School of Public Health had successfully adopted the Haddon matrix in preparation for a public health threat (e.g., SARS outbreak and dirty bomb response). Influencing factors were effectively adapted to facilitate the conditions surrounding emergency readiness [1]. Specifically, the "human" category was renamed "host," and "vehicle/equipment" category had been changed to "agent/vehicle." Otherwise both models were comparable in analysis. This phase factor approach offered a multiple factor concept for delivering public health interventions with strategies to prevent, respond to, or mitigate injuries. Pre-event activities include risk assessment, communications, and prevention efforts, while the event phase deals directly with the crisis. Pre-event activities include risk assessment, communication, community-based medical interventions, counseling, and quarantine measures. Post-event activities involve disaster mitigation, longer-term treatment, risk communication, and recovery efforts.

While the Haddon matrix is an effective tool for addressing pending public health incidents, pre-event strategies are focused on the crisis and not fully involved with prevention. Fortunately, the nationally based Substance Abuse and Mental Health Services Administration (SAMHSA) has successfully adapted the Haddon matrix to include five steps that form a Strategic Prevention Framework (SPF) [2]. This new framework offers individual- as well as community-based collaboration for the prevention of crash injuries. Therefore, Haddon environmental strategies of enforcement and education were broadened to include communities in supporting the reduction of roadway crashes. While traditional education remains effective for addressing individual learning needs, communications, public education, social marketing, media advocacy, and media literacy have been used to support crash reductions (e.g., no texting and driving campaigns). After policies and laws are officially enacted, supportive enforcement strategies currently involve surveillance, penalties, and consequences for unsafe actions as well as participation in community policing and incentive programs for improving public safety. Lastly, collaboration partnerships support further reduction of motor vehicle injuries and fatalities.

There are two guiding principles of the SPF Framework: understanding the community needs and sustainability in achieving and maintaining long-term results. Once safety issues have been identified through analysis of crash data, needed resources are identified that include manpower, equipment, and training; a formal plan is then established, as part of the SPF model. The plan is implemented to address population-level challenges. Finally, evaluation involves the ongoing facilitation of prevention efforts with reliance upon a community-based team approach.

In 2010, Kean University and the New Jersey Division of Highway Traffic Safety (NJDHTS) identified crash prevention strategies for education and enforcement. First, an effective K-12 traffic safety program was established for supporting driver education training and then crash investigation training, and a statewide traffic safety specialist certification was promoted within the law enforcement community. During the past 8 years, the traffic safety community has worked together with Kean University to support law enforcement and public education-based programs, participate in applied research, develop targeted initiatives, and market K-12 traffic safety educational curricula on behalf of the division. This successful outreach initiative also involves community representation, including parents of novice drivers. The following section describes the Strategic Planning Framework as well as the corresponding education and enforcement components.

## 2. Traffic safety injury prevention strategic planning framework (SPF) model

### 2.1 Description

In order to support this initiative, two independent advisory committees were formed with some overlap in representation. The ongoing Education Advisory Committee includes membership from the teacher's professional association, known as the New Jersey Association of Health Physical Education Recreation and Dance (NJAHPERD), Driver Education Association representatives, and New Jersey State Department representatives from the Division of Highway Traffic Safety, Motor Vehicle Commission (MVC), and Department of Education (DOE). The Enforcement Advisory Committee collaboration differs with equal levels of state, county, regional, and local representation. Also, the New Jersey State Police are represented, along with leadership from the Police Traffic Officers' Association of New Jersey (PTOANJ), the New Jersey Division of Highway Traffic Safety, and participating universities.

As expected, both committees serve two distinct roles. The Education Advisory Committee is responsible for conducting K-12 traffic safety education including driver education, while the Enforcement Advisory Committee oversees crash investigation training and local traffic safety programs. Fortunately, the traffic safety specialist certification program addresses the ongoing need to educate officers on new technologies and promote community-based safety projects for college-level credits. **Figure 1** identifies two programs that each advisory committee administers through the injury prevention model. Further information will follow in the next section.

### 2.2 Background

Advisory members are expected to participate in a five-step process to ensure ongoing oversight of the education and enforcement components. Each committee is responsible for (1) assessing the level of crash-related needs and priorities within the state. Then a program component is (2) built to address the targeted need. (3) Strategic plans are developed that involve evidence-based strategies, while (4)

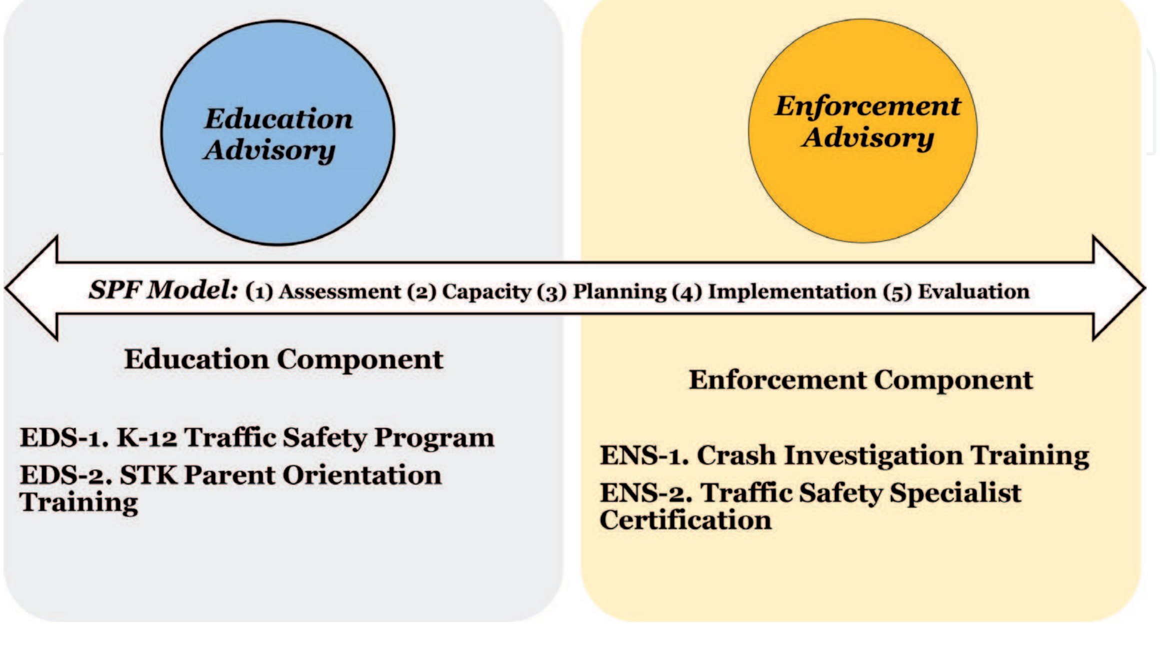


**Figure 1.**
*Traffic safety injury prevention strategic planning framework (SPF).*

evidence-based prevention programs are implemented in specified areas. Finally, (5) programs are evaluated and monitored for ongoing improvement and success.

The SPF procedure resulted in two very important outcomes for the advisory committees to support. The Education Committee has targeted their prevention efforts on the development of a K-12 traffic safety component for educating children (e.g., future drivers) on the importance of following traffic safety procedures. Therefore, rules of the road, seat belt usage, and personal safety are practiced before children mature and become novice drivers, when enrolling in driver education course. Since this is a community-based model, students are involved in activities that promote traffic safety in the community. Therefore, parents and children are engaged in establishing a critical "safety" relationship, long before the child becomes a novice driver.

Since the Enforcement Advisory Committee relies on officers who are dedicated public servants, prevention is focused on implementing community-based safety initiatives to address local needs. This approach begins with the participation in extensive crash investigation training, thus enabling officers to identify potential safety risks that may be overlooked by others in the community. Specifically, the traffic safety specialist certification includes officer recognition as well as the opportunity to participate in projects that involve crash analysis and adoption of crash reduction countermeasures.

### 2.3 Education component (EDS)

A linear approach to traffic safety has been developed for engaging students in the traffic safety community as a passenger, pedestrian, or bicyclist. Elementary students are trained by health and physical education teachers to adopt safety practices and injury prevention behaviors. Middle school students are then instructed on the assessment and remediation of unsafe traffic conditions, while high school students focus on the role of becoming a driver and safe passenger.

### 2.4 K-12 traffic safety program

Implementation of the K-12 roadway safety curriculum has been in targeted areas of New Jersey, instead of on a statewide basis. The K-12 traffic safety programs include several proven resources which were selected based on their effectiveness (**Table 1**) [9]. A total of 76 lesson plans were developed and selected for bicycle [11], pedestrian [11], traffic safety [10], and supplemental units [8]. A series of developmental skills have been incorporated into the program, beginning with awareness of traffic safety behaviors and finishing with students serving as peer advocates. Learning goals involve identification of prevention processes, development of strategies for reducing unsafe safety conditions, and assessment of the traffic systems to identify unsafe conditions encountered by at-risk populations. High school students are also required to analyze crash data to further understand and prevent traffic crashes, develop rationales for peer compliance of traffic safety laws, and lead safety advocacy campaigns [12].

The Grade 9–12 section is dominated by driver education training founded upon the MVC Driver Education Manual. As a result, the traffic safety community encountered the need to further promote advocacy and oversight of driver education. When the New Jersey Driver Education Committee (NJ DEC) Charter Plan was adopted in April 2017, this committee began to work on conducting an assessment of classroom instruction and determined that requiring a standardized curriculum would be ineffective, since most current programs are (80%) in compliance with national

| Grade level | Cumulative progress indicator (CPI) |
|---|---|
| Prekindergarten | 1. Use safe practices indoors and outdoors (e.g., wear bike helmets, cars are used, and seat belts are worn)<br>2. Develop an awareness of warning symbols and their meanings (e.g., red light, stop signs, etc.) |
| Kindergarten-Grade 2 | 1. Identify ways to prevent injury at home, in school, and in the community (e.g., fire safety, poison safety, and accident prevention)<br>2. Identify procedures associated with pedestrian, bicycle, and traffic safety |
| Grades 3–4 | 1. Determine the characteristics of safe and unsafe situations, and develop strategies to reduce the risk of injuries at home, in school, and in the community<br>2. Examine the impact of unsafe behaviors when traveling in vehicles, as pedestrians and when using other modes of transportation |
| Grades 5–6 | 1. Summarize the common causes of intentional and unintentional injuries in adolescents and related prevention strategies<br>2. Summarize the components of the traffic safety system, and explain how people contribute to make the system effective |
| Grades 7–8 | 1. Assess the degree of risk in a variety of situations, and identify strategies to reduce intentional and unintentional injuries<br>2. Analyze the cause of non-compliance with the traffic safety system and their consequences |
| Grades 9–12 | 1. Determine the causes and outcomes of intentional and unintentional injuries in adolescents and young adults, and propose prevention strategies<br>2. Analyze the relationship between alcohol and drug use and the incidence of motor vehicle crashes<br>3. Develop a rationale to persuade peers to comply with traffic safety laws and avoid detractors<br>4. Summarize New Jersey motor vehicle laws and regulations, and determine their impact on the incidence of crashes and injuries<br>5. Plan and implement an advocacy strategy to stimulate action on a state, national, or global health issue, including but not limited to organ/tissue donation |

**Table 1.**
*Traffic safety program.*

guidelines. Furthermore, the New Jersey model has been ahead of the country with involving parents in novice driver education and will be discussed the next section.

### 2.5 Parent-teen orientation training

A national review of Parent/Teen Graduated Driver Licensing (GDL) programs was conducted in 2011 and yielded limited information on behavioral approaches for parents to teach their teenagers to drive. Fortunately, the Children's Hospital of Philadelphia (CHOP) [3] completed a national study that identified teenagers' perspectives on the role of their parents in the GDL process. Under direction of the division, Kean University staff had developed the Parent/Teen Orientation Workshop that empowers parents to support their teens in the development of safe driving skills for life. Learning outcomes were incorporated into this 1–1/2-hour orientation program and continue to be measured in pre−/post-study.

The Parent/Teen Orientation Program has been organized into three modules: introduction, practice driving, and enforcement of the graduated driver's license. This interactive format requires facilitators to briefly review slides for impact, address talking points on the topic, and engage audiences of parents and teens in discussions. Also, several scenarios are presented as learning experiences (**Table 2**).

| Module | Content |
|---|---|
| Introduction | National/teen driver statistics (i.e. no. 1 killer of teens claiming nearly 6000 lives each year, CHOP)<br>Background on how GDL has worked to improve teen driver safety and save young lives. Parental roles and their impact on teen driver safety |
| Practice driving | National teen driving statistics (NHTSA) and changes in behavior that can decrease crash risks with experience<br>Strongly encourage parents to expose their young driver to various road and weather conditions noting that it is safer and smarter to expose them to these conditions while you are in the vehicle<br>Discussion of a typical families schedule taking into account the various types of families (one parent, etc.) showing how an hour a week can be found to practice<br>Alternative approaches for teen driving coaches (e.g., family or friends with safe driving habits) |
| Enforcement of GDL | Presentation of CHOP data showing the safety experience of teens with authoritative parents<br>Teens who describe authoritative parents, as compared to uninvolved parents are:<br>• Half as likely to crash<br>• 71% less likely to drive while intoxicated<br>• 30% less likely to use a cell phone while driving<br>Emphasize that teens need clear instruction and parents act as role models, since they have been teaching their teen to drive by the example since childhood<br>*Practice scenarios:* Exchange between teen and parent when teen's attempt to justify or plead the case for breaking a restriction (curfew-going to a late movie, passenger-carpooling for school activity/sports use of cell phone—they receive a call from parent)<br>Demonstration of the distraction that cell phones create for drivers and the brains inability to focus on both driving and talking on the cell phone at the same time |

**Table 2.**
*Parent-teen orientation program.*

### 2.6 Enforcement component (ENS)

The crash investigation component establishes baseline knowledge for the enforcement initiatives. Basic investigation involves the development of investigation skills to prevent crash risks and optimize traffic flow when a crash does occur. Recognition and preservation of evidence is accomplished by utilizing photographing techniques, sketching, and measuring vehicle damage. Speed calculations are performed, in order to determine time-distance factors of a crash. Advanced investigation is an analytic approach to measurement, photography, and sequence analysis. Work and energy formulas are used to determine speed, while vectors have been adopted as effective tools for presenting crash analysis findings. This background offers tools for investigators to identify potential crash sites and develop solutions to address potential crash hazards. Further information will be presented that identifies crash investigation training content, the traffic safety specialist requirements, and resultant safety benefits for the community.

### 2.7 Crash investigation program

During the past 20 years, New Jersey Division of Highway Traffic Safety (NJDHTS) cosponsors crash investigation training for municipal, county, and state police personnel. In 2010, Kean University was contracted to work with the New Jersey crash instructors and develop a crash investigation training program. After conducting a national review on crash investigation and locating best field practices, courses were created through the Enforcement Advisory Committee. The curriculum has been based on state needs and national practices. This hybrid course design of a traditional and interactive delivery system adequately accommodates the many challenges faced by law enforcement officers working on the most congested roadways in the nation [4]. A general format of instructional goals and objectives, assessment strategies, content, worksheets, and instructional evaluations has also been employed for the basic and advanced crash investigation courses. These tools have enabled the program to be properly vetted and measured for effectiveness of learning strategies, instructor delivery of content, and ongoing analysis of data collection techniques.

### 2.8 Basic crash investigation

Basic crash investigation is designed to offer police officers an awareness of skills required to conduct traffic crash investigations. Students are provided with a working knowledge of evidence and information needed upon arrival at the scene. The course addresses how to safely obtain the needed information without further endangering themselves, the victim, and the community. Students will be trained on properly transferring evidence and information collected at the traffic crash scene to reports and diagrams for courtroom testimony (**Table 3**) [4].

### 2.9 Advanced crash investigation

The prerequisite for this 2-week course is the completion of basic crash investigation. The course involves interpreting tire marks, road scars, advanced measuring methods, vehicle damage analysis, and vehicle behavior during a crash. If applicants have problems with math from basic crash investigation, they should practice algebra skills prior to signing up for the course, since there is a noticeable emphasis on math formulas that relate to collisions (**Table 4**) [4].

### 2.10 Traffic safety specialist (TSS) certification component

The traffic safety specialist certification was first established in Maryland to support the Maryland Strategic Highway Safety Plan [6]. This designation has been designed to recognize police officers who have attained notable experience, education, training, and proficiency in highway safety and traffic enforcement methods and procedures. The program began in 2011 and was opened to police agencies that perform law enforcement duties. In New Jersey, the designation was adopted by a criteria selection committee, in coordination with the Police Traffic Officers' Association and the state police.

The TSS program requires documentation of experience levels, training, job performance, and skill proficiency as a traffic officer. The first phase enables officers to be recognized for specialized training beyond the academy. *Level I* requirements include 3 years of independent patrol/traffic experience, speed detection device certification, standard field sobriety certification, and 30 points of earned electives. One elective point is also awarded for each year (up to three points) of documented military experience, while up to three points (1 = Associates, 2 = Bachelors, 3 = Masters) are awarded for documented college experience. Officers may also obtain up to seven points for traffic safety awards received during their employment.

After the *TSS program-Level I* has been successfully approved, *TSS-Level II* requires applicants to have participated in local traffic studies or traffic safety implementation projects. They must also have 5 years of independent patrol/traffic experience; meet the *TSS-Level I* requirements; and be recognized as a crash reconstruction investigator, drug recognition expert, or commercial vehicle safety

| Module | Content |
|---|---|
| 1.1. Introduction to crash investigation | Overview of crash investigation techniques used to support increased prosecutable crash cases |
| 2.1. Crash investigation background | Review of crash investigation techniques that include at scene traffic enforcement, prevention programs, and resuming traffic flow patterns |
| 3.1. Crash information from people | Identification of conditions affecting the ability of drivers to operate a motor vehicle and pedestrian misconception of driver abilities and motor vehicle capabilities that lead to crashes. Examination of physiological and psychological factors affecting drivers and pedestrians and occupant kinematics concepts |
| 4.1. Recognizing roadway evidence | Recognition, investigation, and recording of physical marks from plotting vehicle positions before, during, and after the impact at the crash scene |
| 5.1. Crash scene measurements | Skills development includes gathering accurate measurements and recording important data from the crash scene. Roadway configurations and intersections are examined to enhance student abilities on developing scale diagrams, while customized traffic templates are utilized to identify grades and superelevations. Recognizing and recording physical roadway marks also assist investigators in plotting the vehicle position before, during, and after the impact |
| 5.2. Crash scene measurements (traffic template) | Examples are presented on the limitation of measurements, along with techniques for using templates for diagramming crash scenes for and courtroom presentations |
| 5.3. Crash scene measurements (field sketches) | Further development and refinement of skills to gather and record accurate measurements and data from the crash scene. Several roadway configurations and intersections are used to enhance student abilities on developing scale diagrams. Illustrations and drawings are also produced from photographs and other reference materials |
| 6.1. Documenting crash scene evidence | Background information is presented on effectively documenting evidence with photography. Emphasis is placed on taking sufficient photographs, based on camera location at the crash scene for reconstruction and courtroom presentations |
| 7.1. Documenting crash scene evidence from vehicles | Vehicle damage assists in determining the cause of a crash. Matching vehicle damage to roadway marks and identifying the difference between contact and induced damage. Also, data collection priorities at the crash scene are featured |
| 7.2. Tire inspection and documentation | Background information on tires and at-scene methodologies are examined relative to documenting evidence. Tire abnormalities, hydroplaning action, and other conditions are further examined |
| 7.3. Evidence from lamps | Descriptions of lamp types and parts and research related to legal statutes. There is also a discussion on incandescent lamps and general terminology used for gaining a better understanding of hot and cold shock. Also, lamp inspection is addressed, as it relates to the crash scene |
| 8.1. Basic mathematics review | Brief review of concepts and function of calculation tools enables students to successfully complete basic mathematical functions |
| 8.2. Coefficient of friction and drag factor | Drag sled and test skid procedures are demonstrated for determining grade and acceleration/deceleration. Emphasis is placed on the importance of locating, recognizing, measuring, and recording physical marks on the roadway at the crash scene |
| 8.3. Estimating vehicle speed | Importance of locating, recognizing, measuring, and recording physical roadway marks and evidence is addressed, along with the procedure used for determining the coefficient of friction and speed estimates for skid marks |
| 8.4. Time and distance | Speed estimates are conducted to calculate time and distance factors of a crash |

**Table 3.**
*Basic crash investigation course content.*

| Module | Content |
|---|---|
| 1.1. Introduction to advanced crash Investigation | Advanced crash investigation requires students to have knowledge of interpreting tire marks and road scars. Advanced measuring methods, vehicle damage analysis, and vehicle behavior during a crash are addressed in this course |
| 2.1. Vehicle damage | Skills are presented for obtaining residual crash photographs and measurement of vehicle damage. The Cartesian coordinate system will be described along with the linear perimeter measurement system. Vehicle behavior in a crash, PDOF, measurement of residual damage, and determination of width or length of damage are also reviewed in this module |
| 2.2. Vehicle damage review | Field exercise is conducted for obtaining residual damage photographs and vehicle damage measurements |
| 3.1. Vehicle behavior in crashes | Newton's laws of motion [5] are related to vehicle behavior during a crash. Relationships between motion, acceleration, and action/reaction are applied to crash investigation and principle direction of force (PDOF) |
| 4.1. Advanced math review | Information is presented for calculating speed estimates from simple skid and yaw marks, as well as other evidence found at the crash scene |
| 4.2. Time-distance calculations | Relationship between time and distance in the crash sequence is reviewed and applied to calculate the vehicle location during a crash |
| 4.3. Work and energy | Work is done when a vehicle slides, while (kinetic) energy dissipates into heat energy, a tool for determining vehicle speed and a major part of crash investigation. Examples are presented on the amount of change produced or work done as there is change in velocity of an object |
| 4.4. Geometry and trigonometry review | Examples are presented on the use of angles, triangles, and trigonometry in crash investigation |
| 4.5. Momentum | Collinear momentum analysis for pre-crash determination is developed |
| 4.6. Two-dimensional momentum | Two-dimensional momentum project is conducted using "X" and "Y" axis information |
| 4.7. Radius and critical speed yaw | Radius and critical speed yaw are presented and measured, in order to calculate an actual average vehicle speed from the marks |
| 4.8. Airborne crashes | Speed of a vehicle will be calculated when it has left the road surface |
| 4.9. Introduction to vectors | Effective formulas and methods are examined for completing vector diagrams, linear-momentum calculations, and scalar exercises |

**Table 4.**
*Advanced crash investigation course content.*

inspector. A traffic study must be submitted by applicants, along with a proof of 30 earned elective points, in order to be eligible for equivalent college credits and the TSS credential that is recognized for court testimony (**Table 5**) [6].

Over 80 courses are approved in 9 designated areas at county-based police academies. Many national programs (i.e., FBI, IPTM, and NIMS) apply because they are held in New Jersey and often sponsored through NJDHTS and NJSP. One half point is awarded to courses that are 4 hours in duration, while maximum credit of 10 points will be received for 80-hour training programs. Quarterly meetings are held to review the awards with Kean University taking the leadership as committee chairperson for the 10-member committee. The program was piloted in February 2016 and continues to attract participants who are dedicated to promoting crash reduction and injury prevention initiatives.

A linear approach to traffic safety education has been used for student engagement as passengers, pedestrians, or bicyclists. Elementary students are trained with

| Categories | Level I | Level II |
|---|---|---|
| 1. Patrol experience | 3 years | 5 years |
| 2. TSS level designation | N/A | Level I |
| 3. Certifications | • Speed detection device<br>• Field sobriety test cert. | • Reconstructionist, DRE, ACTAR cert., or traffic engineering cert.,<br>• Instructor cert. |
| 4. Elective options*<br>• Military (3 points)<br>• Post-secondary (3 points)<br>• Traffic awards (7 points) | 30 points | 30 points |
| 5. Written reports | N/A | Traffic study written report—Participant level |

**Table 5.**
*Traffic safety specialist designation criteria.*

awareness techniques and practice of injury prevention behaviors, while middle school students address traffic safety issues through assessment and remediation of unsafe conditions. High school students are fully engaged in preparing for their roles as drivers and/or safe passengers, but not without the help of parents and the community. Conversely, the enforcement component provides law enforcement professionals with analytical tools for identifying potential crash conditions and potential crash hazards, which may/or may not be apparent to the general public. Furthermore, officer participation in the traffic safety specialist program enables them to share personal traffic safety accomplishments with their peers.

## 3. Effectiveness of the prevention model

### 3.1 Education component

Two studies were conducted to address the effectiveness of the education component. First, a 1-year pilot study was conducted in 2011 that involved teachers from the second largest school district in the state. Evaluations involved ease of usefulness and classroom benefit. A comparison of group differences was based on participation in monthly and weekly presentations. A t-test and ANOVA application was used for evaluation purposes. Next, a 3-year study was conducted with parents attending the Share the Keys, a parent orientation. It was speculated that the school-wide K-12 pilot program would bring community attention to traffic safety and further reduce crash rates over time and parents will actively remain involved in monitoring their novice teen's driving patterns.

### 3.2 K-12 traffic safety program

In fall 2011, the second largest school district in New Jersey participated in a pilot study of the traffic safety component. A coordinator training session and four auditorium programs were conducted by task force representatives. One hundred forty-two teachers used the 76 lesson plans and resources to instruct over 3600 students. This sample group represented elementary teachers (86%), high school teachers (8%), and kindergarten/middle school teachers (6%). The most frequently used lessons were on bicycle safety (27%) followed by pedestrian safety (22%). All

| Lessons plans | (N = 142) |
|---|---|
| Bicycle | 27 |
| Bus safety | 8 |
| Driver education | 10 |
| Pedestrian | 22 |
| Traffic safety | 17 |
| Unspecified | 16 |

**Table 6.**
*Percentage of lesson plans reviewed.*

high school teachers (10%) used the driver education unit because it corresponded with the New Jersey driver education manual (**Table 6**).

When the year ended, a brief survey on the usefulness of the lesson plans and resources was distributed to participating teachers. Self-reported responses (n = 137) addressed time appropriation for classroom use, age appropriateness of content, best features of lesson plans/resources, areas of improvement, and other comments. Seventy percent of the teachers reported that lessons were completed within a 45-minute class period. All respondents felt that the content was age appropriate for their grade level. When asked about the best features of the component, most mentioned content/activities (N = 53), followed by available lesson plans/cods (N = 39), and lessons were easily implemented (N = 25). Also, teachers confirmed that these "interactive" resources were successfully used by substitute teachers.

Overall mean scores for usefulness of components and resources were established and then used to test the null hypothesis of no difference in user satisfaction of resources between monthly and weekly instructor groups. Participating teachers were asked to rate the usefulness of units/lesson plans and corresponding resources for their grade levels, based on the following scores: 1 = very useful, 2 = somewhat useful, and 3 = not useful. Overall responses ranged between 1.35 (introduction) and 1.54 (PowerPoints) with lesson plans and handouts receiving the highest rating of a 1.37 score. The overall, monthly, and weekly user group means for the lesson plan components and resources appear in **Table 7**.

Next, the t-test, assuming unequal variances are $p = <0.05$, df = 92, was conducted to determine differences between combined means of monthly and weekly user groups. The t-statistic (3.505) supported the failure to reject the null hypothesis; therefore, an ANOVA, two-factor without replication, was conducted using

| | Overall mean (N = 142) | Monthly mean (N = 93) | Weekly mean (N = 39) |
|---|---|---|---|
| Introduction | 1.35 | 1.39 | 1.31 |
| Benchmark | 1.49 | 1.64 | 1.35 |
| Plans | 1.37 | 1.52 | 1.23 |
| Handouts | 1.37 | 1.51 | 1.23 |
| Parent info | 1.42 | 1.47 | 1.37 |
| Power points | 1.54 | 1.8 | 1.29 |
| Teacher resources | 1.45 | 1.56 | 1.34 |

**Table 7.**
*Usefulness ratings of lesson plan components and resources.*

| Source of variation | SS | Df | MS | F | P-value | F crit |
|---|---|---|---|---|---|---|
| Rows | 0.061943 | 6 | 0.010324 | 0.999539 | 0.500216 | 4.283866 |
| Columns | 0.223779 | 1 | 0.223779 | 21.66598 | 0.003487 | 5.987378 |
| Error | 0.061971 | 6 | 0.010329 | | | |
| Total | 0.347693 | 13 | | | | |

**Table 8.**
*ANOVA results.*



the mean for each category, in order to determine if there were differences between and within groups on usefulness averages for monthly and weekly instruction.

There appeared to be some variation between the usefulness scores for lesson plan components and resources. However, the values differed between monthly and weekly users, who had rated the lesson plan/resources as being more useful than the other group (p = 0.003487). This finding indicates that a Type 1 error had occurred and a difference existed on usefulness of the traffic safety component (**Table 8**).

While further research is needed on difference in benefits for elementary, middle, and high school teachers, this study was successful in obtaining self-reported benefits and program enhancements. Forty percent of the respondents indicated that program changes were not needed and another group (N = 24) expressed the desire to continue the program in their district. Others felt strong about providing additional time for the lessons (N = 14), incorporating more movement/physical education/walking trips/demonstrations (N = 20) into the program, and additional videos (N = 6) would improve learning. Finally, 10 teachers reported that the lesson plans should be used in turnkey (before/after school) programs.

### 3.3 STK parent orientation program 3-year analysis

Fifty-three school districts participated in the 3-year study that netted 2817 parent/teen teams from 14 counties with a population of over 6,300,000 residents. Nearly half of the participants were from the South (45%), followed by North (42%) and Central (13%) regions of the state. The 2010 US Census county data was also used to identify demographics of this cohort. As the program expanded, the ethnic composition maintained a greater representation of Caucasians (55%) and fewer Asians (5%). Gender was evenly matched between males and females, and only 34% compared to 44% of the population at large had completed college and earned an income of $73,653.



The NHTSA Fatality Analysis Reporting System (FARS) was accessed to identify the fatality rates of individuals between the ages of 16 and 20 on New Jersey roadways. The updated GDL restrictions had played a role in helping to reduce roadway fatalities for this population with a 63% decline in fatal crashes of 16–20-year-old drivers. The fatality rate of teen drivers had steadily declined from 52 to 33 roadway deaths in New Jersey, during this period. *Share the Keys* remained a voluntary program and was adopted by 10% of the school districts to support parents in enforcing and restricting the driving activities of their teens.

Chi-square and independent-sample t-test analyses were conducted to determine the differences between baseline and follow-up responses in all *domains*: *subjective norms, parental behaviors*, and *reported teen driving behaviors*. Most notably, there was a 5% overall reduction in *follow-up* responses (15% vs. 20%) between the two periods. Levene's test for equality of variance was used to identify whether or not variance of scores for the two groups was the same. Percentages, means, standard deviations, and t-scores were calculated for each of the 19 behaviors being measured. No significant differences between the means were present in the *subjective norms* and *reported teen driving domains*, while differences were found in the *parent behavior* and *practice driving hours domains* (**Table 9**).

| Domains & categories | Baseline (n = 2817)* | | | Follow-up (n = 437) | | | |
|---|---|---|---|---|---|---|---|
| | N (%) | M | SD | N (%) | M | SD | T |
| **Subjective norms** | | | | | | | |
| Pstyle 1—permissive | 1315 (46) | 1.53 | 0.49 | 190 (43) | 1.57 | 0.49 | −1.21 |
| Pstyle 2—uninvolved | 125 (05) | 1.90 | 0.29 | 52 (11) | 1.82 | 0.38 | 4.14 |
| Pstyle 3—authoritative | 1237 (44) | 1.47 | 0.49 | 140 (33) | 1.61 | 0.49 | −5.32 |
| Pstyle 4—authoritarian | 76 (03) | 1.91 | 0.29 | 31 (07) | 1.90 | 0.31 | 1.10 |
| No response | 64 (02) | | | 24 (06) | | | |
| Self-reported good driving role model | 2523 (90) | 1.10 | .31 | 407 (93) | 1.07 | .25 | 2.02 |
| No response | 294 (10) | | | 30 (07) | | | |
| **Parent behavior** | | | | | | | |
| Understand GDL | 2330 (87)* | 1.13 | 0.33 | 366 (84) | 1.16 | 0.36 | −1.90** |
| No response | 338 (13) | | | 71 (16) | | | |
| Practice driving | 2127 (80)* | 1.20 | 0.40 | 345 (79) | 1.21 | 0.40 | −0.37 |
| No response | 541 (20) | | | 92 (21) | | | |
| Enforce GDL | 2264 (85)* | 1.15 | 0.36 | 346 (79) | 1.21 | 0.40 | −2.75** |
| No response | 404 (15) | | | 91 (21) | | | |
| Control keys | 2200 (83)* | 1.18 | 0.38 | 285 (65) | 1.35 | 0.47 | −7.19 |
| No response | 468 (17) | | | 152 (35) | | | |
| **Practice driving hours** | | | | | | | |
| 0–3 hours | 747 (27) | 1.73 | 0.44 | 149 (34) | 1.66 | 0.47 | 3.13** |
| 3–5 hours | 433 (15) | 1.85 | 0.36 | 69 (15) | 1.84 | 0.36 | 0.22 |
| 5–7 hours | 460 (16) | 1.84 | 0.37 | 52 (12) | 1.88 | 0.32 | −2.60** |
| 7+ hours | 908 (33) | 1.68 | 0.47 | 120 (28) | 1.73 | 0.44 | −2.06** |
| No response | 269 (09) | | | 47 (11) | | | |
| **Reported teen driving behavior** | | | | | | | |
| Curfew | 2489 (88) | 1.12 | 0.32 | 344 (79) | 1.21 | 0.41 | −4.70 |
| No response<br>Passenger<br>No response | 328 (12)<br>2268 (81)<br>549 (19) | 1.19 | 0.40 | 93 (21)<br>366 (84)<br>71 (16) | 1.16 | 0.37 | 1.70 |
| Seat belt<br>No response | 2586 (92)<br>231 (08) | 1.08 | 0.27 | 356 (82)<br>81 (08) | 1.19 | 0.40 | −5.41 |
| Ask permission<br>No response | 2382 (85)<br>435 (15) | 1.15 | 0.36 | 291 (67)<br>146 (33) | 1.33 | 0.47 | −7.61 |
| No text/cell<br>No response | 2434 (86)<br>383 (14) | 1.14 | 0.34 | 290 (67)<br>147 (33) | 1.34 | 0.47 | −8.51 |
| No alcohol<br>No response | 2645 (94)<br>172 (06) | 1.06 | 0.24 | 381 (87)<br>56 (13) | 1.13 | 0.34 | −4.03 |

*$p > 0.05$ for comparison characteristics of the sample.*
**n = 2668 sample size for the parent behavior domain found in post-survey*
***Sig. (two-tailed) value is equal to or less than 0.05.*

**Table 9.**
*3-year analysis of group differences: Percentages, unadjusted means, and t-test results.*

The t-test results confirmed that there were no significant changes between the baseline and follow-up responses for parenting behavior; therefore, the null hypothesis was accepted. Next, chi-square results were examined to further identify trends in behavior over time. Interestingly, a shift occurred in the *subjective norms domain* between *authoritative* (44–33%), *uninvolved* (5–11%), and *authoritarian parenting styles* (3–7%). *Parent behaviors* remained consistent in all categories except for *control keys* (83–65%) which decreased by 16%, 1 year later. There were few changes in the *practice driving hours domain*, while results were not as positive in the *reported teen driving behaviors domain.* Compliance with *passenger limits* (81–84%) increased, but all other driving behaviors had decreased between 7% and 19% over time and netted a 10% average reduction in teen compliance with safe driving behavior.

Additional independent MANOVA tests were conducted to examine the relationship of driving phases to *control keys* behaviors that had shifted over time in the t-test. Results confirmed that fewer parents *control keys* ($M_1$ = 1.44, SD = 0.50; $M_2$ = 1.24, $SD_2$ = 0.43) during the probationary phase and afterward. Also, teen compliance with the *driving curfew* ($M_1$ = 1.41, $SD_1$ = 0.49; $M_2$ = 1.12, $SD_2$ = 0.32) and *passenger restrictions* ($M_1$ = 1.27, $SD_1$ = 0.44; $M_2$ = 1.09, $SD_2$ = 2.9) had decreased at the probationary phase, not when teens were fully licensed. *Ask permission* to drive appeared to be influenced by the licensing phase, since mean scores continually decreased over time ($M_1$ 1.43, $SD_1$ = 0.50; $M_2$ = 1.31, $SD_2$ = 0.46; $M_3$ = 1.24, $SD_3$ = 0.43).

The overall results identified that there were insignificant differences between baseline and follow-up scores in the 19 behaviors used to prove the null hypothesis of GDL compliance over time. However, the STK interactive intervention was also examined in relation to changes in *subjective norms* (i.e., parenting styles), during the three driving phases. The MANOVA results confirmed changes in levels of parental involvement had occurred during the probationary phase of licensure, not at full licensure, as projected. *Authoritarian* roles increased during the probationary phase, while *authoritative* roles appeared to be strongest after teen drivers earned their basic license. *Permissive* and *uninvolved* roles remained relatively consistent throughout the three driving phases. Interestingly, all types of parents appeared to have benefited from attending the orientation, and they remained actively involved in enforcing the GDL restrictions, 1 year later.

In the *parent behavior domain*, parents reported comparable levels of involvement in the following behaviors: *understand GDL*, *practice driving*, and *enforce GDL*. *Control keys* of their teen drivers, the only category not mandated under the GDL, had considerably decreased over time. There also appeared to be a relationship between parental enforcement and teen driver compliance with the GDL restrictions, especially with *control keys* and *ask permission* to use the car. Although these behaviors netted a 65% compliance level, 36% of teens had received their "unrestricted" basic license 1 year later.

The *practice driving hours domain* remained consistent, except during year 1 when a downward trend appeared in the 7+ hours behavior. There was potential significance in several categories (Year 1–7+ hours, Year 3–0–3 hours, 5–7 hours, and 7+ hours), but proved to be insignificant based on the t-test results. As mentioned, authoritative parents tended to increase practice driving hours when teens received their basic license.

### 3.4 Enforcement component

#### *3.4.1 Crash investigation program*

Examination scores were used to assess whether or not students were successfully learning new information. Basic crash investigation test results were examined in **Table 10** to measure improvements over time. The pre–/posttest scores for 2015

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| | | Mean | Std. div. | Std. error mean | Lower | Upper | t | df | Sig. (two-tailed) |
|---|---|---|---|---|---|---|---|---|---|
| **Pair 1** | **2015 pre−/post** | **20.8000** | **16.08864** | **5.087** | **9.29088** | **32.30912** | **4.088** | **9** | **0.003** |
| Pair 2 | 2016 pre−/post | 34.70000 | 21.51511 | 6.80368 | 19.30902 | 50.09098 | 5.100 | 9 | 0.001 |
| Pair 3 | 2017 pre−/post | 34.0000 | 23.98147 | 7.58361 | 16.84469 | 51.15531 | 4.482 | 9 | 0.002 |

**Table 10.**
*Paired sample incorrect test scores (95% confidence interval).*

showed a mean reduction that ranged between 21 and 35% of "incorrect" answers. which realized a 50% increase over time (3/6%). Further examination of the baseline (pre-test) and posttest results confirmed that overall reduction of incorrect answers had dropped between 12% (*tire marks)* and 50% (*reaction)*. During 2016, in only one area (*understanding of imprints*), there was no difference between the pre-test and posttest scores. These results confirmed instructional benefits that students receive from their crash investigation faculty.

A paired sample t-test was conducted to evaluate the impact of pre- and posttest scores for basic crash investigation. There was a significant decrease in the 2015 posttest scores (e.g., improvement) from Time 1 ($M = 40.80050$, $SD = 20.08759$) to Time 2 ($M = 20.0000$, $SD = 7.78888$, $t(9) = 4.088$, $p < .003$ (two-tailed)). The mean decrease in posttest scores was 20.8000 with a 95% confidence interval ranging from 9.39088 to 32.30912. The eta-squared statistic (9.0) confirmed this effect, too. There was an even greater variance between the 2016 pre-test and posttest scores from Time 1 ($M = 55.50000$, $SD = 26.53405$) to Time 2 ($M = 20.8000$, $SD = 11.36075$, $t(9) = 5.1000$, $p < 0.001$ (two-tailed)). The mean decrease in posttest scores was 34.70000 with a 95% confidence interval ranging from 19.30902 to 50.09098. The eta-squared statistic (9.0) further confirmed this effect in size. The variance was also significant between the 2017 pre-test and posttest scores from Time 1 ($M = 46.3000$, $SD = 23.54688$) to Time 2 ($M = 12.300$, $SD = 6.12917$, $t(9) = 4482$, $p < 0.001$ (two-tailed)). The mean decrease in posttest scores was 34.0000 with a 95% confidence interval ranging from 16.84969 to 51.15531. The eta-squared statistic (9.0) further confirmed this effect in size.

#### *3.4.2 Traffic safety specialist program*

The traffic safety specialist program is unique because it awards police officers who have accomplished significant experience, education, training, and proficiency in highway safety and traffic law enforcement. Level 1 recognizes over 100 individual accomplishments, while Level 2 represents leaders of the traffic safety community. The first cohort of Level 2 designees recently received this award in October 2018. Officers were required to document 3 years of independent traffic control experience, provide documentation of speed detection certification, maintain the Standardized Field Sobriety Testing Certification, and earn 30 professional credit points. Level 2 requirements are similar, except the officer must submit a local traffic study for approval.

#### *3.4.3 2018 Best practices: TSS-level 2*

Since the program is relatively new, officers have submitted traffic studies that address similar conditions. Two reviews involved intersections in North and South Jersey, while the third study addressed traffic safety around a school district. In addition to examining collected data, officers sought legislative guidance on the proposed countermeasures. A brief review of each "best practice" appears in the remainder of this section.

### **3.5 South Jersey county intersection study**

The purpose of this project was to study the intersection of a county road that needed an alternative method of traffic control to make an intersection safer for motorists. A thorough study of this intersection included photographing the intersection with different approach angles and distances, performance of two independent traffic counts during the morning and afternoon hours, and retrieving and analyzing crash data from 2013 through 2016, to examine potential factors such as pedestrian travel, roadway conditions, and obstructions of view. Crash reports from 2013 to 2016 were retrieved and examined for collisions within the intersection. The findings determined that there was a total of 17 collisions caused by vehicles from the northbound direction entering the travel lanes of the route.

Crash reports from 2013 to 2016 were examined for collisions within the intersection. The findings determined that there was a total of 17 collisions caused by vehicles from the northbound direction entering the travel lanes of the county route. There were four collisions as a result of vehicles traveling west and attempting to turn left onto a street and colliding with vehicles. The majority of collisions were caused by drivers traveling northbound and failed to yield or observe vehicle traffic along the county route. After reviewing the US Department of Transportation Manual on Uniformed Traffic Control Devices (MUTCD), it was established that a traffic signal within the intersection would not satisfy any of the nine warrants required to substantiate the creation of a traffic signal.

Other alternatives were prohibiting left turns onto the route from vehicles traveling northbound. It was not feasible, as prohibiting left turns on northbound route would dramatically increase thoroughfare traffic and drivers would use the additional side streets for access. Prohibiting left turns from residential side streets would also force additional traffic to an intersection that was not wide enough to handle the increased vehicle flow. Taking all information into consideration, erection of signage prior to the intersection showing "Intersection Ahead" and another showing "Cross Traffic Does Not Stop" prior to the intersection was deemed appropriate.

### 3.6 North Jersey County intersection study

A township traffic safety department received complaints from residents (e.g., one per month) about an intersection. One of the five crashes, occurring between January and February 2014, resulted in a vehicle winding up on the front lawn of a resident. While the section is straight and leveled with a minimum grade, it contains a curve and has a downhill east to west grade that levels out to the roadway. The speed limit is 25 mph and serves a through street.

Along with the installation of stop signs at the intersection, 100 feet of advanced warning markings were installed in the roadway in June 2002. This action was in response to a citizen's concern over increased intersection crashes. The goal was to warn both lanes of travel that vehicular traffic was mandated to stop at the approaching intersection. All traffic control devices are in compliance with the MUTCD. During this period, a brief study netted contributing crash factors that included driver inattention [7], failure to yield [8], and failure to obey traffic control [8]. Most were Right Angle Turns [2], while Left Turn and Side Swipes netted [1] each.

There are several recommendations that would improve visibility at this intersection. First, the light bulb needs to be changed to a LED on the 8″ flashing signal. By using a LED light, the flashing light would be more visible during daylight hours when all of the crashes occurred. This action was taken and provides more advanced warning for motorists. Another recommendation to improve visibility is the solar panel LED-blinking stop signs. Driver inattention and failure to observe a traffic control device have contributed to crash circumstances, so more visible stop signs will add reinforcement to the drivers who do not come to a complete stop. The solar panel will avoid electrical costs to operate, and the battery will be charged during sunlight hours. The final recommendation is to install an "Intersection Ahead" (W-1) sign on the northbound and southbound roadways. A supplementary sign stating "Intersection Ahead" should be posted below the intersection symbol to alert drivers of the upcoming intersection.

### 3.7 North Jersey traffic stop at the school zone study

Safety concerns associated with all-way stops include pedestrians, bicyclists, and all road users expecting other road users to stop. In accordance with the MUTCD, the decision to install multi-way stop controls requires an engineering study to determine the following:

Where traffic control signals are justified, the multi-way stop is an interim measure that can be installed quickly to control traffic, while arrangements are being made for the installation of that signal. Five or more reported crashes on a road, during a 12-month period, make it a candidate for a multi-way stop installation. Such crashes include right-turn and left-turn collisions as well as right-angle collisions:

- (1) The vehicular volume entering the intersection from the major street approaches (total of both approaches) averages at least 300 vehicles per hour for any 8 hours of an average day; and (2) the combined vehicular, pedestrian, and bicycle volume entering the intersection from the minor street approaches (total of both approaches) averages at least 200 units per hour for the same 8 hours, with an average delay to minor street vehicular traffic of at least 30 seconds per vehicle during the highest hour, but (3) if the 85th percentile approach speed of the major street traffic exceeds 40 mph, the minimum vehicular volume warrants are 70% of the values provided in items 1 and 2.

- Another criterion that may be considered in an engineering study is location where a road user, after stopping, cannot see conflicting traffic and is not able to negotiate the intersection unless conflicting cross traffic is also required to stop.

- It should also be noted that the high school is located at this intersection, which greatly increases pedestrian traffic.

The proposed intersection fell below the vehicular volume to be considered an all-way stop, but the large volume of crashes would have been avoided with such a treatment. An all-way traffic stop intersection was created at the designated location and included two 30-inch retroreflective stop signs (two already existed), two 10-foot u-channel posts and base posts, four all-way supplemental plaques, and restriping of the intersection to include four 4-inch hashed crosswalks, four stop bars, rumble strips at all four approaches, and yellow curbing 25 ft of all crosswalks and 50 ft of all stop signs. After implementation, zero motor vehicle crashes have been reported at the intersection.

## 4. Conclusion

An effective Strategic Prevention Framework (SPF) was established by SAMSHA and adopted in New Jersey to better understand community traffic safety needs and promote sustainability for achieving and maintaining long-term results. Once safety issues are identified through analysis of crash data, available resources are reserved such as manpower, equipment, or training to support a formal plan based on the logic model. Actions are then implemented to address the identified safety needs. A major focus of the education component has been teacher approval of traffic safety program, while little is known about student benefits related to participation. While the lessons were adaptable to a 45-minute period, they promote student engagement that will have a long-term effect on community safety. A second 3-year study, involving parents of novice drivers, will be conducted in summer 2019. Past research has proven that parental monitoring of teen's driving behaviors serves as a prevention of uncheck reckless behavior that is likely to occur without direct supervision.

Most importantly, community leadership needs to be promoting outreach activities based on this prevention model. Through the university, a student internship program has been established to bring the message to the community, which is similar to the role of TSS officers. Interestingly, the crash investigation component continues to operate with law enforcement serving as traffic safety advocates and monitoring the environment on preventing potential crashes. Best practices have been established in New Jersey by the four TSS-Level 2 leaders, with over 100 more TSS officers waiting to qualify for this second tier. Future plans involve an outreach program for officers to develop traffic safety programs in their communities while qualifying for the TSS-Level 2 designation. This injury prevention framework has proven to be effective in utilizing education and enforcement to advocate for the adoption of traffic safety goals. Further research needs to be done, especially in the area of roadway injury reduction involving community support.

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