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# Supporting teen leaders: Validation of the I Drive Smart Survey

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Supporting teen leaders:
Validation of the *I Drive Smart* Survey

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Virginia Commonwealth University, School of Social Work

by

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## Dedication

For those who have died pursuing their freedom on our roadways, and for those of us left behind that wish we could have prevented the loss.

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**Abstract**

**SUPPORTING TEEN LEADERS: VALIDATION OF THE *I DRIVE SMART* SURVEY**

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A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Virginia Commonwealth University, School of Social Work

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Recent policy change allows states to spend federal dollars directly on teen-led driver safety efforts and requires regular evaluations of effectiveness. There are currently no standardized instruments to measure change in teen driving behavior relevant to teen leaders. This study serves the Tennessee Department of Safety and Homeland Security, Tennessee Highway Safety Office and their network of teen leaders to empirically test and refine the *I Drive Smart* survey developed by partners and grounded in the Theory of Planned Behavior (TPB). The survey is designed to be administered by teen leaders to their peers and produce data relevant for use in improving planning as well as tracking changes occurring from their work. The survey measures attitudes, perceptions of social norms (peer, family, and law enforcement), perceptions of behavior control, and both driving and passenger behavior intentions. The *I Drive Smart* web survey was administered by a group of teen leaders to 175 of their peers. Findings were used to inform local planning and in this quasi-confirmatory study aimed at optimizing the survey. An exploratory factor analysis revealed a four factor model aligned with TPB that explained 61.618% of variation. Item reliability analysis demonstrated high internal consistency for the behavior intention scale with a Cronbach's alpha of .884. An ordinary least squares regression test found the predictive validity of the identified components to be strong, explaining 64.5% of variation in the model and identifying perceptions of behavior control as the best predictor of behavior intentions, followed by family and peer norms. The behavior control component retained so much variation that the optimized survey assesses both volitional and non-volitional control concepts. Further, teen leaders were able to successfully administer the survey and found data helpful in supporting their planning. This study demonstrates that teen leaders are capable of directing evaluation activities and that the refined version of the *I Drive Smart* survey has appropriate psychometric properties for teen leaders in highway safety to use.

Standard procedures for using the survey are discussed along with recommendations for analysis that includes triangulation with other local data points.

**Keywords:** Teen leadership; traffic safety; measurement; empowerment evaluation; community-engaged research; survey construction; program evaluation.

## Supporting teen leaders: Validation of the *I Drive Smart* Survey

## Chapter 1: Introduction

### Purpose of the Study

While motor vehicle crashes have declined about 25% since 2005, they are still the leading cause of death and acquired disability for young people in the United States (US) for all age categories spanning from children age eight to young adults age thirty-four (Subramanian, 2012). Of top concern for social workers are the disproportionate rates of crash fatalities among teens, specifically minority and low income teens (Garrison & Crump, 2007; Hirsch, 2003); and the increased fatalities that occur in areas that do not have required driver's education courses (Curry, Garcia-Espana, Winston, Ginsburg, & Durbin, 2012). The recent reauthorization of the *Moving Ahead for Progress in the 21st Century Act of 2012* ([MAP21], *Public Law 112-141*, US Department of Transportation [DOT], 2012[2]) ushers in an exciting time for teen leaders who are working to promote highway safety. For the first time ever, MAP21 allows federal dollars to be used directly to support teen-led planning, implementation, and evaluation of peer-to-peer education and prevention strategies promoting young driver safety. The policy specifically mentions programs seeking to reduce behaviors by teen drivers that lead to crash-related injuries or fatalities (US DOT, 2012[2]).

The *I Drive Smart* survey development project works to situate teen leaders within the context of today's transportation planning world where decisions are increasingly based on scientific evidence and implemented within economic constraints (DeMarchi & Ravetz, 2001). MAP21 has embedded within it demands for data-driven planning and many teen leaders would like to enhance their leadership experience by conducting the required evaluation research themselves. Further, states often lack the capacity to engage in effective evaluation due to shortages in funds, manpower, and expertise. Under MAP21, states must submit reports of effectiveness for their teen interventions regularly (USDOT, 2012[2]). While there are a wealth of intervention guides available for teens to use in planning school and community-based events to promote highway safety (Missouri Department of Health, 2013), there are minimal tools available to support teens in systematic evaluation of these interventions (Streff, 1999). This project occurs in partnership between the author and the Tennessee Department of Safety and Homeland Security (TDSHS), Tennessee Highway Safety Office (THSO), (TDSHS, THSO, 2016[2]) who created the *I Drive Smart* branding to serve as a component of a national young driver safety campaign. The author was asked to create a standardized evaluation instrument with THSO and their partners at Tennessee Technological University (TTU) iCube (TTU iCube, 2016[1]). iCube is an award winning media and innovation center that developed and manages *Reduce TN Crashes* (iCube, 2016[2]). *Reduce TN Crashes* is a web infrastructure funded by THSO and created to support teen leaders to plan and implement an annual strategic plan of highway safety activities in and around their schools. School-based leadership teams are awarded points and given recognition for their work.

Current measurement in driver behavior emerges primarily from criminal justice theories and often measures negative aspects of driver behavior such as aggressiveness, anxiousness, riskiness, frustration, sensation-seeking, and anger. There are currently no standardized measures relevant to teen leaders that can assess change in the underlying dimensions of teen driving behaviors that are positively framed. A central social work ethic regards an assessment process as an intervention in and of itself (Johnson & Yanca, 2010). There have been specific findings that the cognitive elaboration involved in taking a highway safety survey impacted young African American male perspectives on safety behaviors (Falk & Montgomery, 2009; Falk, 2010). A behavior survey is ultimately a norming instrument (Strasser, Aaron, Bohn, & Easles, 1973). Thus, this project considers it of utmost importance that the survey developed creates an experience that positively associates participants with safe driving concepts and seeks to measure the positive impact teen drivers can choose to have.

In the real world, teen safety leaders conduct a range of activities that vary based on their local capacities and desires. The level of sophistication guiding how teen leaders review and select activities could be improved, both by developing skill sets in teen leaders and by improving information available to guide this process. Evaluating for change in something as complex as driving behavior must be approached using multiple data strategies. Having a standardized survey to assess short term changes in driver characteristics directly after program participation is critical for effective evaluation. Ensuring a scientific framework for the *I Drive Smart* survey will ensure data that can theoretically connect short term changes observed by the survey with more long term reductions in local teen motor vehicle crash consequences. Establishing this connection is important and especially relevant considering current demands for data documenting things like cost-effectiveness, program relevance, cultural competence, effectuality, and sustainability (Hardina, 2002). This study reports on the development of a survey tool grounded in Theory of Planned Behavior (TPB), (Azjen, 2011; Fishbein & Azjen, 1975). The survey was created with engaged community partners to serve as both an assessment and evaluation tool seeking to measure teen attitudes, perceptions of social norms (peer, family, and law enforcement), perceptions of behavior control, and both driving and passenger behavior intentions. The survey also includes a highway safety knowledge test. The survey was administered to a development sample and is analyzed here to assess the instrumentation's factoral validity, item reliability, predictive validity, and to use findings to present an optimized version of the survey. Standardized administration procedures and recommendations for use of the survey within a system of measurements are also discussed.

**Engagement Between Community and Academic Partners**

Tennessee youth leaders were part of the national team of advocates who worked to secure the passage of MAP21 and are currently active through various channels to ensure effective policy implementation. Thousands of teen leaders statewide are connected through THSO networks that start in local schools and community groups, branch out through regional networks, and connect statewide through a Students Against Destructive Decisions (SADD Tennessee, 2016) network, which is connected to SADD, Inc. (SADD, Inc., 2016), who is working to coordinate the activities of youth leaders across the nation. Teen leaders also support the Tennessee Teen Safe Driving Coalition (TTSDC, 2016), founded with the National Safety Council (NSC) to bring together youth and adult leaders to develop and steward resources to support teen drivers through graduated driver license (GDL) systems specifically. The author is a former SADD teen leader herself and prior to matriculating into her doctoral program she served in various positions from 2008 to present in supporting the development of teen leadership programs both in Tennessee and nationally. The author served as the founding Statewide Coordinator for SADD Tennessee and TTSDC. She has worked to help evaluate several of the nation's top teen driver safety programs (Fischer, 2014) which include *Reduce TN Crashes*, *ThinkFast Interactive* (TjohnE Productions, 2016) and *What do you consider lethal?* (Impact Teen Drivers, 2016). The author also serves both the National Organizations for Youth Safety (NOYS, 2016) and Students Against Destructive Decisions, Inc. (SADD, Inc., 2016) in developing data-driven decision-making systems and teen-led evaluation strategies for their programs. Through these long standing partnerships, THSO requested the author support the development of evaluation tools that teens could use to meet data demands of MAP21.

Specific to this *I Drive Smart* survey development project, a community-engaged research process was utilized with THSO and their network of highway safety advocates. The author sought to engage community partners in as many stages of the survey development process as possible and worked to ensure the end product would be meaningful for use with the various young driver safety tools provided through *Reduce TN Crashes*. Partners are engaged through an Empowerment Evaluation (EE) framework, with the author serving as the Empowerment Evaluation Specialist. Empowerment in EE is conceptualized as a state where individuals and communities have influence and control over the decisions that are made that affect them in relation to a specific program (Fetterman & Wandersman, 2005). Academic partners in EE are to be coaches, facilitators, and critical friends whose top priorities are to build local capacity and to balance empirical rigor with local relevance. Principles of EE practice include: 1) a commitment to improvement; 2) promoting community ownership of process and product; 3) inclusion of diverse stakeholders; 4) democratic participation; 5) pursuit of social justice; 6) valuing community knowledge; 7) use of evidence-based strategies; 8) capacity building; 9) organizational learning; and 10) accountability of all partners (Fetterman & Wandersman, 2005). EE takes into account organizational factors (structure, functions, and capacities) and how these impact program development, delivery, evaluation, and sustainability. A central purpose in EE is to connect a program's theory of action (how the program is said to work) with its theory of use (how the program actually works) and to ensure these are in alignment. As MAP21 signifies, today's practitioners and policy makers hold the belief that empowering teens can improve their driving abilities, despite there being little empirical evidence supporting the effectiveness of this. For this project, partners developed evaluation infrastructure to support THSO and teens across Tennessee to conduct quasi-experimental effectiveness analyses.

The author's primary functions were to provide advisement on research ethics and to ensure construct validity for the survey, which is grounded in the Theory of Planned Behavior (TPB) and depicts behavior as a function of attitudes, norms, and perceptions of control, which lead to behavior intentions, and ultimately to behavior (Azjen, Albarracin, & Hornik, 2007), as depicted in Figure 1. The survey was administered to 175 teens by teen leaders at Cookeville High School (CHS) in Putnam County, Tennessee via a web link (CHS, 2016; CHS Traffic Education Saves Teens [T.E.S.T.] Club, 2016). This report presents findings from an analysis to assess the survey quantitatively in order to optimize it for continued use. Dissemination is key in community-engaged research and in order to increase relevance and usability of the survey to be developed, it was designed to be integrated within web tools at *Reduce TN Crashes* where teen leaders will sign up their school, plan an annual schedule of evaluation around their interventions, connect to training resources on evaluation design and ethics, be supported to engage in data analysis, submit reports of their work, and be recognized as leaders.

**Delimitations**

Societies have flourished in direct proportion to their ability to deal with hazardous situations in order to reduce human and environmental damage (Haddon, Jr., 1980). The Haddon Matrix is a classic contributor to injury prevention that promotes understanding of the agent-host-environment model. It was a critical component in shifting transportation systems towards considering the driving environment, leading to requirements for safety features in cars and roadways specifically to prevent crashes (Scott-Parker & Mackay, 2015). Haddon establishes criteria for decision making in injury prevention with ten general strategies: 1) prevent the creation of hazards; 2) reduce hazard amount; 3) prevent the release of an existing hazard; 4) modify spatial distribution of hazard; 5) separate the hazard in time or space; 6) protect humans with barriers or walls; 7) modify qualities of the hazard; 8) make people more resistant to the hazard; 9) counter damage already done by the hazard; and 10) stabilize, repair, and rehabilitate those damaged by hazard (Haddon, Jr., 1980). Injury prevention authors conceptualize injuries as an energy exchange of two main types occurring through: 1) interference with body energy exchange, a) at the whole-body level (suffocation, etc.), or b) the local level (frostbite); or 2) the delivery of energy in excess of body thresholds, including a) mechanical (struck by or against), b) thermal (burns, electrocution, etc.), or c) chemical energies (plant and animal toxins); and prevention should seek to intervene to prevent these energy exchanges (McFadden, 1974). In general, there are myriad causes for crashes, and we are still not clear on which is the best way to prevent teen crashes, however the matrix can still be useful in guiding intervention planning (Haddon, Jr., 1980).

This project recognizes that teens do need to learn how to drive and that not having access to safe transportation limits their abilities to access educational and economic opportunities that could enhance and improve their lives. Transportation behavior has been modeled at three levels primarily through: 1) physical analogies exploring trip volume and impacts of gravity; 2) economic theories of rational behavior, primarily the utility-maximization theory; and 3) models of human behavior largely drawn from sociology, anthropology, and neurology (McFadden, 2007). When it comes to driver behavior, there are many challenges to ensuring accurate data surveillance and data primarily comes from crash reports completed by law enforcement, medical records, observations, and self-report surveys (af Wahlberg, 2009). Crash data is collected systematically in Tennessee through the TITAN system (TDSHS, THSO, 2016[1]). The National Highway Traffic Safety Administration (NHTSA) also maintains a national dataset of crash fatalities, the Fatality Analysis Reporting System (FARS), (NHTSA, 2016[2]). Crash frequency data is regularly submitted to sophisticated analysis aimed at understanding the human factors contributing to crashes (Lord & Mannering, 2010; Savolainen, Mannering, Lord, & Quddus, 2011). However, this information does not necessarily serve local teen leaders in directing interventions.

Personality as a factor contributing to crashes has been a major area of interest to science since the 1940s and there was a good deal of research in the 1980s and 1990s that linked the personality trait sensation-seeking with the behavior of risky driving (Jonah, 1997). A person's perspective on their time orientation was also found to be important; with people being grounded in the present (rather than the past or future) identified as a good predictor of safe driving (Zimbardo, Keough, & Boyd, 1997). Sensation-seeking has most often been assessed by scales for thrill, adventure, or experience seeking; susceptibility to boredom; or level of inhibition. Risky driving behaviors commonly measured include driving under the influence of drugs and/or alcohol, speeding, unsafe passing, non-use of seat belts, and breaking any other traffic laws (Jonah, 1997). Scales also exist to measure aggressive driving (Vanlaar, Simpson, Mayhew, & Robertson, 2008); anger, impulsiveness, and boredom (Dahlen, Martin, Ragan, & Kuhlman, 2005); one's propensity for angry driving (Dahlen & Ragan, 2004); and anxiety, distress, patience, and carefulness (Taubman-Ben-Ari, Mikulincer & Gillath, 2004). There are several classic examples of driver behavior questionnaires that seek behavior data in domains for aggressive violations, ordinary violations, errors, and lapses (Lajunen, Parker, & Summala, 2004); and performance deficits, exaggerated safety or caution behaviors, and hostile or aggressive behavior (Clapp, Olsen, Beck, Palyo, Grant, Gudmundsdottir, & Marques, 2011).

A study from the UK (Musselwhite, 2006) of drivers age 17 to 64 revealed four categories of drivers in relation to how they contextualized risk: 1) calculated risk takers feel it is often safe to drive over the speed limit and make decisions based on their appraisal of the driving environment in order to not be held up by traffic; 2) unintentional risk takers are the largest group and have the lowest crash risk, as they realize they should not make risky driving decisions and generally only do so when unaware of it or in a hurry to get somewhere; 3) continuous risk takers were the smallest group and present the highest crash risk and are often younger, male drivers who have not held their licenses for very long; and 4) reactive risk takers are driven by intrinsic motivation meaning they are most likely to drive fast when in a hurry, angry or irritated, or when reacting to environmental distractions (Musselwhite, 2006). One study from Canada found that among people ages 17 to 60, those that were high sensation seekers were most likely to engage in risky driving, even going so far as to exhibit an intended behavior adaptation to the safety technology of anti-lock brakes (ABS), in that they would be more likely to not wear seat belts, follow closer behind the vehicle in front of them, and drive faster on wet roads when driving a car equipped with safety features such as ABS (Jonah, Thiessen, & Au-Yeung, 2001).

When it comes to understanding which interventions actually work to change driver behavior, and specifically teen driver behavior, little is known and the path to understanding has many conceptual speed bumps. For crash prevention, crash involvement is typically the dependent variable and focus of intervention often measured with self report data (af Whalberg, 2009). A primary critique of surveys in highway safety research is concerned with the lack of validity in self-report data, whether from individual memory failure or a cognitive or social distortion (af Whalberg, 2009). There have been attempts to compare self-reports with actual crash data; however while current crash data may be trustworthy (in that crashes reported did actually happen), it is unfortunately not exhaustive (in that all crashes that occurred are not listed). The most valid data often comes from commercial fleet vehicles with documented logs, but this does not represent teen drivers (af Whalberg, 2009). In general using crash experience as a dependent variable is difficult, and the industry often looks at proxy variables including incidents (near misses and close calls), citations received, or behavior variables (such as speeding, aggressiveness, or riskiness) (af Whalberg, 2009). There have been movements to create a continuum of crash involvement based on the severity of conflict experienced (Svensson & Hyden, 2006). Drivers could be prompted to identify times when they were undisturbed, experienced potential conflicts, managed slight conflicts, or suffered serious conflicts (Svennsson & Hyden, 2006).

There is further long-standing critique in highway safety and across all injury prevention programs that there is an inability to theoretically connect short term intervention outputs to long term outcomes (Little, 1968). For example, there has never been a single study able to link participation in formalized driver's education with a reduction in crash outcomes (Lonero & Mayhew, 2009). For teens, using crash experience as a dependent variable is not relevant, as many of the teens who will be participating in the interventions and evaluation are not yet of driving age and may not have a crash experience, a history of citations, or a history of driving behavior to report. Evidence shows that pre-driver attitudes are malleable and that they remain fluid and can therefore be influenced by pre- and early- driver interventions (Mann & Lansdown, 2009). An experimental study with young males found that elaboration-based interventions promoted self-insight into driving behaviors and had positive impacts on self reported risk-taking behavior at follow up among young males (Falk & Montgomery, 2009). Further work found that simply taking a survey alone produced significant improvements in attitude and behavior intentions in several samples of young males (Falk, 2010). While the social desirability of certain behaviors certainly raises the possibility of response bias in a survey, surveys also serve as an intervention in and of themselves. The question-behavior effect says that creating a situation for reflection on behaviors can trigger an attitude change and make safety beliefs more salient (Falk, 2010). This project utilizes a self-report survey; however it is recommended to be analyzed in light of other data discussed further in Chapter 5.

**Significance of the Study**

Transportation is affected by human behavior through its consumers, managers and workers, and policy-makers and voters (Schiller, Bruun, & Kenworthy, 2010). While there are many calls for public participation in transportation planning, those that actually do research are limited to primarily criminologists, medical experts, and those that are interested in research around simulators and other forms of tech-based accident analysis (af Whalberg, 2009). Today's complex driving environments call for sophisticated interventions supporting teens in a holistic way to become good drivers and citizens. MAP21 sets the stage so it is feasible to empower youth to engage as evaluation researchers themselves. There is a real world need for behavior-based data to help decision-makers engage in evidence-informed planning processes to reduce teen crashes and fatalities (Salmon, Lenne, Stanton, Jenkins, & Walker, 2010). Further, prominent taxonomies used measure the negative aspects of human errors (Stanton & Salmon, 2009), when teens consistently express that they want to have their positive aspects promoted (National Highway Traffic Safety Administration, 2006). While the quantity and quality is growing, evaluations of interventions targeting teen drivers are still scant, with even fewer examples of actual teen-led evaluations of teen-led interventions targeting teen drivers. *Reduce TN Crashes* offers a hands-on learning experience for teens in planning and implementing and also works to improve their understanding of social science. Working for overall statistical reform in the social sciences involves placing priorities on clearing up a trained incapacity of the academy and our citizenry by specifically promoting their ability to consume and create statistical findings (Kline, 2013). This involves challenging common fallacies, focusing on the practical significance of findings over their statistical significance, including effect sizes and confidence intervals in reporting, taking replication seriously, and ensuring meta-analytical thinking (Kline, 2013). Service-learning guides and other instructional technologies ensure learning goals are met by students participating as leaders. This approach serves to equip teen leaders and THSO to not only collect valid data, but also to analyze it correctly and use it in a meaningful way.

**Paradigm**

This analysis occurs as applied science, in that it seeks to generate knowledge in a way that helps people (Drake & Jonson-Reid, 2008). Mathematically, it is grounded in the positivist paradigm (Jaccard & Becker, 2010), in that is follows classical measurement theories (DeVellis, 2012) using data obtained from observations made in an empirical way, and assumes that the responses provided on the *I Drive Smart* survey will be useful in helping teen leaders understand the underlying dimensions of teen highway safety behaviors, and further that data will help them to improve planning processes and document effectiveness. While this report does not make generalizations about all teen drivers and is for survey validation only, the *I Drive Smart* survey is designed to create data adequate for making generalizations based on how it is integrated within an experimental design in the future (Drake & Jonson-Reid, 2008). Since the project's CEnR approach puts teens themselves in a leadership role towards collecting and using data, it disrupts the balance between observer and observed (Buchanan, Miller, & Wallerstein, 2007). While this does introduce some measurement error as discussed later in the report, it also increases the viability of the instrument being created to teen leaders and the communities they live in (Chen, 2013).

Positivism is one epistemological approach (or a way of assessing the world around us) that ontologically (which is our assumptions about how we view the universe) is realist in nature and assumes we can measure our way to an objective truth (Burrell & Morgan, 1979). Acting within the positivist paradigm requires the researcher to see human behavior in deterministic concepts that can be operationalized into mutually exclusive categories. The *I Drive Smart* survey is designed to do this aligned with the Theory of Planned Behavior (TPB), a prominent mathematical model used to operationalize understandable and actionable aspects of human behavior (Figure 1). These items are designed to correspond with malleable aspects of teen driver highway safety behavior (Figure 5) so that data created can be utilized to inform local decision-making while also corresponding to the scientific principles of behavior science.

While classical assumptions of the positivist paradigm guide the mathematical survey validation process and should guide its continued analysis, it is specifically designed to be interpreted in light of a subjective triangulation process discussed in Chapter 5. Where positivism focuses on objective and universal truths, subjective approaches place attention on the context of a situation and the free will of individual people (Burrell & Morgan, 1979).The *I Drive Smart* survey produces quantitative data assessing the aggregate or average experience of teens and thus relies on measures of rigor that assess validity and reliability of measurement as discussed in Chapter 3. Subjective methods focus on seeking to understand personal and contextual experience with measures of rigor needing to describe the trustworthiness of the findings and the authenticity of the study design (Rodwell, 1998). The nature of the work teen leaders for highway safety engage in requires that they are also aware of a third framework for building knowledge, the critical paradigm. Classically categorized as either radical humanist (subjective) or radical structuralist (objective), (Burrell & Morgan, 1979); paradigms that guide the use of knowledge building to promote individual and/or societal level change have also been conceptualized to include post-positivist, critical and constructivist ways of knowing (Lincoln, 1990). Post-positivist methods make many of the same assumptions of the positivist paradigm, but also incorporate interventionist methods as opposed to simply documenting the status quo. Critical methodologies often occur in feminist and race –based research and are participatory to maximize the interactive nature of the knowledge building process. Constructivist methodologies operate ontologically assuming that reality is a social construction where people establish meaning relative to the context they exist in, which can include hermeneutic communication techniques and other forms of discourse analysis (Lincoln, 1990).

Reflexivity between epistemological positions can facilitate transcendence in knowledge building (Maton, 2003), and the *I Drive Smart* survey is designed to be embedded in an evaluation system that promotes this. There are calls from within social work to better include people in decisions made about them in the evidence-based practice (EBP) movement (Gambrill, 2011); and also to integrate understandings of the multiple paradigmatic positions into teaching curricula (Graham, 1997). If we can accomplish this, social work stands to be able to better connect what the profession says it does with what it actually ends up doing in the real world (Gambrill, 2001; Graham, 1997). Positivist teaching methods include traditional lectures and assignment of letter grades; with post-positivist methods being similar, except adding components for discussion and feedback (Graham, 1997). Educators working within the critical paradigm will ask students to expend more effort towards personal consciousness raising, often utilizing Socratic questioning and debates, and will often require students to defend a point of view. Constructivist teaching methods present metaphors and then allow students to create structure and evaluation processes for learning, with teachers facilitating a process of student-led discovery (Graham, 1997). Considering the empowerment approach that guides this project, the analysis plan offered in Chapter 5 seeks to support teens to transcend all of these paradigmatic divisions. This process challenges teens and the adults who support them to be aware of all of these ways of building knowledge. Local leader groups must consider the context for ethics within their local communities and should utilize multiple data points in making final decisions about a course of action. While this is challenging, it is of critical importance if teens are to collect data and then use it to make decisions that impact their communities. When thinking about how a project can adapt to local conditions, it is important to consider the teaching style of individual adults and teen leaders. There are roles for teachers operating in all of the above paradigms, as well as room for knowledge building to occur across them all. An effective teen-led knowledge building process will consider the research question they are interested in and then utilize partners with appropriate skills to be most effective.

When developing a psychometric measurement instrument like the *I Drive Smart* survey, positivistic methods were used to guide the survey validation analysis as discussed in Chapter 3. However since the survey is designed to be an evaluation instrument, this positions it as post-positivistic simply because it creates an instrument relevant for the evaluation of change resulting from an intervention. Further, the survey seeks to challenge existing scales that measure pathological deviance like riskiness and anger. The subjective experience of each teen agreeing to complete a survey was carefully considered during survey development and the end product seeks to create data that positively frames teen drivers and serves as a learning experience in and of itself. Critical approaches employ teen leaders in the process as much as possible, to promote change in the structural characteristics of how knowledge is built around teen driver safety. Constructivist methods recommend the survey be analyzed in light of other measures, specifically a philosophical triangulation using a direct behavior, and indirect behavior, and a consequence measure that are related to highway safety and locally relevant. Triangulation between data points is an effective evaluation technique, even if the actual triangulation process is subjective (Denzin, 1970). The *I Drive Smart* survey is designed to serve as the backbone for a data-driven planning system that will work to indentify and utilize multiple data points in determining overall effectiveness. However, a survey cannot serve as a stand-alone evaluation instrument. Standardized processes for this survey and how it can be used with other measures are discussed in Chapter 5.

Finally, the deep structure of this project recognizes knowledge building around evidence-based practices as a process that should occur through membership which is aligned with constructivist paradigms. This is different than the traditional researcher-driven approach to developing a psychometric instrument (Chen, 2013) and thus establishing a philosophical basis for using an engaged epistemology is important. Specifically, this project seeks to change the conditions of accessibility in knowledge building for teens by promoting their equitable membership in the intrapsychic process of knowledge building in order to meet data demands of MAP21, as grounded in the Membership Perspective (Falck, 1988). The Membership Perspective challenges common dualities established in the world and asserts that all human life and activities are group based and that we are all inextricably bound together, while also simultaneously being uniquely individual. Falck defines member as a physical being bounded by semi permeable membranes and cavities, a social being in continuous interaction with others who are both seen and unseen, and a psychological being capable of private experience (Falck, 1988). Things that can be inferred from humans about membership include a member's actions which are seen as socially derived and contributory and that the identity of each member is bound up with that of others through social involvement. Further, a member is a person whose differences from others creates tensions that lead to growth, group cohesion, and group conflict. Human freedom is defined by simultaneous concern for oneself and others. He also defines membership through the lens of boundaries, which denote where one thing ends and another thing begins (Falck, 1988). The first of the two Boundary Principles established is Constant Connectedness, which holds that all components are permanently linked by virtue of common need, function, and prerequisites for survival. Membership is permanent and cannot be reversed. Relationships are not external to the person but denote permanence in time, meaning, and process. The second Boundary Principle is Conditional Accessibility, which holds that the nature of access from one member to another is subject to specifiable conditions, or selectivity. Access is governed by rules that are both facilitative and restrictive and can be thought of as either physical (likened to the cells in a human body) or structural (such as social interaction within social systems), or otherwise functioning in a non-physical sense (i.e. social norms, trends, generational patterns, etc.), (Falck, 1988).

The membership approach to the evaluation of prevention interventions discussed in this project is designed as a unique social work approach to engaging teen leaders in their own process of collecting and using data for evaluation purposes. Using this approach equips the *Reduce TN Crashes* system to change the conditions of accessibility between teens and the knowledge building process regarding who determines the effectiveness of interventions, thus empowering teens to control their own safety information through membership. This project also serves to empower THSO to have empirical observations to provide effective state-level guidance of teen-led strategies, as the peer to peer approach fully emerges on the national stage. In order for teens to be meaningfully engaged in directing their own interventions, they must understand the basics of intervention research and program evaluation. They will need the support of adults to manage the ethical skill set required in managing the responsibilities of knowledge building.

Grounding the evaluative work to be done by *Reduce TN Crashes* teen leaders with a strong philosophical and theoretical basis is meant to empower systems to work in membership to bring sophisticated data to bear regarding the effectiveness of teen-led programs. Further, having a strong philosophical basis helps to promote the transferability of methods being used to improve the conditions of accessibility in regards to knowledge building for diverse populations across a range of environmental prevention issue areas. This also means that teen leaders will have to work hard. Transferring knowledge learned to other people or situations serves to complete the experiential learning cycle (Kolb, 1984; Kolb, 1999; Kolb & Kolb, 2005). Current best practices guiding statistics education for the discipline of Social work call for bachelor's level students to be effective consumers of research with a beginning level proficiency, that master's students should begin to move beyond simply consumers of research to be able to review and analyze the work of others, and that by the doctoral level, students should be able to use statistics independently to conduct and evaluate their work as well as the work of others (Gebotys & Hardie, 2008). This project utilizes technology and the internet to provide assistance to teens so that they can move through the learning cycle using and creating knowledge from statistics before they leave high school, tangibly connecting teen leaders with skills needed for learning in a digital world (Churches, 2005). While teens in this project are not expected to become expert researchers, they are expected to enter college with an increased readiness to engage in research with real-world skills sets in building meaningful and relevant knowledge through membership.

## Chapter 2: Literature Review

### Context of Young Driver Safety

The US continues to be a world leader in promoting safety through vehicle and road building technologies; however, the US has begun to fall behind countries such as Australia, Germany, and Sweden when it comes to reducing overall transportation related fatalities (Transportation Research Board [TRB], 2013). Studying behavioral interventions that seek to promote safe driving is critical; however, research funding into transportation has suffered cutbacks. The US transportation system in general requires significant investments to our infrastructure of modes, roads, and routes, as well as into human and intellectual capital. There are calls for a culture of innovation to continue evolving transportation systems to promote equity and global connectedness (TRB, 2013). A public health approach has been employed over the past 50 years in injury prevention, yet pervasive scientific rigor is still being fully realized throughout injury prevention areas (Sleet, Baldwin, Marr, Spivak, Patterson, Morrison, Holmes, Peeples, & Degutis, 2012). Public participation is also regularly utilized in transportation planning (Schively, 2007). Additionally, advocates are operating in a time where interventions must be guided by scientific evidence and evaluated to assess for effectiveness, and MAP21 does require reports to Congress on the effectiveness of teen-led interventions implemented by states (USDOT, 2012[2]). Evidence-based programs and practices (EBP) that teen leaders come into contact with often come in manuals or kits that contain supplies along with directions for implementation (Rubin, 2010). While this is not exhaustive by any means, a database of EBPs designed for teens and young adults to reduce crashes is maintained and currently contains twenty-two interventions ranked as: 1) effective as a stand-alone program, 2) effective for use as a component of a comprehensive strategy, and 3) those that show promise but lack clear evidence of effectiveness (Missouri Department of Health, 2013).

While methods and practices conducting high-quality intervention research in schools has improved over the last twenty years (Flay & Collins, 2005), it is still common for practitioners to feel that EBPs lack local relevance and many groups make adaptations to the published programs (Castro, Barrera, Jr., & Martinez, 2004; Miller-Day, Pettigrew, Hecht, Shin, Graham, & Krieger, 2013). Making changes to programs does change the basis of scientific evidence supporting the EBPs effectiveness; however, it is possible to be systematic with design and methods to help solve tensions between fit to the local community while also maintaining fidelity with science (Castro, Barrera, Jr., & Martinez, 2004). Practical implications from intervention research call for ensuring the length of curriculum is appropriate for the time avaiable, that student engagement and homework be useful to them, and to pay attention to training and support for those implementing the programs in a way that provides direction sensitive to various styles of implementation by leaders (Miller-Day, et al., 2013). This project works to create infrastructure that allows teens to not only control their own local programs, but also to collect data with which to evaluate them in methods that are designed to align with the fluidity of teen led efforts operating in schools.

## Transportation Needs and Rights of Young People

Developmentally, teens are at a stage where the goal is to become healthy, competent adults and learning to drive is an exciting part of this (Winston & Senserrick, 2006). A recent study of pre-driving teens in Texas found that besides facing a lack of having places they desired to go, teens that could not yet drive independently faced various barriers to their personal freedom that were related to their natural and built environments. These included streets without sidewalks, steep hills, and long distances on un-shaded streets (Weston, 2005). The study also revealed a complex web of factors that influenced teen independent travel options including parental permissiveness, public transportation systems, presence of bike-friendly zones, access to operable equipment (bikes, helmets, etc.), teen and parent attitudes towards walking and/or biking; teen responsibilities in caring for younger siblings; and general fear of kidnappings and neighborhood crime (Weston, 2005). Teens face many challenges in becoming independent travelers, especially for those who may live in more rural areas without public transit or walkable neighborhoods (McDonald & Trowbridge, 2009). Globally, despite the fact that the majority of the world's vehicles are in high-income countries, more than 90% of motor vehicle related deaths occur in low and middle income countries (Will, 2011). Some social workers assert that community work must be connected to human rights and responsibilities (Ife, 2001). This project does promote teen understandings of teen driving rights, but also supports them to fulfill their responsibilities in being a safe driver as well.

Automobiles are the dominant mode of transportation in the US (Schiller, et al., 2010) and pre-driving teens have very little control over their transportation options, as these decisions are normally made at the community level (in terms of availability of public transportation) and by parents at the household level (Weston, 2005). Teens from low income families often face further challenges in securing access to cars with adequate safety features (Trowbridge, 2007), insurance, and driver education (Hirsch, 2003). While car ownership can increase access to work opportunities (Ong, 2002), and daily activity spaces (Villanueva, Giles-Corti, Bulsara, McCormack, Timperio, Middleton, Beesley, & Trapp, 2012); ownership of private vehicles can also create serious economic hardships for families who are especially vulnerable when they are low income, have children, drive less reliable vehicles, and lack alternative means of transportation from outside the household (Fletcher, Garasky, & Nielson, 2005). Complicating ownership of private vehicles for low income individuals are predatory lending establishments commonly used by people who are marginalized from mainstream banks and lending institutions (Karger, 2004; Karger, 2007). This also includes car title lenders who offer high interest, short term emergency cash loans using a car title as security and will repossess the vehicle with non-payment of the loan. Some go so far as to declare an all-out environmental assault in progress against today's low income and minority youth, playing out in the form of injurious social toxins transmitting political, economic, or social poison to one's well-being (Ginwright & James, 2002). There are calls for a paradigm of mobility health to take over for adolescents that seeks to maximize their independent travel and minimize environmental harms resulting from human mobility (Weiss, 2012).

Driving is considered an archetypal task for adolescence (Winston & Senserrick, 2006) and a time when parents lose control over child behavior (Voas & Kelley-Baker, 2008). However there is debate if the prefrontal cortex is developed enough for teens to adequately engage in the complex behavior of driving (Glendon, 2011; Vogeley, Kurthen, Falkai, & Maier, 1999). Overactive sex hormones in the teen's system are also believed to increase their risk-taking propensity (National Highway Traffic Safety Administration [NHTSA], 2006; Steinberg, 2013). The average teen's nucleus accumbens is still developing, which is a region of the brain that has been connected to one's motivation to seek rewards (Glendon, 2011; Paus, 2005); supposedly limiting a teen's capacity to respond to incentive-based reinforcements (NHTSA, 2006; Winston & Senserrick, 2006). While there have been attempts to raise the legal driving age above eighteen (Longyard, 2015), public opinion still largely encourages teens to drive and be independent, with parents increasingly citing a desire to no longer be a chauffeur for their children as a major reason for wanting their children to drive (Rogers, 2015). Recent attention has come to the issue of sleepiness among young drivers (Groeger, 2006); with some parents calling for a change in the hours of the school day, asserting that early school start times cause teens to be out driving while drowsy and endangers lives (Holohan, 2013).

It is typical for young drivers to be considered as a risky driving population that is largely uneducated and inexperienced (Berg, 2006; National Highway Traffic Safety Administration, 2012[1]); and this belief appears to correspond with the over-representation of young driver involvement in fatal crashes (Subramanian, 2012). Driving presents a small margin of error in reacting to prevent a crash (Winston & Senserrick, 2006); and crashes are top among all other forms of injury that results in an individual young person self-selecting out of the gene pool (Haddon, Jr., 1963). Risk for crash is high among all teen groups during the first few months of licensure, but in general males are most at risk for fatal crashes, almost twice as likely over females in the age 16-19 group (Centers for Disease Control and Prevention [CDC], 2015). However, some say that driving is really about self-regulation in general and that lack of self-regulation can impact driving behaviors across the lifespan regardless of age or gender (Gwyther & Holland, 2012). Poor driving behaviors have been found to be associated with fewer parental restrictions and lower grade point averages (McCartt, Shabanova, & Leaf, 2003).

## Measurement in Young Driver Safety

The belief in the US that a man drives as he lives directed science to focus primarily on the individual personality characteristics believed to cause crashes, such as sensation-seeking, risk taking propensity, and thrill or adventure seeking (Jonah, 1997). This focus on individual traits continues in science today, but there is a shift occurring towards recognizing the environmental factors that influence driving related outcomes in teen driver safety (Juarez, Schlundt, Goldzweig, & Stinson, Jr., 2006; Shope, 2006) and across youth safety issues (Klau, Boyd, & Luckow, 2006). Personality is believed to impact driving behavior, specifically attitudes towards safety and perceptions of risk for engaging in unsafe behaviors (Constantinou, Panayiotou, Konstantinou, Loutsiou-Ladd, & Kapardis, 2011; Ulleberg & Rundmo, 2003). Some factors cited for encouraging risky driving in young people include experience-seeking, desire for excitement, sensation-seeking, social influence, prestige-seeking, familiarity with a roadway or vehicle, letting off steam, or getting there quicker (Hatfield & Fernandes, 2009). One study revealed variance in young driver speeding behavior was best accounted for by their excitement-seeking, altruism, aversion to risk-taking, and their perceptions of the likelihood of having an accident (Machin & Sankey, 2008). When looking at risk, one study identified four primary categories of risk, with those making unintentional risks comprising the largest group, followed by deliberate risk takers, reactive risk takers, and calculated risk takers (Musselwhite, 2006). Influencers identified that increased risk taking include gender, sensation-seeking tendency, driving behavior of the parents, amount of supervised practice, and the level of parental monitoring (Prato, Toledo, Lotan, & Taubman-Ben-Ari, 2010).

Crashes where teens are the driver are generally attributed to driver error (Groeger, 2006). Driver errors can be understood to include recognition errors (poor surveillance of hazards), decision errors (breaking traffic laws, not adapting driving style for road conditions), and performance errors (loss of control, over-correction) (Curry, Hafetz, Kallan, Winston, & Durbin, 2011). Non-performance errors encompass a range of errors that limit the driver's functioning including driving under the influence (Bingham, Shope, Parow, & Raghunathan, 2009), while sleepy (Groeger, 2006; Hutchens, Senserrick, Jamieson, Romer, & Winston, 2008), without wearing seatbelts (Awadzi, Classen, Hall, Duncan, & Garvan, 2008), while texting, or while otherwise impaired and/or distracted (Begg & Langley, 2004). Using these categories for distinction, one study found that poor surveillance, distractions, and not adapting driving style for road conditions accounted for almost half of the crashes among the 335,667 fifteen to eighteen year old teens who comprised their study sample (Curry & Hafetz, et al., 2011). In a 2011 study using crash report data from California, common teen driver errors leading to fatal crashes include in order: maintaining an unsafe speed (35.3%), failure to yield to right of way (20.6%), making improper turns (14.8%), failure to signal/sign (8.1), involvement of alcohol or drugs (5.1%), passing/lane change errors (4.3%), driving on the wrong side of the road (3.1%), and other undefined factors (8.7%), (Centers for Disease Control and Prevention [CDC], 2015).

Many attribute poor surveillance to driver distractions, with technology and passengers being top distraction concerns for teens (Kiesbye, 2012), with eating also becoming a recognized issue (Huntington, 2012; Insure.com, 2012). Distractions are conceptualized as visual, manual, or cognitive (Petrie, 2012); with an activity like texting while driving transcending all three. In 2001, New Jersey passed the first ban on cell phone use for drivers of all ages and Washington was the first state to ban texting while driving (CDC, 2015), and most states have seen fit to include cell phone bans for teens as a part of GDL policies (Williams & Shults, 2010). However, these policies are difficult to enforce (Hanes, 2012). Cell phones are attributed as being a major cause of driver distractions; however the reality is that we do not have adequate data to truly asses the various types of distractions that may come into play as causal crash factors (Hanes, 2012). What data is available seems to indicate that both girls and boys report equal cell phone use while driving, and report that they feel texting is more dangerous than talking on the phone (Madden & Lenhart, 2012). However, talking with a hands-free headset is not nessecarily safer, as it appears that cognitive workload and attention resource allocation is what is most important; meaning that if the driver is more engaged in a phone call than driving, then risk is increased (Patten, Kircher, Ostlund, & Nilsson, 2004). Some say that all in-car technologies including GPS can be distractions (Madden & Lenhart, 2012; Macaskill & Smith, 2012) and that we should teach drivers to multi-task, however this faces strong critique and recommendations continue to focus on keeping driving as distraction-free as possible (Edmunds.com, 2012). A meta-analysis of effects of interventions found that combined efforts are most effective in preventing distracted driving and should include legislation, enforcement, reception blocking, parental support, social media, social norms, and education (Caird, Johnston, Willness, Asbridge, & Steel, 2014).

A recent study that investigated driver-related anxiety among college age students found three primary categories of maladaptive behaviors of young, anxious drivers: 1) anxiety-based performance deficits were broadly related to perception of driving skill balanced by general fear of driving and manifested by drifting in and out of lanes of traffic, loosing track of direction, panic and over-correction, and not paying attention to shifts in speed; 2) exaggerated safety/caution behaviors include slowing down at intersections even if the light is green and controlling speed to stay away from other cars and was most prominent in drivers who also had personalities that sought to manage their self image or had previously been in a crash; and 3) anxiety related hostile/aggressive behaviors, which included honking, yelling, and swearing at other drivers and pounding on the steering wheel, which were closely related with road rage and accident-related fear (Clapp & Olsen, et al., 2011). This model sought to explain how young drivers adapt their behaviors when anxious and interventions that seek to increase driving skills and confidence are recommended, as well as anger management, stress/panic reduction, and hazard recovery techniques (Clapp & Olsen, et al., 2011). Interventions should be tailored for and targeted to these various personality types (Ulleberg, 2002). One study found that significant predictors of risky driving behavior intentions were related to anticipated rewards and punishments that may be administered by parents and peers (Scott-Parker, Watson, & King, 2009). Some say that positively framed messages that seek to moderate the positive affect modalities in dual cognitive processing will best serve teen drivers (Rhodes & Pivak, 2011). Learning to drive is a social, education, and psychological process and should be understood in its full complexity (Gregersen & Bjurulf, 1996).

## The Influence of Parents and Family

The role parents play in helping teens learn to drive is an area of recent interest to science and the way parents manage the process is seen as a critical component in producing safe drivers (Simons-Morton & Ouimet, 2006). According to federal law, teens under age eighteen do not have the right to drive without parental support. States determine the specifics of licensure programs to manage this process but all require that a parent or legal guardian sign off for teen licenses and parents must assume financial responsibility. Thus parents can also revoke their child's license at any time (Copeland, 2015). However, some teens do complain that their parents are not effective role models and too many families face financial and related struggles that create barriers to the promotion of safe family driving climates (CDC, 2015). A study of family climate around teen driving found that teens whose families maintained a commitment to safety exhibited better driving behaviors (Taubman-Ben-Ari & Katz-Ben-Ami, 2012). Factors that were important in creating a positive family climate included parent actions such as modeling safe driving, providing supportive feedback during the learning process, sending clear and consistent messages about safe driving, setting and monitoring limits, and overall ensuring effective parent/teen communication and a commitment to safety (Taubman-Ben-Ari & Katz-Ben-Ami, 2012). Supervised practice is critical for teens learning to drive and parents are often the primary driving coaches for teens. There has been little study into this relationship, but inconsistencies between parent and teen expectations have been revealed (Sherman, Lapidus, Gelven, & Banco, 2004), and shared anxiety and tension between novice drivers and parents can lead to parental disapproval and both teen and parent avoidance of the learning process (Taubman-Ben-Ari, 2010).

Teens having responsibilities in caring for younger siblings often includes driving them around and crash surveillance data reveal that child passengers of teen drivers are at an increased risk for being in a crash, particularly during the night time (Chen, Durbin, Elliott, Senserrick, & Winston, 2006). Some say that young children are the worst distractions for teen drivers (Petrie, 2012). It is difficult to ascertain the full impact of crashes on young passengers, as a comprehensive surveillance system does not exist that collects medical and psychological distress across the continuum of service providers who may treat young passengers after crashes (Winston, Elliott, Chen, Simpson, & Durbin, 2004). Ensuring teen drivers are educated about the injury risks for young children and how to properly use safety equipment such as booster and car seats is critical (Chen, et al., 2006). Overall, parents need to be empowered to manage their teen's driving experience more rigorously (Miller & Taubman-Ben-Ari, 2010; Sherman, at al., 2004; Simons-Morton & Hartos, 2003; Simons-Morton & Ouimet, 2006), especially if they are driving around their younger siblings or other children.

**The Influence of Peers and Passengers**

The influence of peers on teen driving has also been a recent hot topic for study; however, whether or not peers have a negative or positive impact on teen driving is unclear (Curry, Mirman, Kallan, Winston, & Durbin, 2012). Studies find that teen drivers perform the best when an adult is their passenger, which suggests that teens are capable of driving safely despite their lack of education and experience (Simons-Morton, et al., 2011). Peer passengers are thought to present risks by being a distraction and/or by promoting risk-taking behaviors. For males, one study found that the promotion of risk-taking influenced male drivers the most which sometimes caused aggressive driving; females were most impacted by the distracting factors of passengers, compounded by their simultaneous use of in-car distractions (radio, cell, etc.), but females were rarely aggressive (Curry & Mirman, et al., 2012). While males have been found to be more likely to engage in risky driving when male peers are their passengers, they also appear to drive more safely when they have female passengers, which suggests that type of passenger does influence driving style (Curry & Mirman, et al., 2012). One study using in-car recording equipment to examine if risky driving occurred differently by passenger type found that teenage risky driving was 67% lower with adult passengers, 18% lower with teenage passengers, 20% lower during early night than day, and 109% higher with more risky friends (Simons-Morton, et al, 2011). One study conceptualizes technology as the equivalent of a peer passenger that can be either harmful or helpful and calls for industries to work together to make sure in-car technologies and policies support teen drivers to maximize the positive effects of both technology and passengers (Lee, 2007).

While the fear is that peer passengers are most likely to have a negative impact on teen driving (Allen and Brown, 2013), another study was able to reveal the positive peer pressure potential among young drivers age 17 to 25 (Buckley & Foss, 2012). This study found that having a friend or relationship partner intervene as a passenger to promote safety did reduce risky driving (Buckley & Foss, 2012). Another study found that teens did engage in riskier driving when their passengers were peers, especially when the teen driver reported that their friends engaged in other risky behaviors such as smoking, drinking, speeding, and not wearing their seat belts; but that teens who reported that their friends were likely to intervene to exert positive peer pressure such as saying don't drive so fast exhibited more safe driving overall (Simons-Morton, et al., 2011). Overall, the influence of passengers has not reached a point of consensus, but it is clear that when a passenger communicates a driving behavior standard, it very frequently will have an effect on the driver (Hu, Xie, Han, & Ma, 2012). There are calls for further development of interventions to encourage youth to speak out, and for peer drivers to respond to requests from passengers for safe driving (Buckley & Foss, 2012; Wallace, 2013). In supporting this positive framing of teen passengers, our model will include behavior intention measures around safe driving and being a safe passenger.

**Evaluation of Interventions**

The primary interventions governments have taken on to reduce teen driver crashes have been to address lack of education through the provision of driver's education and to address lack of experience with Graduated Driver Licensing (GDL) laws (Porter, 2011). Recent trends seek to create GDL systems that function to combine education and other community services, and to engage teens as leaders in addressing larger transportation safety issues. Each of these approaches faces implementation, measurement, and evaluation challenges. However, primary strategies are still largely individual behavioral interventions, and for teen drivers include driver's education programs aimed at increasing education and skills (Williams, Preusser, & Ledingham, 2009) and GDL policies aimed at requiring a slow progression into full driving privileges to increase opportunities for experience (Morrissey, Grabowski, Dee, & Campbell, 2006; Williams & Shults, 2010).

## Driver's Education

Grounded in learning theory, driver's education courses were taught as early as the 1900s, and began to formalize in the 1930s (Williams, Preusser, & Ledingham, 2009). The first license as granted by Chicago, Illinois in 1899 (Mayhew, Fields, & Simpson, 2015); and New Jersey was the first state to require a written test for licensure in 1913 (CDC, 2015). Driver's education quickly became the primary public health intervention to curb the lack of education and experience problem (Mayhew, et al., 2015). A standard of 30 and 6, meaning 30 hours of classroom instruction and 6 hours of behind the wheel instruction emerged by the early 1950s from the Carnegie Unit model of instruction, which is commonly used by education systems to classify and track graduation requirements for billing purposes (Highway Safety Center, Indiana University of Pennsylvania, 2002). The famous DeKalb study began in the 1970s and was a landmark attempt to connect participation in driver's education with a long term reduction in crash involvement (Lonero & Mayhew, 2010; Williams, et al., 2009). However, this study, nor any other study has ever been able to connect participation in driver's education with an actual lifetime crash reduction (Lonero & Mayhew, 2010; Williams, et al., 2009).

Driver's education studies across the board suffer from feasibility issues such as not having a control group, using non-random group assignment, failing to measure or control confounding variables, and/or poor overall program design of driver's education programs (Beanland, et al., 2013;

Lonero & Mayhew, 2010). Theory guiding existing models of driver's education are weak (Keskinen & Hernetkoski, 2011); as is data on what types of interventions are best at measuring incremental improvements in teen knowledge, skills, attitudes, and motivations (Lonero & Mayhew, 2010). The uncertainty that remains around driver's education has more to do with these methodological issues inherent in real-world program evaluation than it does with anyone's disbelief that providing some form of driver's education and/or supervised driving practice are essential for indoctrinating new drivers to the roads. Thus, we need continued study related to untangling the confounding variables that have been shown to affect driving including lifestyle and developmental factors such as attitudes, motivations, and decision-making skills (National Highway Traffic Safety Administration, 2008; Williams, et al., 2009), as well as more robust research on all types of driver training programs and their impact on teens in the short term, as well as impacts on long term crash reductions in their communities (Beanland, et al., 2013).

While there has been no successful connection to long term crash avoidance, there have been recent successes in documenting improvements in various behavior-based proxy variables such as attitudes, knowledge, skills, and insight (af Whalberg, 2009). Recent reviews of pre and post driver license training reveal that some forms of education have been able to improve procedural skill acquisition and others have improved hazard recognition (Beanland, et al., 2013). A study comparing the effects of higher-order driving skills or insight training with hands-on vehicle training found that the insight group showed significant improvements in visual search, composite driving scores, hazard perception, and safer attitudes; while the hands-on group improved only in relation to their on-road direction & control, speed choice, and their composite driving scores (Isler, Starkey, & Sheppard, 2011). Evaluations of skid-control training demonstrate that some teens who receive hands-on training may overestimate their ability to drive in risky situations, causing them to be more likely to choose to drive a car in an unsafe environment, such as on slippery roads (Katila, Keskinen, Hatakka, & Laapotti, 2004). Skill training programs overall may provide more false overestimation of skills than insight training does, however insight training alone may not be enough (Gregersen, 1996).

Despite having no clear consensus on what makes good driver's education, 20 US states still work to ensure driver's education, and two states rely on a demonstration of competency in a driving test rather than a written exam (NHTSA, 2008). Most states also have driver's education overseen by an educational entity; however four are overseen by law enforcement or another legislatively appointed body (NHTSA, 2008). Since NHTSA cut federal funding for driver's education in 1982 (CDC, 2015), most states have stopped providing it in schools and instead work to coordinate private service providers that families can opt to pay for (Carty, 2013). These providers are often poorly regulated and parents face challenges in not only paying for these services, but ensuring they choose an effective one. States without mandated driver's education have been shown to exhibit higher crash rates among minorities, the poor, and females, which does appear to be occurring in Tennessee (Curry & Garcia-Espana, et al., 2012). Further, there is evidence of a mobility bias in public policy making for transportation with minorities and low income in general paying more for and getting less from transportation systems (Bullard & Johnson, 1997; Bullard & Torres, 2004), as well as being over-represented in crash-related fatalities (Garrison & Crump, 2007). When driver's education is not available to the public, low income individuals simply do not have access to this education, and then also do not then receive rewards such as insurance rate discounts typically offered to teens that complete formal driver's education (Hirsch, 2003) and crash reductions. Some also critique procedural inequities in the form of insurance discount incentives given to wealthier teen drivers who can afford driver's education (Hirsch, 2003). Nationally, patterns of availability of driver's education do fall along socioeconomic and racial lines (Curry, et al., 2012).

## Graduated Driver Licensing (GDL)

Deterrence theory guides the entirety of the US highway safety citation system (Ellwanger, 2006) and the recent trend towards Graduated Driver Licensing (GDL) laws started in the 1990s; with all fifty US states having some form of GDL in effect by 2010 (Insurance Institute for Highway Safety [IIHS], 2013). Some say licensure is primarily about revenue generation for the government, and to register and identify drivers so they can be tracked and held accountable for damage done while they were driving (Mayhew, Fields, & Simpson, 2015), and that GDL places undue restrictions on teens (Bystricky, 2015; Pittman, 2013). GDL does appear to have some impact on reducing teen crash rates (Carpenter & Pressley, 2012; Lyon, Pan, & Li, 2012; Pressley, Benedicto, Trieu, Kendig, & Barlow, 2009; Shope, 2007). However, GDL policies are criticized in that they only succeed in controlling the behavior of teen drivers and do not do enough to actually help them learn to drive; and may simply offset crashes due to inexperience to those ages 18-24 (Karaca-Mandic & Ridgeway, 2010). Based largely on the belief that teen crashes are a law of nature, arguments have been made to delay the age of licensure for teen drivers altogether (Longyard, 2015; Williams & Shults, 2010).

GDL laws place restrictions on teens up front, often including limitations on passenger counts, restrictions on night time driving, and bans on the use of cell phones in any way while driving; and then gradually remove these restrictions with the purpose of easing teens into full driving privileges (Williams & Shults, 2010). A 2011 attempt to establish federal minimum GDL standards failed, as consensus has yet to emerge about which are the most cost-effective strategies in GDL, and which are violations of teen rights (Engdahl, 2015). Tennessee uses a four-stage GDL system consisting of: 1) Learner's permit; 2) Intermediate Restricted; 3) Intermediate Unrestricted; and 4) full licensure obtained at age 18. Tennessee's GDL laws are classified as primary offenses, meaning that an officer has probable cause to stop a vehicle if it appears to be in violation of GDL restrictions (Tennessee Department of Safety and Homeland Security, 2013[1]). Currently, there is no reliable data in Tennessee regarding how aware people are of GDL laws, and local municipalities are not required to report GDL warning, violations, or how cases are handled by courts to any sort of centralized repository.

THSO does work to educate Tennesseans about its GDL system and to build infrastructure with which Tennessee can assess and evaluate GDL effectiveness at the behavioral level (Chaudhary, Ferguson, & Herbel, 2004). In one study, officials mailed information booklets to all parents whose teens had just obtained their learner's permits. Participants were randomly assigned to groups that received different levels of intervention, with some groups being mailed more intensive information. To ensure all participants had some level of intervention, the control group received a minimum level of one letter welcoming them and their new teen to driving, offering advice on supervision of practice, and providing recommendations to establish rules and periodically follow up with their teen throughout the learning process. While findings show that parents liked the information and wanted to keep receiving it, there were no discernible effects on teen practice driving or reported parental involvement during the learner stage, nor restrictions imposed by parents. However, across all treatment conditions, overall supervised driving exceeded state requirements by a substantial margin (Chaudhary, et al., 2004). This suggests that while passive information is helpful and desired, parents and teens also engage in more interactive learning activities, which is what teen leaders work to facilitate being available in their local communities.

States that have strong GDL laws have been shown to also have corresponding decreases in teen crashes (Morrissey, et al., 2006; Pressley, et al., 2009; Shope, 2007). One study found that about one-fifth of all crash fatalities among drivers age 15-17 were associated with GDL non-compliance; and these non-compliant drivers were also more likely to be drinking, unbelted, and/or driving on the weekend (Carpenter & Pressley, 2012). An analysis of the relative risk of specific GDL violations found that the strongest reductions in GDL related crashes came from reducing the number of passengers involved in teen driver crashes, followed closely by also reducing night time crashes (Lyon, Pan, & Li, 2012). However, through the lens of a teenager, GDL may be creating a generation of youth marginalized from independent transportation, with GDL doing more to control a teen's behavior by limiting their access to transportation more than it works to teach them how to drive safely (Karaca-Mandic & Ridgeway, 2010). None of these studies examining the impact of GDL made note of the significance of any teen-led driver safety efforts that might have also been occurring during the study's time frame. Recent critiques find that with GDL, teens wait to get their licenses until age 18, at which point they get full privileges and thus crashes are simply offset from younger years to drivers age 18-24 (Karaca-Mandic & Ridgeway, 2010). Despite concerns, some states have went so far as to require teens to have identifying stickers on their license plates to signal law enforcement that they are under age 18, although some call this ageism and condemn the practice for putting teens at risk to predators, which apparently there is one occurrence of in NJ (Courier News, 2015).

A national sample of teens found through a series of focus groups that teens do not like the GDL restrictions placed upon them, particularly the passenger restrictions (NHTSA, 2006). Teens by and large did not understand this restriction and did not agree that passengers always increase crash risk. They also reported that GDL was rarely enforced, which supported their beliefs that passenger restrictions were not meaningful. Teens were also largely unaware of the risk that distractions such as the radio or cell phones played in increasing their likelihood for causing a crash. Teens also reported that they often felt tired all of the time, and yet found that they must drive to go to work, school, and to engage in their daily lives. Teens reported overall that they were very interested in learning more about driving, including about what happens in a crash and how to prevent one, but they often also felt that adults did not trust them with this kind of information.

Teens consistently reported that wanted to have discussions about safe driving with their peers, family, adults, and other experts (NHTSA, 2006).

## Integrative Intervention Models

Regardless of any controversy, the adults in charge of the system are largely convinced that GDL works to create positive results (Shope, 2007; Williams & Shults, 2010). Some call for more coordination between policy makers, vehicle, insurance, and other related industries (Shope, 2007). A coordinated community response will leverage policy-making power to integrate GDL and driver's education with other community services (Gillan, 2006; Williams, 2006). Community-coalition action theory best describes these efforts and should include stakeholders representing a comprehensive group that involves individuals who are focused on exploring the potential for teen passengers to be positive rather than negative impacts on driving (Williams, 2006; Williams & Shults, 2010). A public health approach has widely been adopted across highway safety and there is demand for interventions to address the agent-host-environment triangle, with the car being seen as the agent, the social and driving world the environment, and the teen driver as the host (Sleet, Dellinger, & Naumann, 2011). States are beginning to coordinate blended programs and an evidence-basis is emerging for various types of motor vehicle injury prevention strategies (Missouri Dept. of Health, 2013). Most agree that effective GDL systems that move beyond policy enforcement to include innovative education for teen and parental engagement provides the best opportunities for protecting teens on the highways (Williams, 2006). There are calls for the development of innovative education programs specifically (Beanland, et al., 2013) and integrated community interventions (Williams, 2006). In today's world, this is going to include a range of stakeholders that should include teen and parent groups, schools, law enforcement, health care, and policy makers; as well as business partners such as insurance providers, car dealerships, and manufacturers. Most pediatricians do not consider highway safety as a health priority and report that it is not part of their regular conversations with teens and parents; however, advocates are beginning to encourage pediatricians to provide information about GDL and safe driving and to be prepared to discuss health related outcomes for crashing without a seatbelt, and alcohol/drug use (Campbell, Borrup, Corsi, Kelliher, Saleheen, Banco, & Lapidus, 2009).

## MAP21's New Direction: Teen Leadership

In addition to MAP21, significant developments have occurred recently to support teen drivers and teen leaders for highway safety (Williams & Shults, 2010). Comprehensive teen and community engagement is recognized as a successful strategy for reducing crashes (Williams, 2006). Current priorities of the National Academy of Sciences Transportation Research Board (TRB) Subcommittee on Young Drivers work to advance the science basis for programs and policies (Williams & Shults, 2010) and the TRB lists equity as a critical issue in transportation (TRB, 2013). In reality, teens need real-world, hands-on skills, as well as insight into the fallibility of human driving; as described by the historically significant four-level Keskinen model (Hatakka, Keskinen, Gregersen, Glad, Hernetkoski, 2002). Driver's education typically covers the lowest two levels, vehicle maneuvering and mastering traffic situations, however the top two levels of the hierarchy, goals for life and living and understanding the context of driving, are rarely if ever addressed in standard driver's education and are completely missing from enforcement-based GDL restrictions. Experts recommend strategies that allow young drivers to have meaningful experiences with learning to drive and they recommend active learning methods (Hatakka, et al., 2002; Laapotti, Keskinen, Hatakka, & Katila, 2001). Participatory research projects that focus on co-learning between academics and youth would likely maximize teen potential for leadership and respect the contribution they can make to the scientific community in understanding teen drivers (Simons-

Morton & Winston, 2006) and overcoming historical race and class bias in the transportation system as a whole (Bullard & Johnson, 1997; Bullard, Johnson, & Torres, 2004). A comprehensive model for establishing a traffic safety culture contains interlocking pieces including a society's value placed on traffic safety and the accountability of social institutions in regards to traffic safety, that traffic safety is monitored and guided by effective policies that operate with broad public support, and that individuals engage in behaviors that promote traffic safety (Girasek, 2012).

Several studies have emerged that utilize teen collected data. One study from Tennessee evaluated the *Be in the Zone* (BITZ) program designed as a hospital-school collaborative to provide teen leaders with basic information about texting and driving. Teens were supported to use what they had learned to plan an annual schedule of events related to preventing texting and driving. Teen leaders were also supported to conduct pre and post cell phone use observation studies near their schools which showed significant decreases in texting behavior (Unni, Morrow, Shultz, & Tian, 2013). A similar Battle of the Belts project conducted in Arizona used teen-led seatbelt promotion interventions and teen-collected seatbelt use observation study data. Findings demonstrated that seatbelt use behavior was impacted, and that teens were very receptive to strategies that put them in charge (Goslar, Silvers, Strever, Judkins, Segebarth, & Lerma, 2009). In Minnesota, a 4-week Drive Smart challenge focused on a range of safe driving habits through teen-led interventions, with teen-collected data documenting increases in seatbelt use (Philbrook & Franke-Wilson, 2009). Colorado evaluated the Teen Traffic Safety Challenge, which is a peer to peer campaign consisting of at least two unannounced seatbelt observation studies and at least one safety presentation at each school, which found seatbelt use increased by 20% (Houston, Cassabaum, Matzick, Rapstine, Terry, Uribe, Harwood, Moulton, & Mile-High Emergency Medical and Trauma Advisory Council, 2010). The Why Drive High? social marketing campaign developed in Canada did not assess outcomes from the intervention developed, but did use focus groups to examine the impact of the program on the leaders, who reported that deciding which messages to deliver to their peers was empowering and that having adult support was critical to their success (Marko & Watt, 2011). The Drive Alive Pilot Program (DAPP) developed in Georgia is a theory-driven intervention developed by an academic but designed to be implemented by teens which found a 23.3% increase in seatbelt use (Burkett, Davidson, Cotton, Barlament, Loftin, Stephens, Dunbar, & Butterfield, 2010). DAPP employs teen leaders to conduct as many as 20 highly-visible seatbelt checks on school grounds, to provide incentives and disincentives for seatbelt use, and to support this with programs providing educational information (Burkett, et al., 2010).

**Effectiveness in Youth Leadership**

There is practitioner consensus across multiple issue areas that peer-to-peer intervention is an effective prevention practice (Heifetz, 2006); however little is actually known about the impact this kind of leadership has on teens or how adults can best support them (Weisz & Black, 2010). Evidence does suggest that teens are ideal role models for their peers and using teen leaders can be more effective than using adults, especially when the teen leaders have individually well-defined personalities and get along well with others (St. Pierre, Osgood, Siennick, Kauh, & Burden, 2007). In general, leadership refers to a relational process that combines ability with authority to exert influence and impact (MacNeil, 2006). Despite tens of thousands of pages of research, leadership itself has proven to be quite an elusive concept; with researchers still working to define its essential attributes, functions, and circumstances (MacNeil, 2006). Leadership can be thought of as ability (skills, knowledge, and other personal attributes) and authority (such as voice, influence, and decision-making power), (MacNeil, 2006).

When youth leadership is referred to in the literature, it typically refers to one of three models: 1) an endeavor to emphasize and/or develop leadership skills in individual youth, as well as creating opportunities for youth to exercise leadership; 2) youth having the ability to guide or direct others through influence; or 3) community or other organizations focused on youth voice, with youth leaders providing direction and taking a central role in decision-making, typically engaging in activities such as youth philanthropy, evaluation and action research, and policy advocacy (Libby, Sedonaen, & Bliss, 2006). Teens often initiate leadership activities after being recruited by teachers or friends to participate in community programs, they tend to sustain leadership activities with supportive peer groups that encourage serving on committees and boards; and when allowed to fully participate in decision-making and community service, teens can experience enhanced self-esteem and improve overall youth organization and quality of life (Pancer, Rose-Krasnor, & Loiselle, 2002).

The Search Institute offers one of the most holistic frameworks for understanding youth leadership in regards to developmental assets (Clary & Rhodes, 2006). Their model lists forty developmental components needed by young people, as divided into two categories for internal and external assets. Internal assets should focus on developing a personal commitment to learning, positive values towards other including being caring and honest, maintaining a positive self-identity and sense of personal power, and promote social competencies including planning and decision-making, conflict resolution, and resistance skills. External assets examine support from family and others, clear communication about boundaries and expectations, opportunities for constructive use of time, and community values that demonstrate values including service towards others and personal safety. They also offer a taxonomy of roles for adults and mentors in positive youth development activities. These include formal and informal actions the adult should engage in as they work with teens, their parents, and the community that surrounds the youth. In each of these roles, adults must support the perspective of young people and encourage parents and communities to support young people as well (Clary & Rhodes, 2006).

For teens, participation in planning can be understood as a cluster of activities where youth are empowered to actually examine and take action in the issues they care about (O'Donoghue, Kirshner & McLaughlin, 2002). Despite the general desire to have inclusive and effective public participation in transportation planning (US Dept. of Transportation, 2012[1]), agreement does not exist as to how this can be accomplished (O'Connor, Schwartz, Schaad, & Boyd, 2004; Schively, 2007). Citizen participation has often been conceptualized as a ladder to represent growing levels of authenticity of engagement in guiding change (Arnstein, 1969; Hart, 1997). Hart's ladder is designed for children and shows progression from manipulation by adults to child-initiated efforts (Hart, 1992). Hart warns against manipulation efforts in any way. He also says that serving as decoration or being a token in prevention programs may be considered appropriate for very young children, but should not be considered authentic participation. Levels of authentic participation begin when children are minimally assigned tasks to complete, with authenticity of participation increasing as children are given more responsibility and autonomy. The highest stage is characterized by child-initiated efforts with adults following their lead in decision making processes (Hart, 1997).

A recent modification of Hart's ladder points out that instead of being completely youth directed, balanced decision-making between adults and youth can contribute best in today's world of EBP (Wong, Zimmerman, & Parker, 2010). The Typology of Youth Participation and Empowerment (TYPE) uses a pyramid instead of a ladder to depict shared decision-making between adults and youth at the pinnacle of the model. Key pedagogical tools recommended in youth leadership include case-in-point learning utilizing real-time dynamics, below-the-neck learning utilizing experiential activities, and reflective practice offering opportunities for youth to exercise leadership skills (Klau, 2006). Other recommendations for youth practice also include analyzing power within social relationships, keeping identity central, promoting systemic change, using collective action and environmental strategies, embrace youth culture, and to develop tools to transfer to support other youth in social justice movements (Ginwright & James, 2002).

As MAP21 makes significant data demands, the adults working in this project seek to build infrastructure that will empower teen leaders across the state to authentically engage in planning at the local level and facilitate the development of their autonomy in participation and direction of teen-led actions in delivering young driver safety information. Multiple organizations provide support to teen leaders in developing their own locally tailored interventions, such as the National Organization for Youth Safety (NOYS, 2016), the National Safety Council (NSC, 2016), and Students Against Destructive Decisions (SADD, Inc., 2016). These groups typically prepare and disseminate toolkits outlining processes for teen leaders to follow in order to implement any number of interventions in their schools and/or communities and often use youth conferences to share information and build networks (Pancer, Rose-Krasnor, & Loiselle, 2002). Typical youth-led interventions include philanthropy, court advocacy, social enterprises, community organizing, recreation and event planning, prevention and youth safety, media activism, transportation activism, health and health promotion, and evaluation and research (Delgado, 2006). For highway safety, typical interventions include policy summits, town halls, mock crash simulations, public service announcements, GDL awareness, promotion of parent/teen driving contracts, essay or poster contests, skits, or other activities designed to promote awareness of highway safety (Hollister, 2013). While evaluation of these sorts of interventions is scant, an improved orientation to safety can reasonably be expected of teens who participate in almost any form of highway safety workshop (Rosenbloom, Levi, Peleg, & Nemrodov, 2009).

## Chapter 3: Methodology

Simply put, a survey is a system for collecting information that can include questionnaires (Sue & Ritter, 2012). Measuring short term change from a highway safety intervention typically involves a questionnaire-type survey assessing change in an individual's knowledge, skill, attitude, belief, or some other psychological property as a proxy measure; with the ultimate goal of expecting this to result in accomplishing long term behavior change, such as a measured reduction in crash involvement resulting from driver error (af Whalberg, 2009). The measurement of psychological properties such as attitudes and emotions as organized into a discipline is known as psychometrics (Coaley, 2014; Nunnally, 1975). Psychometricians use mental tests as instruments to combine measurement items into summed scales in order to reveal distinctions in variables that are not readily observable (DeVellis, 2012). The underlying phenomenon that a scale is intended to measure is referred to as the latent construct or the latent variable (DeVellis, 2012). Assessing change using pre and post measurement data to evaluate an intervention's ability to alter factors of a latent construct using psychometrics is common practice in highway safety (Porter, 2011). However there are currently no standardized measures relevant for use by teen leaders that positively frame teen drivers nor measures appropriate for evaluating the type of work that peer to peer prevention programs entail for highway safety.

There are multiple benefits to psychological measurement (Coaley, 2014). For teen leaders, having a behavior survey can serve to provide objective quantified numbers to support their planning processes and to help them detect changes resulting from their work. Further, using common metrics allows for the comparison of the effectiveness of peer to peer programs and services over time and across groups. Replication studies are a critical component of knowledge building and infrastructure supporting this is required for the meaningful use of statistics across the social sciences (Kline, 2013). In order for a measurement tool to be relevant for use, it must meet the basic standards of psychometrics which include: 1) standardization of processes, reliability of items, and both internal and external validity; 2) being grounded in a scientific rationale, with an explanation of its construction; 3) having recommendations for standardized administration procedures; 4) being relevant enough for use with a large enough sample to establish a process for cross-validation and replicability studies; 5) continuously maintaining accuracy and error measures and evidence of validity; and 6) having guidance for interpretation (Coaley, 2014). When selecting existing or designing new measures, it is also important to consider factors such as the scope of attributes that need to be covered, the breadth of groups who can potentially be assessed, and the instrument's acceptability or perceived relevance, its practicality of implementation, fairness for ethical use, and its overall cost/benefit utility (Coaley, 2014).

It is also important to consider survey error at all stages of a survey development process. While the term error is typically thought of as a mistake, it is expected to occur in the surveying context but must be assessed in order to best frame the validity of estimates (Weisberg, 2005). Sampling error can occur in three primary ways whenever a sample of a population is used rather than an entire population itself, which is almost always the case in social science. These include: 1) a potential for systematic sampling bias whenever probability sampling is not used; 2) a coverage error if the sampling frame does not correspond to the total population; and 3) a unit non-response error, which occurs when people selected for the sample choose not to participate. Three additional types describe error in the accuracy of responses including: 1) item non-response error, when participants skip some items; 2) non-response error, which is heavily dependent upon survey design but is due to the respondent, such as whether or not they choose to provide honest answers; and 3) non-response errors due to interaction effects between the participant and the interviewer, which in the case of a web survey is the computer interface (Weisberg, 2005). The final type of survey error is called post-survey error and occurs at the point of processing and analyzing data, however some do not consider this part of the live surveying process itself and thus do not discuss this when discussing survey error. The Total Survey Error Approach (TSEA) seeks to improve surveying processes and does incorporate this (Weisberg, 2005). TSEA also works meta-analytically to understand mode effects in regards to the differences in responses in relation to how data was collected (such as by a person, over the phone, or via the internet); and comparability effects which seek to explain differences in survey results obtained by different groups at different times (Weisberg, 2005).

A six-step process for choosing or developing a system for standardized psychometrics is to: 1) set clear aims regarding the measurement purpose and the target group to be assessed; 2) define attributes clearly, as they will be measured; 3) develop and maintain a written plan describing test content, appropriate populations for use, summaries of items and their scoring needs, administration instructions, time frame and/or sampling recommendations, and guidance on how test scores should be calculated and interpreted; 4) select items for continued use that demonstrate proven reliability; 5) continuously use new trails and participant feedback to refine items and standardized processes; and 6) document ongoing information regarding the test's reliability, validity, and maintain tools to assist transfer of its use (Coaley, 2014). When designing the scalar items themselves, it is important to have a theoretical grounding that clearly connects the latent variable with test items (DeVellis, 2012). Things to consider are the cognitive processes required in providing a survey response, including question comprehension, information retrieval, judgment and estimation, and response options provided (Presser, Rothgeb, Couper, Lesslet, Martin, Martin, & Singer, 2004). Recommendations include first generating an item pool, determining the response format that will provide the most effective measurement, and then to have the item pool reviewed by experts, with final items then administered to a development sample and quantifiably evaluated for optimization of scales (DeVellis, 2012).

Obtaining data through questionnaires imposes a scientific process that is currently guided by certain dynamics that may impact how teens respond to the *I Drive Smart* survey. Parameters that typically govern surveying processes ensure that contact and interaction is a singular event that occurs among strangers; is initiated by the interviewer, typically without the respondent requesting the interaction; occurs without interactional reciprocity, meaning that the researcher asks questions and the respondent answers them; and all with the researcher in complete control of the theory guiding the measurement system, the complexity of the language and grammatical style, and the response options provided for participants to choose from (Blasius & Thiessen, 2012). In lieu of a standard top-down scientific process, the *I Drive Smart* survey was developed using a community-engaged research (CEnR) bottom-up approach (Chen, 2013). CEnR approaches can be very broad, but are typically framed as public health or ecological approaches that demonstrate a commitment to several principles and practices. These include a commitment to the identity of the community being studied, taking a strengths-based approach to maximize community resource utilization through collaborative partnerships, promoting equity and co-learning among partners, maintaining a balance between research and action, ensuring mutual benefit, creating appropriate dissemination for all partners, and will often use cyclical processes focused on system development and promoting sustained system improvements (Isreal, Schulz, Parker, Becker, Allen, & Guzman, 2008). The author sought to serve the needs of THSO and Tennessee's teen leaders to ensure they could meet MAP21 data demands over time, while also respecting the actions of THSO and teen leaders and how they could use data to improve how they serve their communities. The team worked to retro-fit scientific models to the real world actions of what teen leaders were actually doing through *Reduce TN Crashes* to promote highway safety, and how schools were actually allowing them to operate to collect and use program evaluation data in compliance with relevant laws.

## The *I Drive Smart* Survey

Traffic safety is typically considered in terms of the three E's: education, enforcement, and engineering (Groeger, 2011). ). For education, the National Highway Traffic Safety Administration (NHTSA) maintains multiple national awareness campaigns include *Click it or Ticket*, *Booze it and Loose it*; with some campaigns targeting certain groups like rural drivers such as the *Buckle up in your Truck* campaign (Anderson, 2011). The *I Drive Smart* campaign began in 2010 as an effort of THSO in response to the lack of any such campaign targeting teen drivers specifically. The *I Drive Smart* logo and branding was developed throughout 2010 and 2011 by THSO and their network of partners and grantees using input from teen leaders, parents, teachers, law enforcement, health care professionals, and other partners. In choosing the word smart, partners considered the findings from a recent qualitative study that sought to identify teen perceptions of good and safe drivers (Barg, 2009). Teens in the study saw a difference between being a good driver and a safe driver, with good drivers having superior vehicle maneuvering abilities, and safe drivers having more focus on following laws and practicing caution. Differences were noted in subgroups between males and females but the most significant group differences were found among racial groups. Focus groups with African Americans listed has a license as a top quality of safe drivers, for whites the top quality was obeys signs & uses signals, and uses seatbelts was the top safety criteria for Hispanics (Barg, 2009). THSO and partners used an informal process to brainstorm language that would be relevant for use, which revealed that teens responded to the concept of driving smart best because it was positively framed and action oriented.

The author was specifically asked to develop an evaluation instrument that was connected to the *I Drive Smart* branding, was relevant for use in evaluating the peer to peer programs supported through THSO's flagship teen driver safety program *Reduce TN Crashes*, would engage teen leaders as evaluators as much as possible, and could be transferred for use with other groups. With the author guided by the principles and practices of CEnR (Isreal, et al, 2008) and working within an Empowerment Evaluation (EE) framework (Fetterman & Wasdersman, 2005), partners had a series of meetings over 2012 and 2014 to develop the instrument being tested, which contains both psychometric scales assessing young driver behavior intentions and a knowledge test. When designing scalar items themselves, it is important to have a theoretical grounding that clearly connects the latent variable with test items (DeVellis, 2012). The author worked with community partners and sought to ensure theoretical validity so that the questioning format was relevant for measurement and interpretation. During this time frame, community partners reviewed and discussed the preliminary measures and held various informal interviews and focus groups with young people to refine the final development version. In the end, the *I Drive Smart* survey is grounded in Theory of Planned Behavior (TPB), (Fishbein & Azjen, 1975) and contains demographic and inclusion criteria information gathering questions, psychometric scales assessing TPB constructs, a highway safety knowledge test, and has recruitment and administration protocols that are designed to be enacted by teen leaders in alignment with their local school policies.

**Theory of Planned Behavior**

In identifying appropriate determinants that could be of use both to the teen leaders and to scientists in building knowledge for understanding teen driver safety, the Theory of Planned Behavior (TPB) was selected by partners to serve as a framework for the survey. Currently, driving and many other individual behaviors related to health and safety outcomes are studied according to the TPB (Weston, 2005). Mathematically, TPB guides a linear prediction model where scientists enter multiple variables into a statistical software package that then predicts driving behaviors based on how the patterns of variation correlate in the aggregate (Montano & Kasprzyk, 2002). TPB assumes that people make rational decisions and that their actual behavior is a product of one's attitudes, perceptions of social norms, and perception of volitional control over the behavior. These factors combine to predict behavioral intention, which in turn is the most reliable predictor of future behavior (Azjen, 2011). Criticisms of the sufficiency of TPB to understand behavior say that it lacks measures of affect or emotion. Tests of the model with anticipated effects and emotional constructs added however did not appear to improve the predictive utility of TPB models (Azjen & Sheikh, 2013). When individuals feel they have volitional control over a behavior, their perceptions of control are the most reliable predictors of actual behavior (Montano & Kasprzyk, 2008). Perceptions of behavior control are not necessary in all TPB models and most behavior intentions can be reliably predicted by attitudes and norms (Fishbein & Azjen, 1975). Findings show that when it comes to measuring attitudes, they are not always reliable predictors of behaviors, especially when there are effects of reinforcement and/or forced compliance present (Fishbein & Azjen, 1975).

Young drivers are forced to comply with GDL, parental rules, and can only access support programs that are accessible to them in their communities. Thus, driving is not something teens can be expected to feel full volitional control over, thus perceptions of behavior control measures are obtained. TPB grows from the Theory of Reasoned Action (TRA), (Fishbein & Azjen, 1975). TRA says that behavior is a function of one's attitudes and norms with TPB adding to this model to account for how the person perceives their own ability to control the specified behavior. Concept scales sum to measure a person's behavior intention, which guides their actual behavior, as depicted in Figure 1. The TPB concept structure is grounded in learning theory and the expectancy-value model, which asserts that people's evaluations of, or attitudes toward, an object are determined by their salient or readily accessible beliefs about the object, with beliefs being defined as the subjective probability that the object has a certain attribute (Azjen, Albarracin, & Hornik, 2007). For expectancy-value models, objects and attributes can be thought of in a generic sense in that they refer to discernible aspects of their world. When applied to behavior science, the object of interest is a particular human action and the attributes are the action's anticipated outcomes (Azjen, Albarracin, & Hornik, 2007). Many response formats have been used to measure TPB concepts including lickert scales, multiple choice items, qualitative interview, and direct observation with an investigator coding behaviors (Fishbein & Azjen, 1975). All TPB constructs contain random measurement error and rarely exhibit reliabilities in excess of .75 or .80; and reasonable correlation expectations are about .60 (Azjen, 2011).

TPB is a popular model used to understand driving behavior including studies exploring speeding (Elliott, Armitage, & Baughan, 2003; Elliott & Thomson, 2010; Paris, Van den Broucke, 2008); cell phone use while driving (Walsh, White, Hyde, & Watson, 2008); social norms about traffic safety (Atchley, Hadlock, Lane, 2012); people's intention to commit a range of traffic violations (Forward, 2009[1]; Forward, 2009[2]; Parker, Manstead, Stradling, Reason, & Baxter, 1992); and risk-taking among youth (Cestac, Paran, & Delhomme, 2011). One study found that adding the perceived behavior control construct did help improve the model in predicting four common risky driving behaviors (drunk, speeding, overtaking, close following), (Parker, et al., 1992). Subjective norms and behavior control beliefs have consistently showed stronger correlations with behavior intention than between attitude and intention, thus it is important for us to include this construct in our measurement system. Studies have also found that in relation to driving, including variables such as age and sex were unnecessary and did not improve the predictive value of the model, which supports the claims of TPB's sufficiency and its ability to mediate the impact of contextual variations and demographic differences (Elliott, Armitage, & Baughan, 2003; Parker, et al., 1992). The survey does collect minimal demographic information to help assess representativeness. TPB has also been used to evaluate a road safety workshop for 17-18 year olds. Those who participated showed improved orientations to road safety than a control group (Rosenbloom, et al., 2009). Another driving behavior related study employing TPB found that video game playing during adolescence predicted later risky driving through the foundations of attitude and intentions expressed as favor towards risky driving (Beullens, Roe, Van den Bulck, 2011).

TPB recognizes consciousness as a causal agent but at its core is concerned with predicting behavior intentions (Azjen, 2011). However, TPB recognizes that even if a person intends to behave in a certain way, in a real world situation a behavior choice is made. Schematic crash sequences have demonstrated the time it takes for drivers in scanning the road, hazard detection, decision-making, and crash avoidance behavior. Inexperienced drivers take 1.75 seconds, in comparison to experienced drivers who only need 1.5 seconds, and impaired drivers can take more than 2 seconds (Senserrick, 2006). In general, a driver has about a 3 second window to act in order to stop most crash sequences once they have begun. Teens need to be able to make quick decisions in high pressure situations and teens should feel like interventions help them to improve their ability to control their driving behavior. There are some that believe perception of self-control over driving behavior may have more to do with predicting driving behavior than do attitudes, especially among male, minority, youth who are more likely to face barriers to safe driving (Juarez, et al., 2006).

In TPB, the intention-behavior relation is moderated by the actual control over the behavior. For driving, any predictions of behavior would be limited by actual real world situations that might have caused a crash (such as in car/road malfunction, other drivers, weather hazards, etc.). Focusing on behavior intentions is best for evaluating programs designed to prepare a driver to be ready to make good decisions with as much conscious control as possible. This means that while evaluation data collected from teens may show changes in teen driver behavior intentions, this does not say that participation in these teen led interventions is enough. Teens will still need actual real world experience practicing driving, doing self-assessments of driving skills, practicing hazard perception, road scanning, and making risk/consequence calculations under pressure. It will be important for future research to more closely examine correlations to examine which TPB constructs may be mediating or moderating the relationship between the construct and driving intentions across groups.

When specifying intentions, items should clearly state four elements including the behavior, the time, the situation, and the specified object at which the behavior is targeted (Fishbein & Azjen, 1975). For teen driving, there have been several conceptualizations of common factors contributing to teen driving behaviors to include demographic, personality, behavioral, and developmental factors, driving ability, and the physical and social environments (Juarez, et al., 2006; Shope & Bingham, 2008). One measurement model grounded in TPB was designed for teens, but measured risky behaviors of an individual rather than assessing the effectiveness of a program on individuals (Ferguson, Cohen, Pooley, & Guilfoyle, 2012). For the *I Drive Smart* survey, the object of interest is young driver safety behavior and each concept scale uses 3 to 5 items to assess each of the TPB concepts; attitude, perceptions of social norms, and perceptions of behavior control. Each of these is informed by a beliefs-based measurement approach (Fishbein & Azjen, 1975) employing one item attempting to measure a direct belief, one measuring an indirect belief, and one indirect evaluative measure. For perceptions of behavior control, three evaluative measures were used in order to generate data that would shed light on the relative influence teens felt each of the primary programs (GDL, driver's education, peer to peer education) had on their perceptions of their ability to control their own driving behavior.

**Survey Specification**

In addition to ensuring a sound theoretical basis for a psychometric instrument, the target group should also be specified (Coaley, 2014). The *I Drive Smart* survey is designed for young people that are high school age, with the target group being ages 13-20. However, it is likely to be relevant for use with middle school or young college students as well. It is designed to be used pre and post an annual plan of highway safety events specifically to assess behavior intentions about driving rather than actual driving behavior, which makes the survey appropriate for use with both driving and non-driving teens. This also avoids asking teens directly about sensitive information regarding illegal behaviors like speeding or violating GDL laws. There is one item about direct driving behavior that is only shown to teens who indicate that they drive at least some of the time. Additionally, partners have designed the survey to produce data meaningful on multiple levels. On a school by school basis, the items are designed to reveal information that can be used to direct program planning towards the TPB determinants identified to have low scores upon pre survey, and then to assess effectiveness in improving short term program outputs at post survey. At the state and national levels, data can be used to measure the overall effectiveness of teen-led programming. Using standard metrics allow for comparisons to be made among the various clusters of programs chosen and implemented by teen leadership teams to support the overall method of peer to peer highway safety intervention. The *I Drive Smart* survey is designed to serve as the core of an environmental detection system that can identify particularly effective or potentially ineffective techniques that may require closer investigation. It is designed to be interpreted in light of other local data points as discussed in Chapter 5.

The second step in developing a survey is to define the attributes that will be measured clearly, along with scale items (Coaley, 2014). The 33-item development version of the *I Drive Smart* survey tested follows TPB and was built to be administered via the internet and to collect no personally identifying information. The first two items serve to qualify participants for inclusion and include an agreement to the informed consent information and verification of student status at CHS. An open text box collects information from anyone else to identify why they were taking the survey. Three items collect demographics pertinent to analysis including age, gender, and license type. Each of these includes dropdown menus with a list of items and also an open text box to allow teens to enter additional information if they do not fit into one of the categories specified. An additional demographic item is used to assess driver frequency, with a 5 point lickert scale ranging from never to very often. Two items sum to assess past highway safety behavior, one for driving behavior and one for passenger behavior. The driver frequency item is used to flag a skip logic function so that those who indicate they have never driven do not introduce measurement error by providing responses about their past driving behavior.

TPB concepts are measured using 21 total items, occurring in clusters of at least three items matching the direct belief measure, indirect belief measure, and the indirect evaluative measure structure consistent with an expectancy-value framework for TPB (Fishbein & Azjen, 1975). Each of these uses a visual analog scale with bipolar opposites of never on the left and always on the right, with an identified midpoint of sometimes. Numerical values for scale placement were not shown. Indicators of participant sentiment can be influenced by the way the choice scales are presented to them (Dawes, 2007). Frequency expressions in rating scales have been criticized for being vague (Bocklisch, Bocklisch, & Krems, 2012). Teens completing surveys in Tennessee have consistently complained about checkboxes and say that filling in circles make them feel as if they are taking a school-based exam. Upon discussion with existing teen leaders, partners chose to use analog scales to allow teens to input their responses. These slider bars also provide more precise data to reflect variation in participant sentiments in a way that approximates the interval characteristics required of data for multivariate analysis.

Attitude, perceptions of peer norms, family norms, and law enforcement norms are all assessed using three items each, a direct belief measure, an indirect belief measure, and an indirect evaluative measure. Each is summed to form a TPB concept scale score, with the three categories of norms all summed to form an overall social norms score variable. Perception of behavior control is assessed using five items, one direct, one indirect, and three evaluative measures. Each of the evaluative measures are designed to assess teen perceptions of how helpful driver's education, GDL, and peer to peer interventions are in regards to helping them Drive Smart. Behavior intentions are assessed using two items, one for passenger and one for driving behavior intentions. The survey also contains a basic highway safety knowledge test that contains five items. These items are designed to address the primary knowledge domains identified in the National Highway Traffic Safety Administration's (NHTSA) *5 to Drive* campaign. (NHTSA, 2016[1]). These include the importance of seatbelts, not speeding, avoiding the use of cell phones in any way, following passenger restrictions, and not drinking and driving. Finally, an open comment text box asks participants to add anything else they would like to about the survey.

**Overview of the Research Process**

The purpose of the *I Drive Smart* survey development project is to create standardized measures relevant for teen leaders to use in evaluating the highway safety programs hosted within the *Reduce TN Crashes* system. This dissertation serves to document construction and initial validity testing of the survey, which is required for effective measurement systems (DeVellis, 2012). Specifically, this report serves to empirically analyze the survey using data obtained from a development sample. The overall purpose is to assess the model's validity in its ability to measure teen highway safety behavior intentions. This quantitative assessment will follow a classical measurement model for evaluating construct validity (DeVellis, 2012). Classical measurement theories assert that an observed score (such as one obtained by a scale) results from the summation of a true score (or the person's actual truth which cannot be fully measured), plus error (that results from scientific error). Under this theory, survey measures become most meaningful for analysis when systematic efforts are taken to recognize error and to reduce total survey error in a comprehensive way (Weisberg, 2005). Classical measurement assumptions are purely theoretical but can be interrogated with proper theory-development studies across the research continuum that includes theory building, reporting, qualifying, expanding, and testing (Colquitt, Zapata-Phelan, 2007). While working within this perspective, we assume that any error associated with individual items would have a mean of zero if it were to be aggregated across a large enough sample; that one item's error would not be correlated with another item's, meaning that the links between items would always flow through the latent variable being measured and not through each other or other variables; and that error terms would not be correlated with the true score, if it could in fact be measured (DeVellis, 2012).

Central to classical measurement theories are assessments of rigor including the examination of reliability and validity statistics (DeVellis, 2012; Drake & Jonson-Reid, 2008). Reliability is concerned with the amount of random error in a measurement (Rubin & Babbie, 2016). A reliable instrument is one that performs in a consistent and predictable way by containing items and scales that yield data as reflective of the true score as possible. The more reliable an instrument is, the more statistical power it has when used with smaller sample sizes (DeVellis, 2012). A perfectly reliable instrument would always reflect the true score of the latent variable, but in reality can be thought of as the true score divided by the observed score (DeVellis, 2012). Reliability of measures is also concerned with the internal consistency of items, meaning data will demonstrate high correlations among items and the latent variables they are measuring (DeVellis, 2012). Cronbach's alpha is a common index used for assessing internal consistency and can be thought of as the proportion of a scale's total variance that is attributable to the common source of the latent variable, referred to as communality (DeVellis, 2012). Other methods of assessing reliability include inter-observer reliability, test-retest reliability, alternate-forms, split-half methods, inter rater agreement reliability, and temporal stability, or test-retest reliability (DeVellis, 2012; Rubin & Babbie, 2016).

Validity assesses the degree to which the variable examined is the underlying cause of item covariance, and is typically inferred from the quality of the processes under which the scale was developed, its ability to predict specified events, and/or its relationship to measures of other constructs. Validity can be thought of in three main types, content, criterion, and construct validity (DeVellis, 2012). Content validity assesses how well a measure seems to cover the entire range of meanings within a concept (Rubin & Babbie, 2016). Mathematically, a set of items should be adequately reflected by the concept domain scores; assuming that perfect content validity would include a random subset from all items which could obtain measures of the true score (DeVellis, 2012). Construct validity is directly concerned with the theoretical relationships between scores to other scores, and the degree to which the scores behave according to the theoretical framework guiding the psychometric process (DeVellis, 2012). It can be thought of in terms of convergent (when results correspond to other methods measuring the same construct) and discriminant (which is when results do not correspond as highly with measures of other constructs as they do with measures of the same construct) validity (Rubin & Babbie, 2016). Factoral validity is a form of construct validity used to determine if scale items relate correctly to the appropriate dimension or factor, which is revealed using statistical procedures (Engel & Schutt, 2017). Criterion related validity assesses an instrument's  practical use in that measures can be used to establish either predictive validity or concurrent validity. Predictive validity does not necessarily mean there is a causal relationship between the items and the latent variable, but that knowing the items allows one to effectively predict the latent variable score (DeVellis, 2012). Concurrent validity assesses the degree to which an instrument's measurements correspond to a known external criteria (Rubin & Babbie, 2016). Validity assessments frequently use coefficient alpha to determine relationships, which is the average of the correlations between the scores of all possible subsets of half the items on a scale (Rubin & Babbie, 2016). While there is no cutoff value or threshold to quantify construct validity, criteria specific to the given theory should drive how correlations are assessed in order to differentiate from correlations that may be resulting from measurement similarity rather than actual construct similarity (DeVellis, 2012).

While face validity is not an empirical measure, it is important with survey measures. Face validity means quite simply does this look right on the surface and relies on common sense in a given survey context (Drake & Jonson-Reid, 2008). For this project, community partners and the community-engaged research (CEnR) approach served to ensure adequate face validity. CEnR also worked to ensure other subjective forms of validity such as consequential validity, which is concerned with how data collected impacts respondents and/or the community of identity represented in the study (DeVellis, 2012); and viable validity, which is the extent to which an evaluation infrastructure is successful in the real world (Chen, 2013). While generalizability is not important directly in this study, the *I Drive Smart* survey is designed to demonstrate external validity. Generalizability has been reconceptualized in relation to quasi-experimental models used in program evaluation as transferable validity (Chen, 2013) which means that the evaluation system itself is designed to prove useful over time and with replication across different groups of teens working in different communities across the nation (Drake & Jonson-Reid, 2008). An integrative validity model says that an effective innovation will be viable, effectual, and transferable (Chen, 2013). Similar to reliability, viable validity is the extent to which an intervention is successful in the real world. Effectual validity is comparable to traditional positivist validity; but operates more in the critical paradigm and it uses effectuality as a measure of rigor to include both efficacy (which is ultimately determined through randomized control trials) and effectiveness (which is often documented through quasi-experiments), (Chen, 2013).

Specifically, this one sample, non-random, quasi-confirmatory survey development process evaluates the overall construct validity of the *I Drive Smart* survey in measuring teen highway safety behavior intentions using TPB concept scales. First, the survey was assessed for relevant assumptions for multivariate analysis and prepared for analysis. Factoral validity was then assessed using an exploratory factor analysis (EFA) procedure to examine the extent to which the survey behaves according to TPB concepts. Based on how items correlated, the survey was optimized. Reliability for retained items and corresponding concepts were then assessed for internal consistency using Cronbach's alpha. An Ordinary Least Squares (OLS) regression test was performed to test construct validity assessing the relative ability of items and scales to predict behavior intentions. Results from this process are discussed in Chapter 4, with findings from each stage of the process informing the next statistical validation procedure. An overall assessment of measurement error is discussed in light of the Total Survey Error Approach (Weisberg, 2005), which guides development of an optimized *I Drive Smart* survey.

## Population

The 2010 US Census Bureau lists that 23% of Tennessee residents are under the age of eighteen, with 786,967 youth ages 10-19. Tennessee's racial composition overall includes 79.3% white alone, 17% African American, 4.8% Hispanic/Latino, 1.6% Asian, 1.6% of mixed race, and 0.4% American Indian. Overall, Tennessee is 51.2% female and 48.8% male (US Census Bureau, 2014[1]). Tennessee Department of Safety and Homeland Security (TDSHS) data indicate that in 2012 there were 102,124 teens age 16-17 holding Intermediate Restricted or Intermediate Unrestricted Licenses (TDSHS, 2013[2]). Table 1 shows the fatality rate in Tennessee for person's ages fifteen to nineteen from 2000 to 2012. The data surveillance system built into *Reduce TN Crashes* will empower THSO to better understand the local conditions contributing to these reductions so they can be fostered and sustained. Figure 2 shows crashes by drivers of all ages in Tennessee. While Tennessee crashes have reduced across several age categories, young drivers present the most significant reductions over this time period with a 16.7% drop in fatalities for those under age 19, reducing their over-representation among fatalities of all ages by 13.6% (TDSHS, 2013[2]).

Tennessee has 137 school districts comprised of thousands of public, private, and charter schools (Tennessee Department of Education [TNDOE], 2014[1]); which include 1191 high schools (TNDOE, 2014[2]). Tennessee's high schools are the target audiences for *Reduce TN Crashes*, and thus this project as well. In helping us to understand the risk factors faced by teens in Tennessee schools, TNDOE administers the Youth Risk Behavior Survey (YRBS) every other year to assess health issues, which includes a self-reported measure of the frequency in which teens drive impaired and also ride impaired. Figures 3 and 4 present this data from 2003 to 2011, which also demonstrate that teen driving and riding behavior may be improving across Tennessee (TDSHS, 2013[2]). The data surveillance system integrated in *Reduce TN Crashes* seeks to bring data to bear that may establish a more solid connection between Tennessee's inclusion of teen leadership programming and the state's corresponding reductions self-reports of risky behavior and actual teen fatalities and injuries.

## Sampling Frame

The *I Drive Smart* survey was administered to a development sample in order to be quantifiably evaluated (DeVellis, 2012). *Reduce TN Crashes* has almost two hundred participating high schools across Tennessee, and while all of these locations would likely benefit from evaluation, the survey development location was selected by the *Reduce TN Crashes* team based on capacity of the local school partner and their teen leaders to accomplish the task ethically. Cookeville High School (CHS) was selected by *Reduce TN Crashes* and is located in Putnam County, Tennessee which has three high schools for its 401 square miles that serve a population that is roughly 21.3% under the age of eighteen (US Census Bureau, 2016[2]), with a total of 8,449 teens holding some form of Driver's License in 2014 (TDSHS, 2016[1]). The mission of CHS is "to create life-long learners and worthy citizens through quality instruction in a safe learning environment," and it has been recognized at the state's highest ranking for the past three years, which corresponds with its 93.5% graduation rate with increases consistently across population subgroups (Cookeville High School, 2016). CHS ranks in the top 10% of all of the nation's public schools, has been ranked as an international baccalaureate World School for over ten years, and has been recognized for having one of the strongest Advanced Placement programs in the state. CHS is 81% Caucasian, 8.5% Hispanic or Latino, 4.8% African American, and 2.7% Asian, which are all consistent with county-wide populations (TNDOE, 2016). 13% of students identify as having a disability, and 2.4% identify as an English learner. 36.3% are identified as economically disadvantaged students.

The CHS Traffic Education Saves Teen (T.E.S.T.) Club is a strong student organization at CHS that formed in 2010 when Putnam County was ranked number one in the state for traffic crashes involving drivers ages 15-24; and as a result of their hard work, Putnam County's teen crash rate is now among the lowest in the state (TDSHS, 2016[1]). The group started with strong teen, school, and law enforcement leadership and secured initial seed money from the Power of Putnam, a local community-based prevention coalition (Power of Putnam, 2016). In the six years since its inception, the T.E.S.T. Club has garnered multiple national awards from NOYS and the Allstate Community Foundation, as well as statewide awards from the Monroe Carrel Jr. Children's Hospital at Vanderbilt and THSO. T.E.S.T. Club teen leaders have also represented Tennessee at the national level through SADD Speaks and the National Lifesaver's Conference. While this may not create a sampling frame that is parallel to the true population of Tennessee's teens, it does provide enough teen leader and school capacity to ensure project success for development purposes.

## Sample Size

In order to empirically predict the sample size needed based on the number of factors being tested, a power analysis was conducted using GPower 3.1 (Citea, 2012) for linear multiple regression (fixed model, $R^2$, deviation from zero) with an effect size of 0.25, alpha set at 0.05, power at 0.8, and set for 12 predictors. This revealed that for a study of this type, a minimal sample size of 81 is recommended. There is not a consistent way to estimate sample size need for factor analysis procedures, thus the optimal sample size is increased to 125 to accommodate this procedure. CHS's student body head count was 2,169 at the time, which would result in a target observation rate at approximately 6% of the total high school sampling frame.

## Data Collection Procedures

Study data were collected and managed using the Research Electronic Data Capture (REDCap) system hosted through VCU's Center for Clinical and Translational Research (CCTR). REDCap is supported by VCU's Center for Translational Science Award ([CTSA] Award Number UL1TR000058) provided through the National Center for Advancing Translational Sciences (VCU CCTR, 2016), however findings do not necessarily represent official views of the National Center for Advancing Translational Sciences or the National Institutes of Health. REDCap is a secure, web-based application designed to support data capture for research studies by providing: 1) an intuitive interface for validated data entry; 2) audit trails for tracking data manipulation and export procedures; 3) automated export procedures for seamless data downloads to common statistical packages; and 4) procedures for importing data from external sources (Harris, Taylor, Thiekle, Payne, Gonzalez, & Conde, 2009). REDCap also offers features that allow the user to enlarge text or enable text to speech options that increase accessibility. An informed consent process was included in the REDCap interface, and a copy of this document was also linked into both the informed consent text and the survey end page as a downloadable Adobe PDF document. The informed consent text informs participants about the study, addresses the basic elements of consent, explains what Drive Smart means, and prompts teens to download the PDF version to share with their family later. The survey does not collect any personally identifiable information and does not ask sensitive questions. It was designed to allow parents, teachers, or other interested individuals to also take the survey and specifically asked them to please enter their correct information when prompted to by the survey. Participants could skip any items they wanted, except for one item that documented their consent agreement, and the other that documented their sample inclusion status as a student at CHS or not.

T.E.S.T. Club leaders worked to disseminate this link using training and recruitment material templates developed by the *Reduce TN Crashes* team to ensure validity of data collected and basic human participant protections. T.E.S.T. Club leaders were provided information about research ethics and Local Education Agency (LEA) policies about administering surveys in their school. They were then allowed to develop their own plan of how to best draw a convenience sample to represent their student body. They chose to use open recruitment through multiple methods. T.E.S.T. Club leaders launched recruitment on Thursday March 3, 2016 by setting up information tables in the lunch room. Teens could use tablets provided to complete the survey, or could scan QR tags provided on posters and handout cards to take the survey on their own devices. Several teachers also volunteered to provide an opportunity for students to take surveys during class time. An open station was also made available in a school computer lab where teens could drop in and take the survey anytime they wanted to. Announcements were made throughout the recruitment period to remind students about the opportunity to participate, how to do so, and that the survey would close on Friday March 11, 2016.Overall, this provided just over one week for teens to take the survey. Additionally, due to school-level internet issues, paper copies of the survey were administered to approximately 172 teens, with 77 of these completed and returned. The T.E.S.T. Club evaluation leaders worked to enter data from the paper surveys as precisely as possible. 35 of the 77 paper surveys were able to be successfully interpreted for entry into the computer interface; a 43% rate of return, with 45% of those being useable; resulting in an overall 20% success rate for paper-based administration. These 35 surveys do introduce measurement error from these mode effects, which impacts 20% of the total study sample collected (N=175, an 8% observation rate).

**Analysis Plan**

### Hypotheses

Specifically, this project will test a series of hypotheses relevant to an empirical process designed to validate a psychometric instrument, as guided by an overall research question that seeks to identify sources of error present in the development version of the *I Drive Smart* survey that can be controlled. A battery of quantitative procedures will be utilized in order to identify patterns in the dataset that can be used to confirm the validity and reliability of the instrument. The survey development process planned utilizes an exploratory factor analysis (EFA), an item analysis, and then an Ordinary Least Squares (OLS) regression test to guide optimization of the overall *I Drive Smart* survey. Both EFA and OLS are multivariate analysis (MVA) research procedures classified within the General Linear Model (GLM). The GLM provides a framework for understanding how various bivariate and multivariate techniques fit together in the research continuum (Tabachnick & Fidell, 2007). Conducting MVA also comes along with a set of assumptions relevant to the GLM's various techniques (Dattalo, 2013). For this analysis, data will first be assessed for EFA and OLS relevant assumptions including completeness, influence of outliers, absence of multicolinierity, and the presence of homoscedasticity (Dattalo, 2013).

MVA allows researchers to analyze complex social phenomenon and interventions through relationships between dependent variables (DV) and independent variables (IV), serving to either engage in data reduction or simplification, describing relationships among variables, or for mathematical prediction (Dattalo, 2013). This survey development project serves a data reduction purpose, seeking to make the development sample study data comprehensible to guide an assessment of the survey's reliability and validity to make item refinements for its continued use. The survey is designed to evaluate change in teen highway safety behavior intentions, which serves as the DV for this analysis. The behavior intention variable is a summed score consisting of a passenger and driving behavior intention item. The TPB concepts of attitude, social norms, and behavior control are also measured as concepts and serve as the IVs for the study. The wording of these items is designed to shed light on which of these determinants demonstrates the most potential for improvement upon pre survey, as well as which measures are best to use in assessing for relevant change as a short-term, post-intervention output.

## Factoral Validity - Exploratory Factor Analysis

Exploratory Factor Analysis (EFA) seeks to find the linear combinations within the dataset that retain the maximum amount of information resulting from the measured variables and seeks to uncover the structure of the dataset in order to best identify the factor structure (Dattalo, 2013). This is a process of data reduction that seeks to make the dataset more comprehensible by examining the common variance in factors. Assumptions for multivariate analysis in EFA include proper specification of variables that approximate interval data and ensuring that there are no outliers impacting correlation coefficients. EFA is ultimately a linear process and significance tests do assume multivariate normality, however these assumptions are less important with adequate sample sizes, especially those derived empirically through power analysis as was done for this study.

Homoscedasticity is also assumed in EFA, but is not considered a critical assumption of the process. EFA assumes that there are underlying dimensions shared by clusters of variables, with an expectation of moderate to moderate-high intercorrelations among sub-scale items. For an EFA to be most effective, factor labels should have face validity and be grounded in relevant theory.

In assessing the model's fit, the value of the Kaiser-Meyer-Olkin (KMO) test serves as an index of homogeneity to identify how well the items on each factor belong together. KMO values fall on a scale from 0 to 1, with values over .9 indicating a marvelous fit, those larger than .8 a meritous fit, over .7 are middling, .6 mediocre, .5 miserable, and values below .5 are seen as unacceptable (Dattalo, 2013). Communalities are also important and measure the percent of variance in a given factor that is explained by all the factors combined (Dattalo, 2013). When extracted these will have a value less than 1, with any items over 1 considered a spurious solution within a model that is either under- or over- specified (Dattalo, 2013). When an item has a low communality, then the factor model is not explaining very much about that item, and it should potentially be removed or restructured. However, communalities must be interpreted in light of the related factor's overall interpretability in relation to the specified theory, and even items with low communalities can be meaningful if they are connected to a well-defined factor (Dattalo, 2013). The eigenvalue is also important in EFA procedures, which measures the variance in all of the variables as they are loaded onto the specified factor on a scale from 0-1 (Dattalo, 2013). Initial EFA results are not readily interpretable, thus a rotation of the factor axis is typically applied in order to create more standardized reference points for the variables (Dattalo, 2013). A series of trigonometric functions multiply the unrotated structure coefficients by a set of constants in order to produce rotated factor matrices, which are often easier to comprehend. These rotated solutions also generate new eigenvalues based on the standardized process. Rotations are classified as either orthogonal (which equalizes eignevalues to provide a simple-structure solution), or oblique (which accommodates intercorrelation but also requires the estimation of a greater number of coefficients which can increase sampling error), (Dattalo, 2013).

For this project, the EFA occurs to test the hypothesis that data will match TPB in relation to measurement of the latent construct of young driver behavior intentions. In the EFA, the first step is to extract relevant factors to assess the total variation in the dataset. Six EFA models will be assessed to determine the one providing the best fit. Criteria for retaining factors will include: 1) a KMO score larger than .7; 2) items with an eigenvalue over 1; 3) factors that together explain at least 60% of variance in the model; and 4) a scree plot that demonstrates the sharpest points of inflection for identified components.  A factor loading threshold will be determined and components named based on the model chosen. Refined methods for creating factor scores are preferred over direct summing in order to best retain the relationships between the individual factors, thus factor scores will be generated and potentially used in the OLS regression test rather than the summed scores from the survey. This approach allows only the shared factors to have an impact on the factor scores and produces factors scores that are uncorrelated with other factors and each other (Dattalo, 2013).

**Item Reliability – Cronbach's Alpha**

Items must have variation in order to be meaningful for analysis (Heise, 2010). Variation can be assessed through Cronbach's alpha scores calculated and examined to determine the internal consistency of scale items (Tavakol & Dennick, 2011). This process calculates item-to-total-score correlations and creates an index of internal consistency known as the alpha score. Internal consistency examines the extent to which the test items are measuring the same concepts and that they are interrelated. Alpha assumes that the sub-scale items are actually measuring the overall scale dimension. For this study, concept scales are guided by TPB and consist of 3 items including a direct belief measure, an indirect belief measure, and an indirect evaluative measure, which sum to form an observed concept score. Three item concept scales are included for attitude and for perception of social norms for peers, family, and law enforcement. A five item concept scale is used to assess perception of behavior control, which includes a direct and indirect belief measure and three evaluative measures related to each of the primary teen driver safety strategies of drivers education, GDL, and peer to peer education. If the *I Drive Smart* survey has internal consistency, data will demonstrate high correlations among items and the latent variables they are supposed to be measuring (DeVellis, 2012). Based on the findings from pre-screening and the EFA procedure, different groupings of items will be identified as relevant for reliability analysis. Further, all sub-scale items should demonstrate interrelatedness prior to their being used to predict behavior intentions. The refined factor scores produced for identified components will be assessed for their relative predictive validity as compared to the original TPB concept scale scores, with appropriate refinements made to the survey accordingly.

### Criterion Validity - Ordinary Least Squares (OLS) Regression

Ordinary least squares (OLS) regression is used to predict the variance in an interval level dependent variable (DV), based on linear combinations of independent variables (IV) in order to establish that a set of IVs can work together to explain a proportion of the variance in the DV using an ANOVA-based significance test of the $R^2$ index (Dattalo, 2013). MVA assumptions required for OLS regression include the inclusion of relevant variables and exclusion of irrelevant ones, independent error terms, low measurement error and no missing cases, linear relationships between the independent variables and the dependent variables, additivity, and the absence of multicolinearity to ensure that the IVs are not linear functions of each other (Dattalo, 2013). A regression equation is created to guide predicted values of the DV using the model's regression coefficients, which represent the amount of change occurring in the DV that results from the IV changing one unit; and the constant, derived from where the regression line intercepts the y axis to represent where the DV will be when all the IVS are at a value of 0 (Dattalo, 2013). The coefficient of multiple determination, or $R^2$, represents the percent of variance in the DV explained collectively by the IVs entered into the regression model, with the goal being to find the best fitting equation to link the IVs with the DV. The Adjusted R-Square takes into account the number of variables used in the model, with the degrees of freedom and gives is a measure of the variance explained. The F-score is generated through the ANOVA procedure in SPSS included in the OLS process (Tabachnick & Fidell, 2007). It is possible to have a significant F test for a model, and then have insignificant coefficients, which are examined in the procedure with *t*-tests. The standardized versions of these coefficients are the model's beta weights (B), and serve as the ratio of the predictive power of the associated IVs (Dattalo, 2013). Residuals are the differences between observed and predicted values generated by the regression equation, which can also be standardized for comparison. The null hypothesis for an OLS regression is that knowing values of the IVs provides no extra information about the DV ($B_1 = 0$); with the alternative being that knowing values of the IVs does provide extra information about the DV ($B_1 \neq 0$).

For the model in this project, young driver safety behavior intentions will serve as the DVs for a series of OLS regression procedures to test the hypothesis that knowing the values of the TPB concepts collected by the survey will help to predict values of the DV, using the enter method. The factor scores and corresponding concept scales identified in the EFA procedure will also be tested. In assessing the goodness of fit of for regression models, one seeks to understand the model's ability to describe the DV by knowing the values of the IVs (Dattalo, 2013). Comparisons between the models will be assessed based on the following criteria: 1) a statistically significant value for the adjusted $R^2$ assessing the percent of variance explained by the model; and 2) an examination of the significance of regression coefficients, their standard errors and confidence intervals for IVs. Survey error will be discussed along with presentation of an optimized version of the survey for future use.

## Chapter 4: Findings and Discussion

This report documents the construction of the *I Drive Smart* survey and these findings serve to present data obtained from a development sample, two critical components required in moving toward the standardization of processes to evaluate teen-led highway safety interventions (Coaley, 2014). Data were downloaded from the REDCap system directly into Statistical Package for Social Sciences (SPSS) version 22. A codebook and analysis log were maintained and serve to document data management and to promote replication of this analysis in the future. All aspects of human participant protections for this study were approved by departmental advisors and Institutional Review Boards (IRB) through both Tennessee Technological University's (TTU) School of Business and Virginia Commonwealth University's (VCU) School of Social Work. Findings are presented with a discussion, as findings from each procedure informs the next step in the analysis, with the ultimate finding being an optimized version of the survey. Findings from the pre-screening process are first discussed along with a description of how data was managed in regards to missingness, outliers, orthogonality, and homoscedasticity. Table 2 presents descriptive statistics regarding the final study sample (N=175), accompanied by a discussion of its representativeness in relation to the sampling frame and population. Qualitative data collected from the open comment box included in the survey is then discussed. Table 3 shows all of the items included in the development version of the survey and provides descriptive data obtained from the study sample for all items, including Theory of Planned Behavior (TPB) concept scale scores. Measures of central tendency and variation across the distribution are shown at the item level including sample size, mean, standard error, median, standard deviation, skewness, and kurtosis. Table 4 presents factoral validity findings with the best fitting rotated factor matrix from the Exploratory Factor Analysis (EFA) procedures, including correlation coefficients as they load onto identified components, communality, and percent of variance explained.  Reliability of scales and items is then assessed using Cronbach's alpha as a measure of internal consistency, including scales for the original TPB concept scores and the refined factor scores generated from the EFA procedure. Tables 5 and 6 present predictive validity findings from quasi-confirmatory ordinary least squares (OLS) regression tests. Table 5's model used all of the TPB concept scale items as independent variables (IV) and the summed score for highway safety intentions as the dependent variable (DV). Table 6's model used the refined factor scores produced in the EFA procedure regressed onto the same DV, highway safety intentions. Survey error is then summarized following the framework provided by the Total Survey Error Approach (Weisberg, 2005) and an optimized version of the *I Drive Smart* survey is presented.

**Data Prescreening**

At the end of recruitment, there were 184 individual cases downloaded from the REDCap system. Variables align with a data codebook, which also documents how items are summed for scoring purposes. In addition to items collected directly from the survey, the REDCap system also creates a unique identifier for each entry, as well as a timestamp for survey initiation and completion. Upon examination, 7 of the 184 cases were deleted as not meeting the inclusion criteria. These included 6 cases flagged as test entries and 1 entry self-identified as a T.E.S.T. Club Advisor. The remaining 177 cases were then submitted to a series of tests to ensure the final study sample to be used meets the assumptions necessary for multivariate analysis.

**Completeness**

In screening a dataset for completeness, a researcher seeks to reduce measurement error by analyzing response errors for missing items. Standard procedure is to identify and assess missing data and categorize the degree of missingness as missing completely at random (MCAR), missing at random (MAR), or missing not at random (MNAR) (Dattalo, 2013). Two cases were marked as incomplete by the REDCap system, and upon inspection were determined to have insufficient evidence to believe the participant had fully completed the survey. T.E.S.T. Club representatives had mentioned there were a few teens that started the survey, experienced a computer lag, and then reloaded the survey to complete a new one. Thus, these 2 cases were deleted and assumed to be MAR, leaving 175 cases. All other cases seemed to have been completed, thus it is assumed if an entry was left blank it was potentially for a reason. All missing responses were recoded to a value of 1 and all other non-missing responses recoded as 0. A series of bivariate correlation coefficients were then created to examine Pearson's *r* (*r*) to look for patterns, with *r* values fall along a scale of 0-1, with lower values denoting less correlation. Values under 0.3 are seen as MCAR, although this cannot be fully determined in one study. Values from 0.3 to 0.5 are considered MAR, and values over 0.5 are potentially MNAR (Dattalo, 2013). The null hypothesis for assessing completeness is that missingness among measures of variables will not be correlated ($r < 0.3$), with the alternative hypothesis being that missingness will be correlated ($r > 0.3$).

For retained cases (N=175), cases with missing values were first subjectively assessed. There were nine missing values on driving behavior intentions, which corresponded with the participant's driver frequency being never, thus these values were expected to be missing. Other missing items did appear to exist within otherwise completed entries. When examining pairs of items with values of *r* over .5, the strongest correlations in patterns of missingness were for family and law enforcement norms. For family norms item pairings, *r* values ranged from .569 to .864, with the strongest correlation being between family members setting good examples and the teen's concern for meeting family expectations ($r = 0.864$). For law enforcement norms, values ranged from .627 to .814. Feelings of support by law enforcement was highly correlated with the teen responding that following traffic laws were important to them (r = 0.814). For peer norms, considering fitting in with friends as important was correlated with the other two peer norm items at the same value (r = 0.602). For perception of behavior control items; r values ranged from 0.574 to .814. The direct and indirect belief measures for this scale were correlated (r = 0.705), indicating that teens' perception of their power to choose to drive smart was tied to their belief about not driving smart causing a crash. The latter was also correlated with the belief that driver's education would be helpful (r = 0.814). The lowest correlation over the threshold of concern, feeling the power to choose to Drive Smart with thinking that driver's education would help (r = 0.574), which does make practical sense.

While findings are preliminary, these items were retained and determined to be MNAR at this time. A Missingness Analysis procedure was also run in SPSS to assess patterns of missingness by demographic factors for all items with 10 or more missing values, which included the 9 non-drivers and 1 male non-driver who chose not to answer either of the behavior items. This revealed a pattern of missingness for non-drivers that demonstrate as a group they had issues answering some of the items. These non-drivers who were mostly ages 14-15 had significant differences in missingness for the direct and indirect belief measures of attitude and perception of behavior control, the entire law enforcement norms scale, and both of the behavior intention items. While coming from a very small sample size, this data does suggest that these items could be reconstructed to optimize measurement. This also indicates that perhaps underlying beliefs about driver safety had not yet been formed for these individuals. While not enough for quantitative analysis, there were also four individuals who reported frequent driving but did not answer the passenger behavior item, indicating that they may never ride as a passenger.

In order to guide scale optimization for future use, a screening criteria for the passenger behavior item could reduce error. Additionally, the indirect belief measures for attitude (Driving Smart will save your life) and perception of behavior control (not Driving Smart will cause a crash) may be too confusing or emotionally charged, as these were not answered most by often or very often drivers. These items may present a situation where teens who have experience on the road have actually seen too much poor driving that did not result in a crash; or possibly that they were aware of people who had no-fault crash experience even though they were smart drivers. However, these items could potentially produce more precise measurement with a simple fix by rewording the use of will cause a crash to may cause a crash. Further, there may be reactivity to norms items by certain groups. While the sample size is inadequate for drawing conclusions, observed responses can inform survey optimization. One frequent driver did not answer any norms items at all but did complete the rest of the survey. This could have been a computer glitch, or he could have been indicating that those domains were not relevant to him in any way. There were three individuals missing all values on the family norms scale, which may indicate that these individuals do not have people they consider to be family in their lives or could be experiencing some sort of family discord. Some of these missing values did include the non-drivers, who might have felt the norms items did not apply to them yet. Patterns of missingness across norms categories at the individual level also appeared for one person identifying themselves as non-binary gender. They had missing values for peer, family, and law enforcement norms, with each concept scale having at least one item within each selectively answered. This individual may have been indicating they did not quite fit into any of the response options provided. It is also possible that any of these individuals regardless of other factors could also be skipping norms questions because they feel highly driven by an internal locus of control and thus less reliant on the external influencers of social norms.

The law enforcement norms were not answered most frequently by males who indicated they drive at least sometimes. There were also three negative comments about law enforcement officers made in the open comment box at the end of the survey, all saying officers set bad examples by texting and/or driving distracted themselves. One statement which was not necessarily reflective of law enforcement but does sum up the times stated simply "*All Lives Matter. Let's drive safe people. BAM!*" While the survey does not collect race or ethnicity, negative responses about law enforcement could be related to larger issues. This survey occurred during a time where there is national concern around how African American people specifically are treated by law enforcement through the Black Lives Matter movement (Altman, 2015). In reality, officers do drive with many in-vehicle distractions and best practices are that they undergo special training to maximize the human brain's ability to multi-task while driving. This does not mean there are not local problems with in-vehicle officer behavior, it simply asserts that statements like this should be validated by teen leaders through discussions with local law enforcement partners.

## Outliers

In screening a dataset for the absence of outliers, a researcher is seeking to identify measures in the dataset that are significantly inconsistent with the total dataset. OLS regression is sensitive to outliers, which could cause an overestimation of correlation coefficients (Dattalo, 2013).
A Cook's distance (D) measure was derived through a linear regression, with the behavior intention score used as the DV and all other individual scaled items as IVs. Cook's D provides an overall measure of the influence an outlying case has on the estimated regression coefficient and is obtained through SPSS's linear regression procedure. Influence is a product of leverage (unusual values of the IV) and discrepancy (distance between predicted and observed values on the DV) and is important to assess when using multivariate analysis sensitive to outliers (Dattalo, 2013). To calculate a cutoff point in establishing a Cook's D value as a potential outlier, three techniques were used and averaged together. The first method uses the formula n/k and the second uses 4/(n-k-1), and the fourth simply enters a value of 1 (Dattalo, 2013). In these methods, n equals the number of cases in the entire dataset and k equals the number of IVs. For this dataset, these calculation are 4/175 = .0228571 and 4/(175 – 17 – 1)=.025478, which when averaged with 1 equals .349445. In assessing outliers, the null hypothesis is that there is an absence of outliers in this dataset (D < .349445), with the alternative hypothesis being that there is not an absence of outliers (D > . 349445). A frequency

table of the Cook's D values generated by SPSS reveals that for this dataset, 21 cases did not calculate a value for Cook's D as a result of missing values; and that none of the values were over the cutoff value. Thus, we can accept the null and assume that there is an absence of outliers.

## Multicolinearity

Screening a dataset for the absence of multicollinearity is important in order to reduce errors in the probability of rejecting the null hypothesis for MVA procedures. This technique seeks to discover the presence of orthogonality among IVs and to ensure that each IV adds to the model's ability to predict the DV (Dattalo, 2013). Orthogonality is defined as a perfect nonassociation between variables (Tabachnick & Fidell, 2007). The opposite of this is a perfect correlation, or a singularity (Tabachnick & Fidell, 2007). While orthogonal IVs may produce the best prediction models, these perfect nonassociations can be difficult to identify. Screening a dataset for the assumption of the absence of multicollinearity ensures that predictions are not made on IVs that are too highly correlated. For this analysis, screening consists of an inspection of bivariate correlations among pairs of IVs using Pearson's r (r), (Dattalo, 2013). Typically, r values over .80 identify a potential problem with multicollinearity. For this analysis, r values from .5 to .9 will be examined and potentially reconstructed; with intercorrelated items over .9 potentially dropped from the model. The null hypothesis for this phase of screening is that IVs are orthogonal ($r = 0$) or present the absence of multicollinearity ($r < 0.9$); with the alternative being that IVs are at singularity ($r = 1$) or there are high levels of multicollinearity ($r > 0.9$).

In examining bivariate correlations to examine multicollinearity between pairs of IVs, there were mild correlations present (ranging from .5 to .6). The attitude indirect belief measure was correlated with indirect evaluation measure ($r = .591$), and also to the behavior control evaluative measure for peer to peer programming ($r = .592$). Considering the indirect attitude belief measure was flagged as potentially sensitive during screening for missingness, this item demonstrates need to be reconstructed here as well. Within the peer norms concept, the direct and indirect belief measures were correlated (r = .542) and these items may be redundant. The indirect peer belief measure is also correlated to belief in peer to peer intervention as being helpful (r = .571), and may need to be reconstructed to be most useful to the model. At this point, it is suggested to optimize the scale by making the direct belief measures more about what peers actually do, and the indirect belief measure more about perceptions of what peers will do in regards to intervening to promote Driving Smart. No pairs of items in the family norms category demonstrated intercorrelation. For law enforcement norms, the indirect belief measure and the evaluation measure may be redundant (r = .576). The evaluation measure regarding the importance of following traffic laws was also correlated with the behavior control items related to the perceived helpfulness of driver's education (r = .504), GDL (r = .565), and peer to peer intervention (r = .622 ); thus the item may not be adding a lot to the predictive ability of the model. Among the perception of behavior control items, the indirect belief measure was correlated with all three of the evaluative measures and was flagged during missingness screening as a potentially sensitive item, thus it too may not be adding anything useful to the model. The highest r value (.674) was between two of the indirect evaluation measures falling under the perception of behavior control concept, the beliefs that GDL and teens talking to other teens would be helpful. While these items may be statistically redundant, they do serve a practical purpose. These items provide teens an opportunity to rate the relative influence of these primary interventions on their perceptions of behavior control. While this screening can inform optimization of the scale, we can proceed with MVA assuming the absence of multicollinearity among pairs of IVs.

### Homoscedasticity

In screening for homoscedasticity, a researcher is working to ensure an accurate as possible estimation of standard error, which will lead to identifying confidence intervals that are as accurate as possible (Dattalo, 2013). Homoscedastic is defined as a state when the variance of one variable is the same at all values of the other variable (Tabachnick & Fidell, 2007). The method used in this analysis to screen for homoscedasticity was to examine histograms, p-plots, and scatter plots of predicted DV values and the residual values derived from SPSS through the linear regression procedure with behavior intentions as the DV and all other items as the IVs. Residual values are a function of predicted values, and there should be no correlation between error terms and the predictability of the model. The null hypothesis for this phase is that there is no correlation between residual and predicted values, suggesting homoscedasticity; and the alternative hypothesis is that there is a correlation, suggesting heteroscedasticity. When examining outputs, there does not appear to be any correlation present between residual and predicted values, suggesting homoskedasticity. In observing the charts produced by SPSS, this model visually appears to present low to moderate heteroskedasticity, but not enough to be of concern for these MVA procedures (Dattalo, 2013).

**Study Sample**

An empirical power analysis predicted sample size needed based on the number of factors being tested (Citea, 2012) to be at minimum 81, which was optimized for the factor analysis procedure to be 125. Cookeville High School's (CHS) student body head count was 2,169 at the time, which would result in a target observation rate at approximately 5.7% of the total high school sampling frame. After data cleaning and pre-screening, there are a total of 175 cases in the final study sample dataset, an 8% observation rate considering the entire CHS student body. Table 1 provides demographic data for the study sample. This convenience sample reflects an appropriate age range for a high school population, with most participant being ages 16, 17, or 18. Females are slightly more represented here than males, and most participants had some form of license and drove at least some of the time.

Measures of central tendency are descriptive statistics that attempt to describe the dataset in the most concise and representative way possible, as opposed to measures of variability which attempt to examine the extent to which scores differ proportionately (Jaccard & Becker, 2010). Central tendency measures rely on a the assumptions of a normal distribution, which can be understood as a probability density function (Jaccard & Becker, 2010). Distributions should reasonably meet the theoretical assumptions of the normal curve in order to be relevant for comparisons with statistical procedures (Jaccard & Becker, 2010). The mean score is the mathematical average of all scores for items, and the standard error of the mean reflects how accurate this mean hypothetically estimates a population mean. The median is the middle score in a distribution, with 50% of scores falling above and 50% falling below this value. Standard deviation serves as an index of variability, expressing the positive square root of the distributions variance, which represents the average deviation in scores from the mean (Jaccard & Becker, 2010). Skewness refers to the tendency for scores to cluster on one side of the mean or the other, with positive skew denoting the median and mode fall below the mean; and negative skew that they fall above the mean (Jaccard & Becker, 2010). Kurtosis assesses the distribution of scores in regards to its peaks and tails, with a leptokurtic distribution having a sharp peak and long flat tails; as compared to a platykurtic distribution with a flat peak and short, steep tails (Jaccard & Becker, 2010).

Table 2 provides descriptive data assessing central tendency for all TPB items and knowledge measures, including the mean and the standard error of the mean, standard deviations, and skewness and kurtosis measures. Histograms were also reviewed to obtain a visual image of these measures, which were all fairly well fitted to the normal curve, although each was negatively skewed with the median values falling above the mean score. Driving behaviors (M=83.25) were reported to be safer than passenger behavior (M=75.23), both on a scale of 100. Of the TPB concept scales (300 point maximum scale), attitude had the highest score (M=264.19), followed by law enforcement norms (M=240.29), then family norms (M=239.74), with peer norms indicating the lowest score and thus serving as the determinant offering the most room for improvement (M=212.77). Among the indirect evaluation measures for the perception of behavior control concept scale, participants gave teens supporting each other for highway safety the highest score (M=84.07), then GDL (M=76.94), then driver's education (M=75.85). The knowledge items had the highest average scores overall and were all heavily skewed, with most everyone getting a perfect score. The knowledge items where students missed the most were about distractions, specifically understanding the range of different types of in-car distractions (M=.83), and also how passengers can become a distraction for teen drivers (M=.86).

**Summary of Qualitative Comments**

A total of 20 comments were made in the open text box provided at the end of the survey, which resulted in 35 total phrases being coded into one of ten categories. There were five phrases that were supportive of peer to peer education and T.E.S.T. Club activities, with two additional phrases directly complimenting the adult advisors of the T.E.S.T. Club for their support of teens. There were five comments reporting that teens felt they had learned something from T.E.S.T. Club activities, with four additional phrases indicating the activities had impacted their actual behavior choices in the real world. One teen says:

> "*I really love this program because it helps my generation fully understand and evaluate their driving choices and maybe even choose a different path that saved their life*."

There were three teens who mentioned having personal experience with a crash, including one who credits the T.E.S.T. Club activities with saving their life:

> "*My family was involved in a crash not long after last year's safe driving rally and before we may or may not have worn seatbelts. After watching the demonstrations on the MOCK crash, I realized how important it was to wear a seatbelt. It probably saved my life*."

There was one teen who requested more information about GDL, indicating how complicated this information can be for teens to understand and retain:

> "*I need a refresher on the GDL requirements. I know T.E.S.T. Club has given us cards and things on it, but I can't remember some of it*."

Three negative comments were made about how the drivers education program was taught at the high school, and three negative comments were made in regards to law enforcement behaviors in that they text and drive. One comment also stressed the importance of modeling smart driving:

> "*Police officers text and drive and use their phones. They should be setting good examples for teens and they are not. I see them on their phone a lot."*

There were seven comments directly about the *I Drive Smart* survey itself, including 3 positive comments including "excellent survey!", three comments questioning the term Drive Smart, and one who said "just okay as a survey." One teen simply commented: "You do not always have to drive smart." Another teen's comment reflected the common tendency to adjust risk-taking according to driving conditions and perceived ability:

> "*Driving smart is a good idea, but if you have the reflexes and are not on anything you can be a little lenient*."

One teen's comment questioned the concept of Driving Smart, but also recognized that driving is a complex task that involves more than just one 's self and thus is necessary:

> "*I don't think that driving unsafely is always going to cause wrecks, however, I also don't think that the threat of taking your own or someone else's life should be considered as if it would never happen to you. Even if you do survive a wreck due to unsafe driving, what would happen if your kids were unsafe while driving, and learned to be unsafe because of you? They could die, someone else's kid could die, and there are so many other casualties that could happen... (what if you hit a dog? a cat?  or an innocent bird?)*."

In general, while some teens did reject the term Driving Smart, this is ultimately good in a measurement system, as variation is needed in order for variables to be of significance to be studied. Ultimately, as an evaluation instrument, the *I Drive Smart* survey is designed to both establish healthy highway safety norms, while also creating data valid for analysis in assessing change from participation in activities. One teen's comment does provide evidence that the T.E.S.T. Club and the survey are both working to establish healthy safety norms for teens:

> "*Even though I am fourteen and I am not driving yet, I am very active in our school's safe driving club and am ready to drive smart in the future when I start driving*."

**Factoral Validity - Exploratory Factor Analysis**

In testing for construct validity using an exploratory factor analysis (EFA) procedure, one is seeking to uncover the factor structure of data and assess how well data behaves in line with specified theory (Dattalo, 2013) which in this case is the Theory of Planned Behavior (TPB) (Fishbein & Azjen, 1975). Six separate data reduction procedures were run in SPSS using principal axis factoring for all independent variables (IV) in order to generate correlation coefficients, indices to assess the homogeneity of variables, a scree plot, factor scores, and a factor matrix; each seeking factor solutions for a 3, 4, and 5 fixed factor model. Three of these models sought an oblique solution using a direct oblimin rotation, and three sought an orthogonal solution using a varimax rotation. Criteria for retaining the model with the best fit included: 1) a KMO score larger than .7; 2) interpretable items with an eigenvalue over 1, 3) interpretable factors that together explain at least 60% of variance in the model; and 4) a scree plot that demonstrates the sharpest points of inflection for identified components.

Using direct oblimin rotation for the 3 factor model, the value of KMO measure of the sampling adequacy of the correlation matrix was .855, which is meritous. The three retained factors explained 54.577% of the total variance contained in the correlation matrix. The 4 factor model also had a meritous KMO value of .855, and the retained factors explained 61.618% of the total variance, however the rotation failed to converge in twenty-five iterations and thus did not produce a pattern matrix or factor scores. For the 5 factor model, the value of KMO measure was also meritous at .855; and the five retained factors explained 66.768% of the total variance. However, the fifth eigenvalue dropped below 1, which indicates the factor is superfluous. Using varimax rotation, the 3 factor model, the value of KMO measure of the sampling adequacy of the correlation matrix was .855, which is meritous. The three retained factors explained 54.577% of the total variance contained in the correlation matrix. For the 5 factor model, the value of KMO measure was also meritous at .855; and the five retained factors explained 66.768% of the total variance. However, the fifth eigenvalue again dropped below 1, which indicates the factor is superfluous.

The 4 factor model with varimax rotation was determined to provide the best fit with a meritous KMO value of .855 and explaining 61.618% of the total variance, as presented in Table 4. Factors were named by examining the factor loadings for each and identifying which items were best explained by which factor, with each item being matched with only one factor. Factor one captured the most variance and explained 32.278 % of the total variation (initial eigenvalue = 6.337; rotated = 2.979). It was named perceptions of behavior control and contains the TPB perception of behavior control items for the three indirect evaluation measures regarding how helpful drivers education, GDL, and peer to peer programs are to teens. This factor also contained the evaluative item for the law enforcement norms domain, suggesting that law enforcement norms could be measured under the behavior control construct as helpful or not helpful rather than in a norms category of its own. The indirect belief measure for the attitude domain is also retained on this factor along with the indirect measure designed for the perception of behavior control scale. This suggests these items may be measuring the same thing. The direct belief measure under perception of behavior control was retained on this factor, but at a lower loading value than other items. The second factor retained all three peer items clearly aligned with TPB and explained 9.766% of the model (initial eigenvalue = 1.660; rotated = 2.203) and was named peer norms. The family norms items loaded onto the third factor, which was named accordingly and explained 7.533%. (initial eigenvalue = 1.281; rotated = 2.051).The fourth factor explained 7.041% of the model (initial eigenvalue = 1.197; rotated = 1.232) and retained two of the three law enforcement norms items, the direct and indirect belief measures.

**Reliability - Item Analysis**

In assessing the reliability of the scales within the instrument, an assessment of variance was conducted by generating Cronbach's alpha (alpha) scores using the reliability analysis of a scale feature in SPSS. Generating alpha is a process where the percentage of variance in the observed scale as compared to a hypothesized true scale composed of all possible items in the universe (Dattalo, 2013). For alpha measures, values range from 0-1 with higher values indicating higher levels of internal consistency among item responses. An alpha of at least .7 is the commonly acceptable threshold for this reliability coefficient in order to claim a scale is adequate, with values above .8 being considered good (Dattalo, 2013). In assessing the DV scales, alpha was good for behavior intentions (.884); however less than adequate for behavior (.629). When assessing internal consistency among all IVs combined, alpha = .884, which indicates good reliability. The attitude scale items alone had a coefficient of .751, which is adequate. Peer norms were less than adequate at .691, as were family norms at .594. Law enforcement norms were adequate at .709. The perception of behavior control items had an alpha of .813 which is good.

The factor scores generated from the 4 factor model in the EFA procedure were then examined for internal consistency, using the items in Table 4 that are highlighted in grey under each component. Factor one which explained 32.278% of the total variance, was named perception of behavior control had an alpha of .849, which is good. Factor two was named peer norms and consists of the same items originally contained in that domain, thus alpha was the same at .691. Factor three was also the same as the original survey for family norms with an alpha of .594. Factor four contained two of the three law enforcement norms measures, however alpha went down whenever the evaluative measure was removed from this scale to .585. Alpha can be deflated when used to examine consistency in a scale that is attempting to measure more than one dimension. Since norms are such complex phenomenon, these lower alphas may not necessarily indicate lack of dimensionality in the item's variance (Dattalo, 2013). This reliability analysis does provide further evidence to require reconstruction of the indirect belief measures of the attitude and perception of behavior control items, as well as reconstructing the norms items.

**Predictive Validity - Ordinary Least Squares (OLS) Regression**

A regression procedure is used to predict a score on one variable from a score on other variables (Tabachinick & Fidell, 2007). Using the enter method, a series of OLS regression procedures were performed to compare sets of IVs in their relative ability to predict young driver safety behavior intentions. Two OLS procedures were run, one testing the original TPB items as summed from the *I Drive Smart* survey, and one testing the four factor scores and corresponding concept scales identified in the EFA procedure. In assessing the goodness of fit of for regression models, one seeks to understand the model's ability to describe the DV by knowing the values of the IVs (Dattalo, 2013). Comparisons between the models will be assessed based on the following criteria: 1) a statistically significant value for the adjusted $R^2$ assessing the percent of variance explained by the model; 2) a significant F test with appropriate critical values; and 3) an examination of the regression coefficients, including unstandarized Beta (B), its standard error, standardized beta (β), t-test and confidence intervals for IVs. Comparison between the findings will serve to inform the optimization decisions in this development process.

Table 5 shows the findings from a regression of all the original TPB scale items onto the behavior intention score. This behavior intention score did present a high reliability and at this point is believed to be an effective DV. The TPB IV items have issues as discussed throughout the paper but are used here in an exploratory fashion to guide survey construction. The overall model did produce a strong $R^2$ value, estimating that all items combined serve to explain 71.5% of the variability in behavior intentions ($F_{17,136} = 23.574$, $p \leq .001$). While at this point the model looks good, when assessing the significance of the confidence intervals for the predicted values, only five of the items served as effective predictors of behavior intentions. Four items were significant ($p \leq .001$) and serve as the best predictors for the full TPB development model. These included how teens felt about the helpfulness of peer to peer support for highway safety ($t$=3.432), their direct belief regarding their perception of their power to choose to Drive Smart ($t$=3.577), their belief that not Driving Smart would cause a crash ($t$=4.098), and the indirect evaluative measure for their perceptions of their ability to control their own behavior regarding the importance of following traffic laws ($t$=4.726). One additional item from the peer norms concept scale regarding friends setting a good example for Driving Smart also served as a good predictor.

Table 6 shows the findings from a regression of the four refined factor scores generated during the EFA procedure onto the behavior intention score. The overall model did produce a strong $R^2$ value, estimating that all items combined serve to explain 64.5% of the variability in behavior intentions ($F_{4,149} = 70.463$, $p \leq .001$). When assessing the significance of the confidence intervals for the predicted values, three of the four factor components served as effective predictors of behavior intentions. Each of these four items were significant ($p \leq .001$) and serve as effective predictors. These included the component for perceptions of behavior control ($t$=10.684), family norms ($t$=7.573), and peer norms ($t$=7.306). Law enforcement norms fell well below the cutoff value and was thus insignificant ($t$=-.864). In comparing these models, the development version ($R^2$=.715) of the survey does explain a larger percentage of the variation in all items than the factor scores ($R^2$=.645). However, when looking at individual items the first model has many items that appear superfluous..

**Optimization of Scale**

When selecting items for continued, one should select items that demonstrate proven reliability in a framework that has both internal and external validity (Coaley, 2014). An optimized version of the *I Drive Smart* survey is the ultimate finding of this study. First, an assessment of overall measurement error is discussed (Weisberg, 2005), followed by a discussion of the implications of the survey for local CHS partners to assess the context validity of findings (Chen, 2013), and finally an optimized version of the *I Drive Smart* survey is discussed, which is also presented in the Appendix.

**Assessment of Survey Error**

An assessment of overall survey error serves to best frame the validity of estimates and to guide survey optimization (Weisberg, 2005). The Total Survey Error Approach (TSEA) will be used to guide this discussion (Weisberg, 2005). Sampling error can occur in three primary ways whenever a sample of a population is used rather than an entire population itself including: 1) a potential for systematic sampling bias whenever probability sampling is not used; 2) a coverage error if the sampling frame does not correspond to the total population; and 3) a unit non-response error, which occurs when people selected for the sample choose not to participate (Weisberg, 2005). Three additional types describe error in the accuracy of responses including item non-response error, when participants skip some items. Non-response errors are heavily dependent upon survey design and can be due to the respondent, such as whether or not they provide honest answers, or due to interaction effects between the participant and the interviewer, which in the case of a web survey is the computer interface (Weisberg, 2005). The final type of survey error included in the TSEA approach is called post-survey error and occurs at the point of processing and analyzing data (Weisberg, 2005).

There is some level of sampling error that occurs with any convenience sample which is present here, as the sample was collected by teen leaders. While this cannot be quantified, it does exist somewhere on a continuum between it being a very authentic sample because teens did the recruiting, or that it is very inauthentic because it was mostly the friends of these teen leaders who took the survey. While everyone in the school ultimately was offered a chance to complete a survey, only about 8% did. While this could be considered some form of non-response error, teens were only attempting to draw a 5-15% sample size and were not offering incentives or aggressively recruiting, and their recruitment methods did ultimately meet the project goals. There were a few responses that were incomplete likely due to technology and internet issues, which could potentially be improved to reduce participant frustration and incomplete response error. Coverage errors also exist in that Cookeville High School is a top-performing school that does not necessarily represent an average group of teens in regards to academic performance. It is also predominantly Caucasian with slightly more females than other high schools. Most importantly, they do a significant amount of award-winning teen-led highway safety that existis within the context of comprehensive community-led safety planning (Power of Putnam, 2016) and has actually brought down teen crashes (TDSHS, 2016[2]). While the survey does need to be continuously assessed with different groups of teens, this development sample does provide information from an informed and engaged group of young people who have demonstrated safe community norms.

When looking at the item level, there was some non-response error as discussed in the prescreening section on missingness. While this sample size was not large enough to contain missing values meaningful for quantitative analysis, it does appear that patterns of missingness may correlate with demographic factors for certain groups; specifically for non-drivers and gender non-conformers. While one can never truly assess whether or not participants provide honest answers, teens participating in this dataset did overall demonstrate that they were engaged with the survey. There were very few missing values overall, and those that were missing appeared to be missing for a reason and are considered to be communicating information. Further, qualitative information provided in the open comment box provided very meaningful and useful comments to CHS in regards to their local highway safety programming. Other comments about the survey itself were appropriate in regards to both positive and negative feedback provided. Further, teen leaders from the T.E.S.T. Club report that the survey was well received by their peers and school officials.

The final type of survey error is called post-survey error, or error that occurs after the participants have completed their surveys. Due to school-level internet issues, paper copies of the survey were administered to approximately 172 teens, with 77 of these completed and returned. This created a unique form of post-survey error that occurred as a result of the modality of survey administration. Given that slider bars were used on the web survey, teens used the printed version by making a mark on a visual scale. The T.E.S.T. Club evaluation leaders then worked to enter data from the paper surveys in the REDCap system, translating the paper analog scale into the digital format as precisely as possible. 35 of the 77 paper surveys were able to be successfully interpreted for entry into the computer interface; a 43% rate of return, with 45% of those being useable, resulting in an overall 20% success rate for paper-based administration. These 35 surveys do introduce measurement error from these post-survey mode effects, which impacts 20% of the total study sample collected (N=175, an 8% observation rate for a student head count of 2,169).

Post-survey error also occurs in how data is handled and managed after collection. This report serves to document how the dataset was managed in regards to survey construction. However, teen leaders are responsible for how data is to be used at the local level. In regards to sampling, T.E.S.T. Club leaders decided that the recruitment strategies they used were ultimately successful, however they want to be able to have a survey that can be administered more readily on paper for when the internet is not available. There were page loading and other computer lag issues for several teens, especially those attempting to pass around the same laptop to take the survey with. There were also multiple school-level internet connection outages that served as a source of frustration for teen leaders and potential survey participants. When taking the survey on paper, teens naturally struggled with understanding the analog scale on paper; and the leaders also struggled with transferring the markings from the paper-based analog scale into the computer interface. Even though teens do in many ways reject checking boxes, leaders did come to understand that having the boxes over the visual scale allowed for the use of data from both paper and computer –based surveys to be combined mathematically.

**Implications for Community Partners**

A report summarizing pre survey data by item and TPB concept score was provided immediately to T.E.S.T. Club leaders to inform local planning for CHS. T.E.S.T. Club leaders reviewed this information and met to discuss the report. They felt that the information was extremely helpful in guiding their planning. At the time of this report, they were working to identify strategies that would provide their school with more advanced highway safety information, as well as interventions to promote peer norms and to improve relationships between law enforcement and teens, specifically around ensuring everyone is aware of GDL rules and why they are in place. The data collected also revealed that there may be some issues with formal driver's education coursework in the school. T.E.S.T. Club leaders were part of a recent effort that successfully installed driver's education courses in all three Putnam County high schools. The programs have not been in place for very long and are likely in need of refinement. Furhter, given the current state of knowledge guiding exisintg driver education curriculum (Lonero & Mayhew, 2010), there is much room for improvement in how driver education is provided through schools. T.E.S.T. Club leaders are working with the author to develop a process where teens can evaluate driver education as it is being implemented across Putnam County to ensure that the policy they helped to get passed is implemented in a way that supports the public will and provides the best outcomes for all.

There were also three negative comments about law enforcement officers made in the open comment box, all saying officers set bad examples by texting and/or driving distracted themselves. The T.E.S.T. Club is also working with local officers to validate these statements with other data sources to determine if there is in fact a cause for concern. In reality, officers do drive with many in-vehicle distractions and best practices are that they undergo special training to maximize the human brain's ability to multi-task while driving. CHS does demonstrate a need for more advanced safety information, in that almost everyone scored a 100% on their knowledge test. Teens could benefit from understanding cognitive loads as connected to professional training which could be addressed directly or indirectly (Strayer & Cooper, 2015). Law enforcemebnt could potentially speak with teens about the realities of the risks they must take to manage all of the in-vehicle equipment that informs their work. Experts could speak also about cognitive workload for operating other common vehicles, such as having an airplane pilot speak about cockpit controls and how they have become highly automated yet still require human decision-making. One teen also mentioned that their license was suspended due to poor grades and not poor driving. T.E.S.T. Club leaders are also working to identify ways to assess the effectiveness of laws that link school performance to driving, as these may inadvertently be preventing teens punished for bad grades from benefitting from behind the wheel educational opportunities or experience-gaining as guided by GDL.

## Discussion of Survey Optimization

The optimized version of the *I Drive Smart* survey contains 31 items. The first two items were retained from the original version and serve to qualify participants for inclusion and include an agreement to the informed consent information and verification of student status. Three items collect demographics pertinent to analysis including age, gender, and Driver License type. An additional demographic item was added to assess passenger frequency as aligned with the original item assessing driver frequency, measured with a 5 point lickert scale ranging from never to very often. These can be used to inform skip logic so only those with actual real world passenger or driving behaviors are shown corresponding items, which reduces measurement error. The two items assessing past highway safety behavior, one for driving behavior and one for passenger behavior, were retained and may become more useful with other samples over time.

The response format for TPB items was adjusted to utilize check boxes appropriate for combined paper and web-based administration, with values including never, rarely, sometimes, often, and very often. Attitude is measured with the same direct and evaluative measures as the development version, but now includes more specific indirect belief measures pertinent to risky behaviors teens engage in including texting, driving under the influence, and speeding. The direct and indirect belief measures for peer and family norms were reworded minimally to be more clear and action-oriented, with the first asking directly about peer and family intervening behaviors, and the latter about their indirect support for Driving Smart. A not applicable option was also added to these norms categories to reduce response error by allowing those who do not feel as if they have family or friends to indicate this. The law enforcement norms concept scale was removed and integrated into the perception of behavior control concept scale.

Factor one identified in the EFA procedure was named perceptions of behavior control and retained the overwhelming majority of variation in the dataset, which indicates that important information is contained in this scale. For optimization of measurement, this concept scale has been restructured to contain two components, one for perceptions of volitional control and one for non-volitional control, consistent with TPB (Fishbein & Azjen, 1975). The volitional concept scale now has three items from the original version of the survey, the original direct measure for behavior control, the indirect belief measure re-worded to use the word may rather than will, and a new indirect evaluation measure developed for the optimized version. The non-volitional concept scale includes the original indirect belief and evaluative measures from the law enforcement concept scale, a new item assessing indirect beliefs about community support for Driving Smart, and the original items for perceptions of the effectiveness of interventions in helping teens to Drive Smart, including driver's education, GDL policies, and peer to peer support, with an additional item added related to helpfulness of law enforcement support.

The open text box is retained, as CHS and the T.E.S.T. Club did appreciate the feedback obtained through this item. Finally, the knowledge items may be too easy. This could be an impact of sampling bias towards the teen leaders who led recruitment efforts, or it also could be an actual reflection of the work T.E.S.T. Club has been doing throughout the school year in regards to promoting highway safety knowledge. CHS is also a top performing school in regards to Advanced Placement. Currently, no changes are recommended for the knowledge items until they can be tested with other groups of teens. Knowledge has not been shown to have a significant connection to driving behavior or crash risk (af Whalberg & Dorn, 2012), although it still serves as the primary evaluative criteria for many teen programs. While knowledge items are traditionally considered in terms of right and wrong for scoring purposes, there are psychometric techniques for using this sort of information to inform item-trait characteristic analysis to reveal patterns among the incorrect responses given (Nunnally, 1975). Once more variation is obtained for these items from other samples, this sort of analysis could be done to make knowledge test data more useful in guiding planning and assessing which interventions work with which types of teens best at which points in their lives.

**Limitations**

In assessing limitations in a given study, one seeks to understand the various threats to internal validity in regard to the research design and how they might impact the usefulness of the study's findings (Drake & Jonson-Reid, 2008). Common threats to internal validity: 1) stem from design and implementation issues including measurement error, treatment fidelity, and contamination across groups; 2) include subject level factors such as history, maturation, attrition from study groups, mortality, social desirability, and regression to the mean; and 3) examine expectation effects which result from the relationship between the observer and the observed which can impact findings (Drake & Jonson-Reid, 2008). Measurement error is an ever-present threat to internal validity and was discussed previously in this report in order to guide the survey optimization process. Maturation of subjects is not a concern for this one-sample study, however the age range included was fairly representative of a typical high school population's age breakdown. The history of the development sample does introduce a limitation to these findings. As discussed, CHS is a recognized national leader both in academics and teen-led highway safety. Thus all of the concept scales produced scores that were high. There is no sample for comparison, but it is expected that this group of teens would perform higher on a written test and would exhibit more positive norms as compared to an average high school in Tennessee or anywhere else across the nation. The T.E.S.T. Club's recent addition of driver's education to their formal programming also impacts these findings, especially since local issues with the quality of programming were noted. While this information was very useful to local partners, it does introduce some limitations on these findings.

Social desirability is a top threat to internal validity for these measures, as teens may simply provide the answers they think people want to hear. Ensuring confidentiality is critical in promoting honesty in responses, and qualitative comments indicate that at least four teens were thinking critically about the term Drive Smart and they questioned it directly. Regression to the mean, or returning to an average state of being is also of minor concern. For example, a given teen might have had a bad experience with a friend of family member on the day the survey was administered which might have led them to  indicate a lower score for survey items corresponding to the family norms category, however if this teen were measured again on another day they would not provide this same negative response. Expectation effects, commonly referred to as the Hawthorne effect, seek to understand when participants simply respond to receiving attention from the investigator. The *I Drive Smart* survey seeks to create a positive norming experience for teens with meaningful information embedded within the items to help them come to understand the underlying dimensions involved in making safe decisions while on the highways. Some studies may seek to remove the Hawthorne effect by creating control groups where either the investigator and/or the participants are unaware of the treatment conditions. While this may be relevant in randomized control trial studies, it is not particularly important in the evaluation of safety promoting activities that occur as a part of a normal school day and the goal is for every student in every school to be exposed to relevant interventions promoting safety.

Continued administration of this survey and replication of survey validation studies will work to overcome many of these limitations by assessing if they play out with other groups at other points in time. Further, continued use of the survey will create a statewide dataset where a comparison sample can be generated to gauge effectiveness decisions across locations. Further, there are schools with officials who want to engage teen leaders for safety but currently do not have an active team leading interventions. These schools can use the survey to better understand teens in their schools. While not relevant to this study, lack of treatment fidelity will be important for teens to understand as they begin to use this instrument. Survey administration protocols are designed to collect evidence of effectiveness regarding the entire annual plan of highway safety interventions that occur throughout the year, and thus interventions cannot be separated mathematically. Teens should supplement this annual evaluation with more subjective evaluation methods that occur immediately after specific components implemented throughout the school year. The test-retest effect will also come into play when teens use this survey in the real world as a pre and post survey, as the protocols do not call for attempting to link participant identities. Attrition is also expected in school samples, as there are almost always students who start or stop attending a given school in an academic year. Mortality may also occur, and unfortunately also because of teen crashes, which often stops teen programs but should call for a specialized program to deal with this situation. Teen leader groups using this survey should be aware of these issues and ensure local recruitment is ethical and seeks to maximize inclusion and representativeness in sampling.

## Chapter 5: Implications

Findings from the development sample collected by teen leaders from the Cookeville High School T.E.S.T. Club (n=175) show that teen leaders found data collected useful to inform local planning. Further, this quasi-confirmatory validation study did identify opportunities to optimize the survey for continued use. An exploratory factor analysis revealed a four factor model aligned with TPB that explained 61.618% of variation. Components were aligned with Theory of Planned Behavior, with perceptions of behavior control explaining 37.278%, peer norms 9.766%, family norms 7.533%, and law enforcement norms 7.041%. Item reliability analysis demonstrated high internal consistency for the behavior intention scales, with a Cronbach's alpha of .884. An ordinary least squares regression test found the predictive validity of the identified components to be strong, explaining 64.5% of variation in the model and identifying perceptions of behavior control as the best predictors of behavior intentions, followed by family and then peer norms. The behavior control component retained so much variation that the refined survey assesses both volitional and non-volitional control concepts. This study suggests that the refined version of the *I Drive Smart* survey has appropriate psychometric properties for teen leaders in highway safety to use, and is expected to be especially useful when administered ethically and in a standardized way. Further, teen leaders were able to successfully administer the survey and found data extremely helpful in supporting their planning. The results of this study demonstrate that teen leaders are capable of directing evaluation activities and that teens can be meaningfully engaged in using evaluation data to promote change.

In order for a psychometric instrument to be an effective component of a measurement system, it should be accompanied with recommendations for standardized administration procedures within a design that promotes the instrument's ability to be relevant for cross-validation and replicability studies in order to document continued evidence of validity; as well as offering guidance for interpretation of data obtained from the measures (Coaley, 2014). As the survey and its processes are replicated, continued investigation should occur in regards to ensuring its acceptability to different groups, practicality of implementation across settings, fairness for ethical use with diverse populations, and an overall cost/benefit utility assessment (Coaley, 2014).

The membership approach to the evaluation discussed in this project is designed as a uniquely social work approach to engaging teen leaders in their own process of collecting and using data for evaluation purposes through membership (Falck, 1988). In order for teens to be meaningfully engaged in directing their own interventions, they must understand the basics of intervention research and program evaluation. Further, this task is so large it must utilize adults and teens as equal partners that share skills sets and resources to ensure young people are indoctrinated into driver safety as effectively and efficiently as possible. While this survey is designed to play a meaningful role in this process, more will be needed. In order to prepare teen leaders for this task, best practices in teen-led highway safety intervention development and planning are discussed, along with recommendations for standard use of the *I Drive Smart* survey in relation to activities chosen by teens. Suggestions for developing locally relevant procedures are discussed including recruitment, administration, analysis, reporting, and dissemination. Ethical issues are also discussed. Finally, recommendations are made to interpret the survey's findings in light of other evaluative information collected throughout the year by using philosophical triangulations that incorporate multiple data points. Implications are then discussed for teen leaders who wish to do this, the adult advisors that support them, and academic partners who wish to help advance the science of teen driver safety.

## Best Practices for Teen-Led Interventions

It is important to consider the types of interventions the survey is relevant for use with as an evaluation instrument. While efficacy studies and randomized control trials dominate prevention literature, community-based practitioners often find it difficult to translate these research findings into improved outcomes for the groups they work with (Castro, Barrera, & Martinez, 2004). Evidence-based programs (EBP) models in highway safety typically come to schools in manuals or kits; and often these are adapted broadly by local practitioners (Castro, et al., 2004). *Reduce TN Crashes* does not focus on the efficacy of any one particular intervention, but instead creates infrastructure for effectiveness trials of the various interventions and/or combinations of interventions that teens choose to implement in their schools. This infrastructure allows for data to be brought to bear on a series of quasi-experiments regarding the effectiveness of each local group's interventions. Quasi-experiments are similar to experiments in that they have treatments, outcomes, and experimental units; however they do not seek random assignment in making comparisons between pre and post groups (Cook & Campbell, 1979). Theories of quasi-experiments are still developing and while there are limits to generalizability, they are high in transferability and can be very useful in producing rapid program evaluation data that teen leaders and government agencies need to guide evidence-based decision making around what types of interventions they will support. Further, employing a quasi-experimental model creates space for teen leaders across the state to serve as data collectors and gain skills as evaluation researchers while still protecting the privacy and confidentiality of their peers. It is a reality that the programs that have data behind them are the ones that survive in today's EBP-driven world. This evaluation infrastructure seeks to change the conditions of accessibility (Falck, 1988) for teens in the process of knowledge building around what works and what doesn't; specifically by supporting teens to understand the research process so that they can help to create data to investigate the types of interventions that they believe in.

Teen perspectives on driving appear to be connected to how they view their ability to control their own behavior. One study found locus of control was important, with some teens perceiving crashes as occurring as a result of teen behavior and others believing that other forces in the environment contribute to crashes (Elliott, Jacobson, Winston, & Ginsburg, 2012). Teen leaders should recognize factors of the individual that can be changed and should also address factors of the environment that can improve teen decision-making capacity. Chapter 2 reviews the literature and provides a framework for teens to help them understand the context of teen driver safety programs and what we currently know about what is working and what doesn't. Teens are the right group of people to direct programs in this area, but they do need support of adults. This will require an ecological perspective, which is one that considers how the forces of nature in any given environment impact the decisions that individuals make (Sallis & Owen, 2002). Since this perspective considers the connections between people and their environments, it is important to understand that while individuals are shaped by their environments, they also have the ability to promote change through intervention (Johnson & Yanca, 2010). Comprehensive efforts will address individual and environmental domains concurrently in ways that are relevant to local conditions targeting primary prevention content towards universal (meaning appropriate for everyone) audiences, secondary prevention to selected groups (meaning groups identified to be at risk, such as providing booster seat education to teens who are known to drive younger siblings frequently or information about driving with a trailer attached for teens about to move away from home to attend college), and tertiary prevention to indicated populations (for example, providing support for teens that have demonstrated poor highway safety decision-making or for those impacted by a crash) (Hudson, Zimmerman, & Morrel-Samuels, 2006).

Figure 5 presents currently identified influences on teen driver behavior (Shope, 2007; Shope & Bingham, 2008), which has been adapted to situate their identified components into two categories. The first includes things that cannot readily be changed, including demographic and developmental factors as well as personality. While these are not likely to change in a given individual, understanding these factors may be useful in identifying selected groups to target with specific information. The second category includes things that can be readily changed by teen leaders as they are a result of the person acting in their environment, and thus a change in the environment may result in improvements in the person. These include individual driving abilities and community access to driver's education, perceptions of the norms-setting standards for safety behavior, and the physical driving environment itself including cars, roads, and all other aspects of the tangible world a teen may be operating in.

Typical teen-led activities transcend community practice models and often include locality development, social planning, and social action (Hardina, 2002). Table 7 presents a summary of common change strategies that groups of teens plan and implement that operate on a similar theory of change, which can be expected to create short term impacts on attitudes, norms, behavior control, and behavior intentions, which can then be theoretically expected to lead to long term changes in driving behavior and thus prevailing crash rates. These include activities that provide information, enhance skills, provide support, enhance access or reduce barriers to supports, change consequences, alter the physical environment, and modify policies at multiple levels. State leaders have selected the various interventions currently available through *Reduce TN Crashes* based on the availability of resources, feasibility for quality implementation, and likelihood for being effectual. There is also an interface on the site that allows teens to design their own intervention for promoting highway safety. Best practices are briefly reviews here to provide an initial framework for teens leaders to follow when developing their own interventions.

Best practices in academic-driven intervention research identify six steps for development including: 1) problem analysis and project planning; 2) information gathering and synthesis; 3) designing the intervention to fit identified needs; 4) pilot testing in real world settings; 5) evaluation and advanced development moving the intervention towards a random assignment experiment; and 6) disseminating both the early research findings and transferring the intervention materials in other settings (Fraser, Richman, Galinsky, & Day, 2009). Best practices in designing an injury prevention intervention include: 1) setting a key health outcome that is clear, measurable, and related to a long term injury reduction vision; 2) indentifying behavioral objectives that are linked to the key health outcome desired; 3) identifying target constructs and how they influence behavioral objectives; 4) designing and developing an intervention to address these constructs; 5) evaluating effectiveness in changing these constructs; and 6) refining interventions and the behavior change model as needed (Winston & Jacobsohn, 2010). Best practices for annual planning for community-organized practice includes: 1) problem identification through culturally relevant community engagement; 2) adequate assessment of the multiple factors impacting local culture; 3) inclusive goal setting and prioritization of efforts; 4) stability of organizational structure and consistent implementation; and 5) appropriate and exhaustive evaluation that promotes continued effectiveness and sustainability (Hardina, 2002). Community coalitions that are working comprehensively to develop innovations also must be concerned with organizational capacity, which can be understood in relation to a coalition's efforts to include its: 1) formal linkages to partners (such as memorandums of understanding and job descriptions); 2) champions (which are people in positions of power that support the innovation); 3) resources (in terms of money, people, space, technology, etc.); 4) expertise (of the individuals directing the innovation); 5) administrative policies and procedures (that ensure the innovation occurs as planned and with integrity); 6) alignment with perceptions of stakeholders; and 7) its overall effectiveness as an innovation (Johnson, Hays, Center, & Daly, 2004).

## Standard Surveying Procedures

While it is appreciated that October is the federally recognized Teen Driver Safety Month (NOYS, 2016), teens should have appropriate highway safety information year round in a structured and systematic way. *Reduce TN Crashes* encourages teen leaders to create an annual plan of highway safety activities integrated with their school's schedule. Thus, environmental level evaluation data will be most meaningful if collected in relation to events in a way that guarantees temporal order. Temporal order ensures chorological measurements in order to create data relevant for assessing change before and after an intervention (DeVellis, 2012). The researcher must ensure pre measures occur before the intervention being evaluated, and that the post measures are collected after intervention exposure. The survey is designed to be administered by teen leaders themselves to their peers using convenience sampling on paper or using a web survey. T.E.S.T. Club teen leaders were prompted to consider sampling in a controlled fashion, such as emailing the survey link to every student or selecting specific classes to recruit from; or in an uncontrolled fashion, such as by sharing the link via social media, or putting up posters with web links and making announcements to recruit participants. In reality, CHS chose a combined method that was effective at reaching the study's desired sample size. However schools will need to identify the best way to draw a convenience sample from their student body that is as representative as possible and protects student identity. All schools will have some level of sampling bias and coverage error which should be documented along with observation rates at pre and post.

While data generated can be used many ways, at its most basic level is it designed to produce annual short term program output evaluation data that is meaningful to teen leaders. Pre survey measures should be summed according to concept score scales and used to guide planning. For example, if the peer norms score is low, then the given school should consider interventions that promote peer intervening behaviors that support safe driving. When the post survey data is obtained at the end of the school year, *t*-tests and chi square tests should be performed to examine change at the item and concept score levels to asses for significant change in both central tendency and variation among items and scale scores. All reports should thoroughly explain all events occurring throughout the year, leader group capacity, and should include indices of effect size and confidence intervals so that findings can later be used in meta-analyses. School-level data can be combined at the state level in order to make comparisons. Continued validation of this survey instrument should also occur, and teens may decide to take this upon themselves as they enter college and begin looking for experiential learning opportunities to integrate into their programs of study.

Teens should prepare reports of their findings and share them with relevant local groups. Teen reports should present findings in relation to scientific understandings of the components of a program, which include inputs, throughputs, outputs, and outcomes (Engel & Schutt, 2017). Teens should first summarize program inputs to include the resources that went into their annual plan which might include service hours, money, printing supplies, or other program expense costs. Program throughputs describe processes and should document how many planning meetings occurred, how many events were implemented, what percentage of the student body participated in each event, and other pertinent information such as how many service hours were spent directly on each program component. Program outputs are considered to be the direct product of the program's activities and consist of the findings from the *I Drive Smart* survey itself. Other measures can also be used to track short term program outputs and are discussed in the next section of this report. Teens can also create meaningful reports from their work by preparing systematic summaries of their annual planning processes or discussing how effectively teens were engaged as leaders. There will always be some level of error in all measurement and this is okay. Teen leaders should think about survey error beforehand and develop and document local procedures that seek to minimize error as much as possible. Every report of data should consider error and discuss limitations to their findings as guided by their study design. States can utilize data to summarize the effectiveness of teen-led programs implemented for the combined sample, but again must discuss limitation to their findings.

## Ethical Considerations

Practitioners need rapid program evaluation data, however they are often concerned about being able to collect valid data while protecting privacy and confidentiality (Higgins & Straub, 2006). In today's internet-based world, people need to be very cautious about creating data about themselves, as those with malicious intent could potentially re-identify data (Yakowitz, 2015). This sort of post-data collection breach of confidentiality is most concerning to individuals in relation to intimately personal data such as medical or financial records. While these concerns are valid, having accurate data is critical to informing research and policy making and when it is properly collected to be anonymous or else anonymized adequately, it can be ethically used to guide decision-making (Yakowitz, 2015). The processes recommended for the *I Drive Smart* survey are designed to be compliant with federal regulations related to human protections, but will need to be tailored for local needs. There are special Federal rules in place to protect young people who participate in surveys (US Department of Health and Human Services [DHHS], Office of Human Research Protections [OHRP], 2009) and to ensure ethics in all types of research (Trochim, 2006). While invasive research projects (such as doing a blood test) require a parent's signed permission for their teen to participate, this project is to assess outcomes through program evaluation (US DHHS, OHRP, 2009; Trochim, 2006) and does not collect signed permission slips so as to not create any documents that track who does or does not complete a survey.

There are nine key functions of human protections relevant in community-engaged research (CEnR). These include: 1) that risks of research are minimized; 2) that risks are reasonable to anticipated benefits from the research; 3) that the selection of subjects is fair; 4) that each participant gives voluntary and informed consent; 5) that procedures are in place to monitor data collected to ensure safety of subjects; 6) that adequate provisions are in place to protect the privacy of participants and to maintain confidentiality of data; 7) that conflicts of interest are transparent and managed appropriately; 8) that consideration is given to the inclusion and protection of any relevant vulnerable populations; and 9) that proper training in human subjects protection is provided for all research personnel (Ross, Loup, Nelson, Botkin, Kost, Smith, Jr., & Gehlert, 2010).

Adults supporting teens to engage in research activities should be trained in human participant protections, and there are free modules online that provide nationally recognized certifications (National Institutes of Health, Office of Extramural Research, 2016). Most universities will also have a process in place to provide training to their personnel, students, and affiliates; and getting certified is often part of standard education programs that utilize social sciences. For this project, teen leaders administering the survey considered the three essential ethical principles of research when determining the best way to sample from their peers. These include: 1) beneficence, which is concerned with who benefits from the research process occurring; 2) respect for persons, which includes a range of design factors that should be considered including making the surveying process as easy as possible, and ensuring that if teens take the time to complete the survey that data will in fact be utilized in a meaningful way to improve their lives; and 3) justice, which is concerned with who bears the costs of research versus who gets the rewards from the process. Further, no one should ever attempt to force or coerce anyone to complete a survey (US DHHS, OHRP, 2009). An informed consent process was built into the web survey and teens could choose to skip any questions they wanted. This should be replicated whenever the survey is used, along with ensuring the provision of basic training for teen leaders to ensure the privacy of their peers is protected.

These federal ethics must also be considered in relation to state law and local policy. Pursuant to Tennessee Code Annotated (TCA) 49-2-211, the ultimate responsibility for managing all survey administration in schools falls on each Local Education Agency (LEA) who can choose to impose other restrictions (State of Tennessee, 1999). Teen leaders and the adults who support them should be aware of relevant state and local laws in regards to survey administration in schools. The survey is designed to be used by teens to evaluate the programs that they and the adults who support them choose to implement as part of a regular school day. Based on local school policy, teen leaders might choose to distribute copies of the informed consent text from the survey, or to provide an information letter that can be sent home to parents informing them about the surveys. For schools requiring a parents' actual signature before any survey administration regardless of risk, it is recommended to send the survey link directly to parents and ask them to have their teens complete it rather than attempt to track signed permission slips from parents. While there is not adequate data to determine which recruitment methods will be most effective, schools must consider this for themselves and document their decision-making. Ensuring adequate sampling that represents approximately 5 to 15% of the student body is an ethical way to minimize the burden of completing surveys on students and school officials while producing a sample size large enough for adequate statistical conclusion validity for evaluation purposes (Dattalo, 2008; Dattalo, 2010). Teen leaders should also rely upon local school officials for ensuring students with special needs can participate in the survey, which may include those that do not speak English or students with disabilities. Schools could also provide small incentives (like a keychain or other small item), but teen leaders should make sure that incentives do not become coercive or leave students that decide not to participate out in an unfair way. Again, there will always be survey error around sampling and local groups should document how they made their best efforts to minimize it to be inclusive and representative.

Schools must also be prepared to have data collected that may point to negative aspects of their performance. In this study sample, data were collected that revealed potential issues with driver's education and law enforcement norms. It is important for teen leaders to not take data like this and jump to conclusions, but instead to compare any negative statements with other local data sources to seek convergent validity, which is when findings from multiple data sources point to the same conclusion (Engel & Schutt, 2017). There is valid critique of driver's education curriculum models (Lonero & Mayhew, 2009) and while the individual teacher may bear the brunt of negative comments when teens are given an opportunity to give anonymous feedback; attempting to alter the instruction model itself guiding the teacher's actions may present the best opportunity for improvement. In regards to law enforcement norms, it is important to maintain local relationships that are meaningful and focus on providing positive support to teens before an infraction is committed. Anonymous surveys can be used as an opportunity to complain about authority figures, and teen leaders must be able to utilize various data points to seek convergent validity before acting in a certain way. In the instance of CHS, both quantitative and qualitative data came back very positive in regards to student support for teen-led interventions. While this is excellent news for the T.E.S.T Club, other teen leader groups administering this survey must be prepared to hear negative feedback about their group's actions. Managing this is difficult for anyone and the role of adult advisors will be key in supporting teen leaders to use negative feedback to improve processes.

**Utilization of Supporting Evaluative Information**

There is a real world need for program evaluation to be conducted by THSO and teen leaders for highway safety in response to MAP21. Demonstrating the principles of Empowerment Evaluation (EE) (Fetterman & Wandersman, 2005), this project seeks to integrate the survey developed into infrastructure that will better enable local and statewide evaluation of the interventions implemented by teen leaders using various epistemological approaches. The *I Drive Smart* survey is designed to evaluate an annual plan of activities; however teens should also collect information about individual program components implemented throughout the year. When looking at individual components, qualitative information is likely to be more useful in helping teens to decide if the component is good or not. This can be assessed using a simple observation process where teen leaders subjectively assess the quality of the component and the reaction of their peers.

Using a structured observation tool can help to promote validity in findings and allow them to be compared. If more specific information is needed to assess the component, then methods like focus groups or brief interviews may yield the most useful information. Teens could also conduct very brief intercept interviews where they simply ask and record if participating teens liked a specified activity or not. Teens can also solicit feedback via social media, but should be sensitive to privacy and confidentiality issues considering this format is open to the public. Knowledge tests are also likely to be most relevant when administered just after an activity that is designed to provide specific information.

While crash rates are typically collected at the county level, the *I Drive Smart* survey will collect school-level data only. Other measures must be assessed in order to connect these short-term school-specific findings with larger trends in crash rates for the county or state. The county-level saturation rate should be tracked by identifying how many high schools are in the county and how many are engaged in teen-led activities. Teen leaders from high schools also frequently intervene in middle school and elementary schools with programs like the *Ollie the Otter* booster seat education program (TTU iCube, 2016[3]). While the *I Drive Smart* survey will only collect data from the participating high school, throughputs tracking all activities that occur outside of the school should be documented so they can eventually be incorporated into systematic evaluation processes. These might include teen leaders attending a community meeting to speak about highway safety, environmental assessments of road conditions, or providing parent training. Other factors should also be considered such as the availability of driver's education, the quality of law enforcement, and access to health care and trauma services. Cost-benefit analyses are also important and typically consider factors such as operational costs, earnings, reduced costs due to prevented consequences, and will often include a calculation of net benefits (Engel & Schutt, 2017). As confidence intervals and effect sizes are obtained for various combinations of interventions, cost-benefit calculations can become more sophisticated. As interventions emerge as particularly successful, they should be flagged as potentially worth the expense of a more in-depth study that may include a randomized control trial study to assess efficacy in a controlled setting.

Specifically, the survey is designed to guide local planning using pre survey data and to document short term program outputs once the post survey data is collected. In properly using the behavior intention survey data collected to link actions with changes population-level outcomes, concept scale scores should be interpreted in light of other data points considered in relation to each other by local leaders. Triangulation between data points is an effective evaluation technique, even if the actual triangulation process is subjective (Denzin, 1970). Data triangulations strengthen a researcher's confidence in being able to document effectiveness and often include methodological or observer triangulations (Denzin, 1970). The change in concept scale scores measured by the *I Drive Smart* survey are recommended to be analyzed in light of other data points that are readily available from local communities and ones that can be conceptually linked together. A basic structure for this triangulation has been created for *Reduce TN Crashes* and is grounded in three central philosophical themes emergent in social science including: 1) causation, which considers cause and effect relationships; 2) mind and matter, which considers what people feel and dream about; and 3) substance and qualities, which explore connections of apparent fundamental truths embedded in our reality (Falck, 1970). Exploring metaphysical relationships for evaluation through philosophical triangulation is an innovative approach designed specifically for *Reduce TN Crashes* teen leaders. The design could not occur with authenticity outside of a community-engaged research (CEnR) design where knowledge building is seen as an intrapsychic process that occurs through membership and collective action (Falck, 1988).

Specifically, tools created to guide teen-led triangulations for evaluation in Tennessee include the self-report indirect observation of behavior intentions obtained through the *I Drive Smart* survey to consider mind and matter; a measure of real world truths about teen safety obtained through a direct observation of seatbelt use to explore substance and qualities; which should both be considered in light of matters of causation, by assessing the actual change in consequences occurring locally in the rates of teen crashes and fatalities. A cell phone-based application (app) has also been developed by iCube with support from State Farm Insurance Company that provides an interface to allow teens to conduct simple, ethical, and valid pre and post seatbelt use observational studies at their schools (Montgomery, 2015). This local data also gives teens information related to the short term outputs related to their programs and is meant to be analyzed using chi square tests to assess for change in the proportion of unbelted to belted teens. The overall county level crash and fatality rate is also measured on an interactive map hosted on the *Reduce TN Crashes* site. Over time, additional triangulation data points can be utilized, with convergence in findings increasing the effectual validity of peer to peer highway safety. Over time, this system will collect data that will allow statewide and national highway safety leaders to better understand which types of teen-led interventions are most effective in the short term, as well as if they also appear to contribute to long term reductions in overall crashes in a given area.

**Implications**

While not standard practice, teens have been effectively and meaningfully engaged in evaluation and research on many occasions and across issues (Delgado, 2006). Adults should take a proactive stance and support interested youth by helping them to develop research competencies (Delgado, 2006). In order to be scientific, young people must follow ethical principles just as anyone of any age would be required to do. For teens to truly control their own research agenda, we must systematically support them to develop the skills they need which include critical thinking, listening and communication, patience and persistence, and flexibility to work both alone and in groups

(Delgado, 2006). Just like all scientists, teen researchers will struggle to identify gaps in their knowledge, recognize their biases, and to manage their insider and outsider group identities. Community researchers could use journaling or other techniques to explore the impact of collecting data from one's peers on the teen leaders themselves (Mosavel, Rashid, Daniels, & Simon, 2011). Young people will need support from experienced researchers to ensure they are protected as children themselves, while also ensuring they are trained to protect their peers and to respect the identity of their school and community as they assume the responsibilities of reification and knowledge building.

Academic partners will also be needed for very practical purposes such as providing support to manage study budgets, giving advice on how to draw the best convenience sample, helping teens design focus group protocols, and providing general support to help teen leaders collect and use data. While the measurement of the illusive properties of latent constructs are seen by some as a methodological impossibility (af Whalberg, 2009; Coaley, 2014; Kline, 2013), it is also likely that the skill level of the academy and citizenry just isn't where it needs to be for psychometrics to truly be meaningful (Higgins & Straub, 2006; Kline, 2013). This is okay because it is relatively new knowledge for the human race, as is program evaluation and intervention research. Efforts must not assume that all academics know these things and should include training and support to mobilize adults at all levels that are working with teen leaders on evaluation activities; and this is especially true when they are not trained researchers themselves (Clary & Rhodes, 2006). Further, academic partners will be needed to support these leaders as they matriculate into college so that teens can continue to develop their ability to engage in social science and evaluation beyond where participating in this project can take them.

Specific to the *I Drive Smart* survey, we must ensure continuous survey development which should include people other than the author also submitting data to validation studies. While the initial triangulation proposed for teens to use is simple, it is adequate to help guide groups to draw conclusions about the overall effectiveness of their work. However, many new techniques exist that could be used by teen leaders to enhance the quality of their evaluation data by sophisticating their triangulations. For example, in-vehicle data recorders offer new opportunities for data collection, as well as an opportunity to provide brief interventions using real-time text messages to drivers using in-vehicle displays (Toledo, Musicant, & Lotan, 2008). Automated video analysis offers a continuous in-car stream of behaviors that could be utilized as a direct behavior observation (Laureshyn, Svensson, & Hyden, 2010). Further, Global Positioning Systems (GPS) devices have been installed in cars and provide data useful in assessing the validity of crash and near-crash data (Greaves & Ellison, 2011). While each of these involves a seemingly invasive data collection technique, teens and adults working in membership could improve how these measures inform evaluation. The engagement of teen leaders in the collection of these sorts of data points could work to improve participant recruitment, inform more ethical consent procedures, support analysis in light of other local data points, and help to determine the best dissemination channels that will promote real world change from study findings.

**Conclusions**

It has been a historic goal to combine the promotion of highway safety programs and evaluation into a single program. In the 1970s, the National Safety Council (NSC) started a School Honor Roll program that involved school officials using check-off lists that denoted recommended safety issues had been addressed; with successfully participating schools being placed on a national Honor Roll and facing increasingly complex challenges each year (Strasser, Aaron, Bohn, & Eales, 1973). The *Moving Ahead for Progress in the 21st Century Act of 2012* (MAP21) ushers in a call to action for a national teen-led research agenda that advances the science of teen driver safety. While the

NSC Honor Roll program may not exist in its original state any longer, the desire to integrate safety programs with evaluation activities is alive and well and manifest in this project which reflects the work of THSO and Tennessee's network of teen leaders, as well as the network of community-based partners for prevention that readily support them statewide (Prevention Alliance of Tennessee, 2016). Effective transfer of knowledge gained to other issues is part of the experiential learning cycle (Kolb & Kolb, 2005). As local leaders gain evaluation skills in relation to highway safety, they should be encouraged to utilize them in planning and evaluation across other youth safety issue areas. Further, there are specific calls for the next generation of researchers to utilize the Theory of Planned Behavior and Reasoned Action approaches to advance behavior science by developing interventions uniquely tailored to an individual's needs and personal factors (Jaccard, 2012). This will require interventions and math that are paired together and designed to transcend the traditional divide to use nomothetic prediction-based math that can identify traits and then utilize interventions targeted towards the individual's ideographic (or rare) characteristics (Jaccard, 2012).

Effectively utilizing engaged epistemological approaches, data can be collected and analyzed in a way that could systematically connect theory of action to theory of change (Fetterman & Wandersman, 2005); and short term program outputs to long term environmental outcomes (Little, 1968). Program and evaluation theory has gotten quite sophisticated and there are many tools and processes to guide adults that can be adapted for use by teens (Alkin, 2013). An excellent free guide exists to support people to understand how to use both descriptive and inferential statistics (Trochim, 2009). Further, the internet has made statistical software packages readily available so that anyone can quickly perform the math involved in using inferential statistics to guide decision-making (Free Software Foundation, 2013). There are also excellent sources providing SPSS tutorials (van den Berg, 2016); and one only needs to type in the name of the procedure they are attempting to run and the name of the software program being used into a search engine to have a multitude of video tutorials available to guide them. These and many other tools have made math more accessible to young people and they should be encouraged to utilize technologies available to them across a range of digital mechanisms such as instant messaging, emailing, blogging, reviewing posted documents, video conferencing, and other forms of online collaboration and communication (Churches, 2009). The challenge teens face today is not the math because there is an app for that now. The challenge is learning to appropriately connect culturally relevant theories through interventive action ato human behavior so that the math is meaningful for use in improving real world conditions. This report serves to support teen leaders in this mission.

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# Appendix

**Figure 1:** Theory of Planned Behavior Model

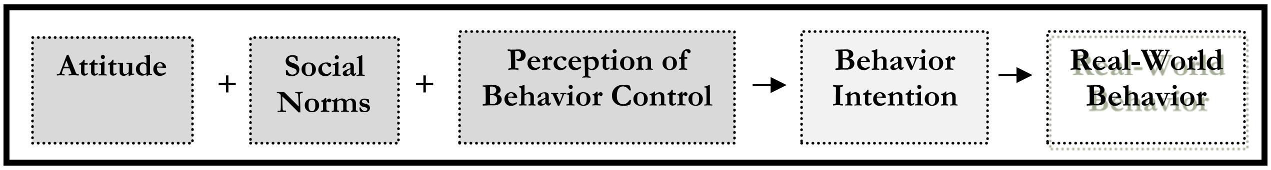


**Table 1: Persons aged 15 to 19 Killed in** Tennessee **Traffic Crashes by Person Type**

| Year | Teens as Drivers | Teens as Passengers | Total Teen Deaths |
|---|---|---|---|
| **2000** | 87 | 66 | 153 |
| **2001** | 85 | 59 | 144 |
| **2002** | 104 | 60 | 164 |
| **2003** | 85 | 58 | 143 |
| **2004** | 102 | 65 | 167 |
| **2005** | 74 | 49 | 123 |
| **2006** | 88 | 65 | 153 |
| **2007** | 100 | 53 | 153 |
| **2008*** | 72 | 33 | 105 |
| **2009** | 48 | 42 | 90 |
| **2010** | 46 | 30 | 76 |
| **2011**** | 52 | 25 | 77 |
| **2012** | 57 | 32 | 89 |

*First year that THSO-directed teen leadership interventions occurred.
**Year that fewer teen leadership support services were offered by THSO.

**Figure 2: Tennessee Drivers Involved in Fatal Crashes by Age, 2002-2011**

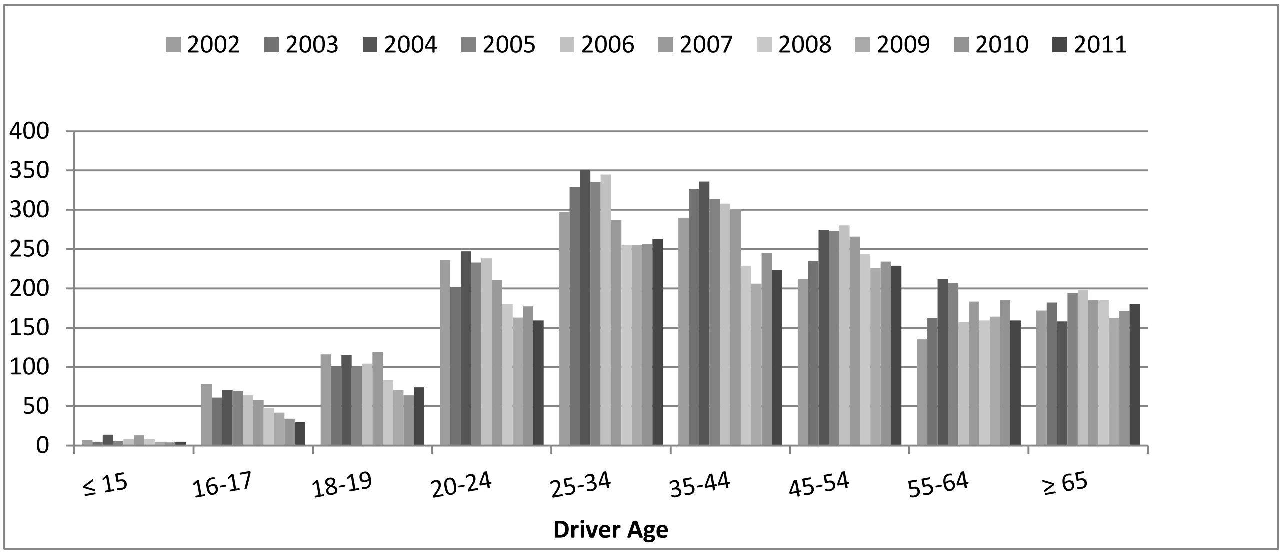


**Figure 3: Percentage of Tennessee students who rode one or more times during the past 30 days in a car or other vehicle driven by someone who had been drinking alcohol**

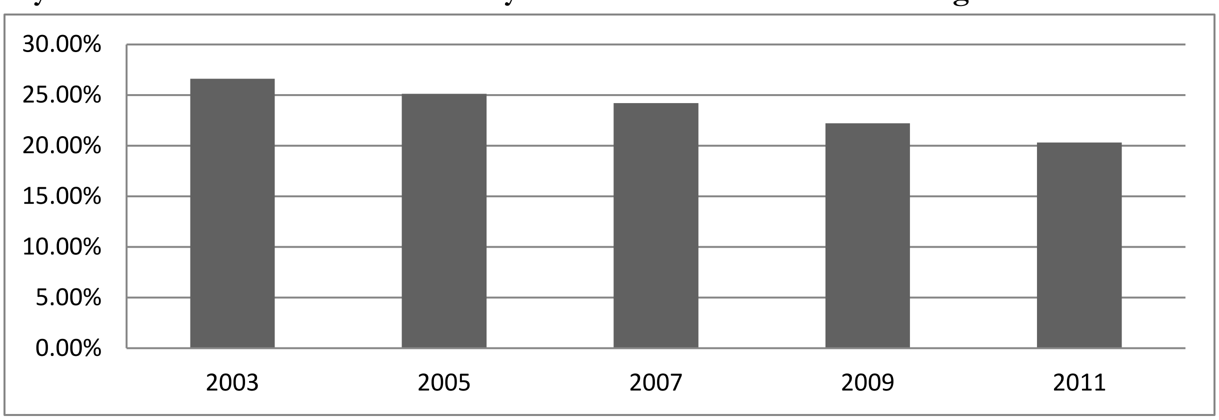


**Figure 4: Percentage of Tennessee students who drove a car or other vehicle one or more times during the past 30 days when they had been drinking alcohol**

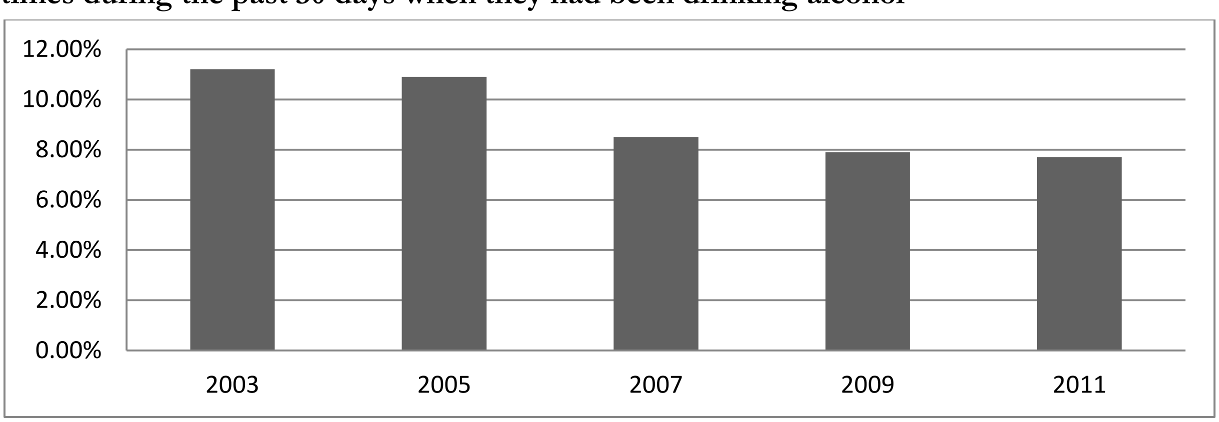

**Table 2: Demographics of the final study sample (n=175)**

| Characteristic | Frequency | Percent | Cum Percent |
|---|---|---|---|
| **Age** | | | |
| 14 | 4 | 2.3 | 2.3 |
| 15 | 15 | 8.6 | 10.9 |
| 16 | 38 | 21.7 | 32.6 |
| 17 | 55 | 31.4 | 64.0 |
| 18 | 47 | 26.9 | 90.9 |
| 19 | 15 | 8.6 | 99.4 |
| 20 | 1 | 0.6 | 100 |
| **Total** | **175** | **100.0** | **100.0** |
| **Gender** | | | |
| Male | 73 | 41.7 | 41.7 |
| Female | 99 | 56.6 | 98.3 |
| Non-conformers | 3 | 1.7 | 100.0 |
| **Totals** | **175** | **100.0** | **100.0** |
| **License Type** | | | |
| None | 11 | 6.3 | 6.3 |
| Suspended/revoked | 3 | 1.7 | 8.0 |
| Hardship | 5 | 2.9 | 10.9 |
| Learner's Permit | 24 | 13.7 | 24.6 |
| Intermediate Restricted | 51 | 29.1 | 53.7 |
| Intermediate unrestricted | 41 | 23.4 | 77.1 |
| Full License | 38 | 21.7 | 98.9 |
| Not sure | 2 | 1.1 | 100.0 |
| **Totals** | **175** | **100.0** | **100.0** |
| **Driver Frequency** | | | |
| Never | 9 | 5.1 | 5.1 |
| Rarely | 13 | 7.4 | 12.6 |
| Sometimes | 24 | 13.7 | 26.3 |
| Often | 44 | 25.1 | 51.4 |
| Very often | 85 | 48.6 | 100.0 |
| **Totals** | **175** | **100.0** | **100.0** |

**Table 3: Descriptive Data from Study Sample**

| Survey item | Sample Size | Mean | Standard Error of Mean | Median | Standard Deviation | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|
| Driving Smart means making good choices. | 175 | 87.33 | .886 | 90 | 11.726 | -1.328 | 1.669 |
| Driving Smart will save your life. | 173 | 86.32 | 1.089 | 91 | 14.323 | -1.320 | 1.118 |
| Driving Smart is the right thing to do. | 175 | 90.47 | 1.002 | 95 | 13.249 | -2.679 | 8.705 |
| **Attitude Score** | **173** | **264.19** | **2.450** | **270** | **32.229** | **-1.893** | **5.203** |
| My friends help me to Drive Smart. | 169 | 71.46 | 1.867 | 79 | 24.273 | -1.160 | .810 |
| My friends set good examples by Driving Smart. | 169 | 71.51 | 1.587 | 76 | 20.637 | -.686 | -.112 |
| Fitting in with my friends is important to me. | 171 | 70.45 | 1.931 | 78 | 25.256 | -.901 | -.078 |
| **Peer Norms Score** | **165** | **212.77** | **4.330** | **220** | **55.623** | **-.8** | **.363** |
| My family members help me to Drive Smart. | 172 | 81.81 | 1.243 | 84 | 16.307 | -1.727 | 4.426 |
| My family members set good examples by Driving Smart. | 172 | 78.67 | 1.352 | 83 | 17.735 | -1.156 | .854 |
| Meeting my family's expectations is important to me. | 171 | 78.77 | 1.474 | 84 | 19.272 | -1.033 | .196 |
| **Family Norms Score** | **170** | **239.74** | **3.012** | **245** | **39.269** | **-.826** | **.632** |
| Law enforcement Officers support me to Drive Smart. | 172 | 79.52 | 1.601 | 86 | 20.995 | -1.399 | 1.620 |
| Law enforcement Officers will catch me if I do not Drive Smart. | 170 | 75.17 | 1.785 | 81 | 23.278 | -1.433 | 1.617 |
| Following traffic laws is important to me. | 173 | 85.99 | 1.297 | 92 | 17.058 | -2.239 | 5.950 |

**Table 3: Descriptive Data from Study Sample**

| Survey item | Sample Size | Mean | Standard Error of Mean | Median | Standard Deviation | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|
| **Law enforcement Norms Score** | **170** | **240.29** | **3.777** | **254** | **49.246** | **-1.424** | **2.138** |
| **Combined Social Norms Score** | **161** | **692.38** | **9.136** | **719** | **115.922** | **-.818** | **.249** |
| I have the power to choose to Drive Smart. | 174 | 91.29 | .879 | 95 | 11.590 | -3.615 | 20.055 |
| Not Driving Smart will cause a crash. | 173 | 75.72 | 1.453 | 81 | 19.115 | -.776 | .143 |
| Taking a Driver's Ed course helps teens to Drive Smart. | 172 | 75.85 | 1.637 | 82 | 21.463 | -1.183 | 1.296 |
| (GDL) laws help teens to Drive Smart. | 172 | 76.94 | 1.671 | 83 | 21.920 | -1.608 | 2.698 |
| Supporting each other for safety helps teens to Drive Smart. | 171 | 84.07 | 1.536 | 94 | 20.083 | -1.591 | 1.763 |
| **PBC Score** | **168** | **405.18** | **5.532** | **422.50** | **71.708** | **-1.495** | **1.763** |
| **Combined Score: Att + Norms + PBC** | **156** | **1366.60** | **15.150** | **1403** | **189.221** | **-1.235** | **1.563** |
| In the future, I will Drive Smart. | 173 | 86.01 | 1.329 | 93 | 17.475 | -1.907 | 3.288 |
| As a passenger, I will say something to support others to Drive Smart. | 173 | 84.53 | 1.287 | 91 | 16.933 | -1.569 | 2.155 |
| **Behavior Intention Score** | **173** | **170.53** | **2.445** | **182** | **32.164** | **-1.646** | **2.187** |
| When riding as a passenger, I say something if the driver is not Driving Smart. | 171 | 75.23 | 1.676 | 82 | 21.921 | -1.008 | .526 |
| When behind the wheel, I Drive Smart. | 165 | 83.25 | 1.219 | 88 | 15.662 | -1.184 | 1.093 |
| **Behavior Score** | **163** | **158.03** | **2.551** | **168** | **32.566** | **-.882** | **.414** |

**Table 3: Descriptive Data from Study Sample**

| Survey item | Sample Size | Mean | Standard Error of Mean | Median | Standard Deviation | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|
| Knowledge about seat belts | 175 | .99 | .006 | 1 | .076 | -13.229 | 175 |
| Knowledge about speeding | 175 | .97 | .013 | 1 | .167 | -5.709 | 30.940 |
| Knowledge about distractions | 175 | .83 | .029 | 1 | .378 | -1.759 | 1.106 |
| Knowledge about passenger distractions | 175 | .86 | .027 | 1 | .351 | -2.059 | 2.265 |
| Knowledge about driving under the influence | 175 | .90 | .023 | 1 | .305 | -2.637 | 5.013 |
| **Knowledge Score** | **175** | **4.55** | **.059** | **5** | **.778** | **-1.830** | **3.201** |

**Table 4: Components Identified as Explaining Variation in Behavior Intentions**

| Item | Component | | | | Commun-ality |
|---|---|---|---|---|---|
| | Perceptions of Behavior Control | Peer Norms | Family Norms | Law enforcement Norms | |
| Driving Smart means making good choices. | .460 | -.457 | .282 | -.180 | .532 |
| Driving Smart will save your life. | .688 | -.324 | -.056 | -.024 | .582 |
| Driving Smart is the right thing to do. | .594 | -.523 | .110 | -.169 | .667 |
| My friends help me to Drive Smart. | .562 | .376 | .161 | -.146 | .505 |
| My friends set good examples by Driving Smart. | .639 | .274 | .133 | -.093 | .511 |
| Fitting in with my friends is important to me. | .348 | .428 | .066 | -.078 | .315 |
| My family members help me to Drive Smart. | .445 | .253 | .354 | .088 | .395 |
| My family members set good examples by Driving Smart. | .559 | .029 | .235 | -.096 | .377 |
| Meeting my family's expectations is important to me. | .409 | .129 | .294 | .287 | .353 |
| Law enforcement Officers support me to Drive Smart. | .527 | -.086 | .149 | .430 | .492 |
| Law enforcement Officers will catch me if I do not Drive Smart. | .599 | -.090 | -.150 | .277 | .466 |

| | | | | | |
|---|---|---|---|---|---|
| Following traffic laws is important to me. | .708 | -.094 | -.156 | .147 | .556 |
| I have the power to choose to Drive Smart. | .455 | -.051 | .142 | -.249 | .292 |
| Not Driving Smart will cause a crash. | .616 | .197 | -.305 | -.215 | .558 |
| Taking a Driver's Ed course helps teens to Drive Smart. | .665 | -.084 | -.197 | .175 | .519 |
| (GDL) laws help teens to Drive Smart. | .680 | .144 | -.293 | .072 | .574 |
| Supporting each other for safety helps teens to Drive Smart. | .827 | .062 | -.229 | -.182 | .774 |
| **Rotated Explained Variance** | 37.278 | 9.766 | 7.533 | 7.041 | 61.618 |

**Table 5: Original *I Drive Smart* Survey Items Regressed to Predict Behavior Intentions**

| Independent Variables | Unstandardized Coefficients | | β | *t* | 95% CI | |
|---|---|---|---|---|---|---|
| | Beta | SE | | | LB | UB |
| Constant | -5.256 | 13.673 | | -.384 | -32.295 | 21.783 |
| Driving Smart means making good choices. | .074 | .160 | .028 | .460 | -.243 | .390 |
| Driving Smart will save your life. | .047 | .142 | .022 | .331 | -.235 | .329 |
| Driving Smart is the right thing to do. | .254 | .149 | .112 | 1.708 | -.040 | .548 |
| My friends help me to Drive Smart. | -.012 | .071 | -.010 | -.170 | -.153 | .129 |
| My friends set good examples by Driving Smart. | .271 | .088 | .186 | 3.077** | .097 | .446 |
| Fitting in with my friends is important to me. | -.098 | .059 | -.083 | -1.652 | -.215 | .019 |
| My family members help me to Drive Smart. | .017 | .099 | .009 | .170 | -.180 | .213 |
| My family members set good examples by Driving Smart. | -.156 | .094 | -.091 | -1.649 | -.342 | .031 |
| Meeting my family's expectations is important to me. | -.014 | .085 | -.009 | -.168 | -.183 | .155 |
| Law enforcement Officers support me to Drive Smart. | -.074 | .081 | -.055 | .912 | -.235 | .087 |
| Law enforcement Officers will catch | -.074 | .081 | -.055 | -.912 | -.235 | .087 |

**Table 5: Original *I Drive Smart* Survey Items Regressed to Predict Behavior Intentions**

| Independent Variables | Unstandardized Coefficients | | β | *t* | 95% CI | |
|---|---|---|---|---|---|---|
| | Beta | SE | | | LB | UB |
| me if I do not Drive Smart. | | | | | | |
| Following traffic laws is important to me. | .541 | .114 | .305 | 4.726*** | .315 | .767 |
| I have the power to choose to Drive Smart. | .486 | .136 | .196 | 3.577*** | .218 | .755 |
| Not Driving Smart will cause a crash. | .398 | .097 | .250 | 4.098*** | .206 | .590 |
| Taking a Driver's Ed course helps teens to Drive Smart. | -.136 | .088 | -.097 | -1.538 | -.310 | .039 |
| (GDL) laws help teens to Drive Smart. | .065 | .100 | .043 | .644 | -.134 | .263 |
| Supporting each other for safety helps teens to Drive Smart. | .419 | .122 | .275 | 3.432*** | .177 | .660 |

Note. *p≤.05, **p≤.01, *** p≤.001; $R^2_{adj} = .715$ ($F_{17,136} = 23.574$, $p < .001$).

**Table 6: Four Factor Component Model Regressed to predict Behavior Intentions**

| Independent Variables | Unstandardized Coefficients | | β | *t* | 95% CI | |
|---|---|---|---|---|---|---|
| | Beta | SE | | | LB | UB |
| Constant | 172.339 | 1.440 | | 119.714*** | 169.495 | 175.184 |
| PBC | 17.993 | 1.684 | .527 | 10.684*** | 14.665 | 21.321 |
| Peer Norms | 12.567 | 1.720 | .357 | 7.306*** | 9.168 | 15.966 |
| Family Norms | 12.803 | 1.691 | 3.70 | 7.573*** | 9.462 | 16.143 |
| Law enforcement Norms | -1.594 | 1.845 | -.042 | -.864 | -5.240 | 2.052 |

Note. ***p≤.001; $R^2_{adj}$ = .645 and was statistically significant ($F_{4,149}$ = 70.463, p < .001).

## Optimized *I Drive Smart* Survey Instrument

### I. Informed Consent template

You are being asked to take this survey if you are a student at ______. Taking this survey means that you will be helping teen leaders from your school working with ______to know if what they are doing is effective. The survey should take you about 5 minutes to complete and does not ask for any information about your identity and no one will know what answers you enter. Please only take this survey once and answer the questions as honestly as you can. If you are a parent, teacher or someone else, you can still take this survey, but please enter your correct age and information when the survey asks. If you decide to complete this survey, you will be asked to review a series of questions about Driving Smart. You will not get a grade on this survey and you will have options to tell us what you think. Always Driving Smart means that you always make good choices when behind the wheel and that you always support others to Drive Smart when you are a passenger. Driving Smart means that:

- You hold a valid license or permit whenever driving a vehicle and have insurance coverage.
- You make sure your vehicle has good tires, brakes, headlights, windshield wipers, and that other essential safety features like airbags and seatbelts are working correctly.
- You wear your seatbelt and make sure that passengers are buckled up. When driving young children, you make sure they are in car seats or booster seats.
- You follow the Graduated Driver License (GDL) restrictions on nighttime and early morning driving and/or any passenger limits that may apply to the stage of your license.
- You follow all traffic laws like stop signs, traffic lights, lane restrictions, and speed limits.
- You don't do risky things while driving like using alcohol or drugs, drag racing, talking or texting on a cell phone, fiddling with the radio, or driving while very sleepy.
- You are respectful of other people using the roadways. For example, you are cautious around people walking or riding bikes; and you slow down in school zones, construction zones, and are careful to move over if there is a disabled vehicle on the side of the road.

- When riding as a passenger, you support whoever is driving you to Drive Smart by doing things like wearing your seatbelt, navigating, answering cell phone calls or texts, and supporting a calm and safety-focused environment to help the driver concentrate.

If you want to have a copy of this information to look at while you take the survey and/or to share with your family later, you can download it by clicking here: ______. You will also be redirected to this same link at the end of the survey. If you have any questions or comments about this survey, please send us a message here _____. If you have any questions about your rights as a participant in this study, contact _____.

**II. Study sample inclusion**

1) Which school do you attend? [dropdown list of participating schools]
    i. If not a student, what is your interest in taking this survey? [open text box]

**III. Demographics**

2) How old are you? [manual entry in real numbers]
3) Do you identify with a gender? [Male, Female, Something else? open text box]
4) Which type of license do you currently hold? [No Answer, None, My license is currently suspended/revoked, Hardship License, Learner's Permit, Intermediate Restricted, Intermediate Unrestricted, Full, Not sure, Something else? open text box]
5) How often do you drive? [Never, Rarely, Sometimes, Often, Very Often]
6) How often do you ride as a passenger? [Never, Rarely, Sometimes, Often, Very Often]

**IV. Young Driver Safety Behaviors:**

**Think about what it means to Drive Smart. Use the bar to indicate how often you Drive Smart.** [No Answer, Never, Rarely, Sometimes, Often, Very Often]

6) When riding as a passenger, I say something if the driver is not Driving Smart. (shown to riders only)
7) When behind the wheel, I Drive Smart. (shown to drivers only)

**Behavior Score = 0-10**

**V. Attitude:**

**Think about what it means to Drive Smart. Use the bar to indicate how much you agree with each statement.** [No Answer, Never, Rarely, Sometimes, Often, Very Often]

8) Driving Smart means making good choices.
9) Texting while driving may cause a crash.

10) Driving under the influence of alcohol or drugs may cause a crash.
11) Excessive speeding may cause a crash.
12) Driving Smart is the right thing to do.

**Attitude Score = 0-25**

**VI. <u>Social Norms – Peer:</u>**

**Think about what it means to Drive Smart. Use the bar to indicate how much you agree with each statement about the group of people you consider to be your friends.** [No Answer, Not Applicable, Never, Rarely, Sometimes, Often, Very Often]

11) My friends will say something if their driver is not Driving Smart.
12) My friends support Driving Smart.
13) Fitting in with my friends is important to me.

**Peer Norms Score = 0-15**

**VII. <u>Social Norms – Family:</u>**

**Think about what it means to Drive Smart. Use the bar to indicate how much you agree with each statement about the group of people you consider to be your family.** [No Answer, Not Applicable, Never, Rarely, Sometimes, Often, Very Often]

14) My family will say something if their driver is not Driving Smart.
15) My family supports Driving Smart.
16) Meeting my family's expectations is important to me.

**Family Norms Score = 0-15**

**Combined Social Norms Score = 0-30**

**VIII. <u>Perceptions of Behavior Control:</u>**

**Think about what it means to Drive Smart. Use the bar to indicate your perspective for each statement.** [No Answer, Never, Rarely, Sometimes, Often, Very Often]

20) I have the power to choose to Drive Smart.
21) Not Driving Smart may cause a crash.
22) Being a Smart Driver is important to me.

**Volitional Behavior Control Score = 0-15**

**Think about what it means to Drive Smart. Use the bar to indicate how much you agree with each statement about the place you consider to be your community.** [No Answer, Not Applicable, Never, Rarely, Sometimes, Often, Very Often]

23) Law enforcement Officers will catch me if I do not Drive Smart.

24) My community supports Driving Smart.
25) Following traffic laws is important to me.
26) Taking a Driver's education course helps teens to Drive Smart.
27) Graduated Driver Licensing (GDL) laws help teens to Drive Smart.
28) Teens supporting each other for highway safety helps teens to Drive Smart.

**Belief in Supports for Non-Volitional Behavior Control Score = 0-30**

**Perceptions of Behavior Control Score = 0-45**

IX. **Young Driver Safety Behavior Intentions:**

**Think about what it means to Drive Smart. Use the bar to indicate your perspective for each statement.** [No Answer, Never, Rarely, Sometimes, Often, Very Often]

25) In the future, I will Drive Smart.
26) As a passenger, I will say something to support others to Drive Smart.

**Young Driver Safety Behavior Intentions Score = 0-10**

X. **Highway Safety Knowledge Test:**

**Last Step! Please mark the best answer for each question:**

27) Wearing your seatbelt reduces the chance that you will die or be seriously injured if you are involved in a car crash. [No Answer, True (Correct), False]
28) If it is raining or snowing outside, you may need to drive slower than the posted speed limit. [No Answer, True (Correct), False]
29) Which of these behaviors can be deadly for drivers of any age? [No Answer, Texting while driving, Driving while very sleepy, Talking on a cell phone, Driving under the influence of alcohol or drugs, All of the above (Correct)]
30) Which of these behaviors can increase a teen driver's risk for causing a crash? [No Answer, Keeping your cell phone turned off, Driving with too many passengers in the car (Correct), Wearing your seatbelt, Scanning the road for hazards, All of the Above]
31) Which of the following could you lose if you choose to mix drinking and driving? [No Answer, Your License, Your Freedom, Your Life, All of the Above (Correct)].

**Highway Safety Knowledge Score = 0-5**

XI. **Open Comment:**

**You're all done! Please add anything else you want to say about this survey.** [Open text box].

**Figure 5: Conceptualization of teen driving factors malleable to teen intervention**

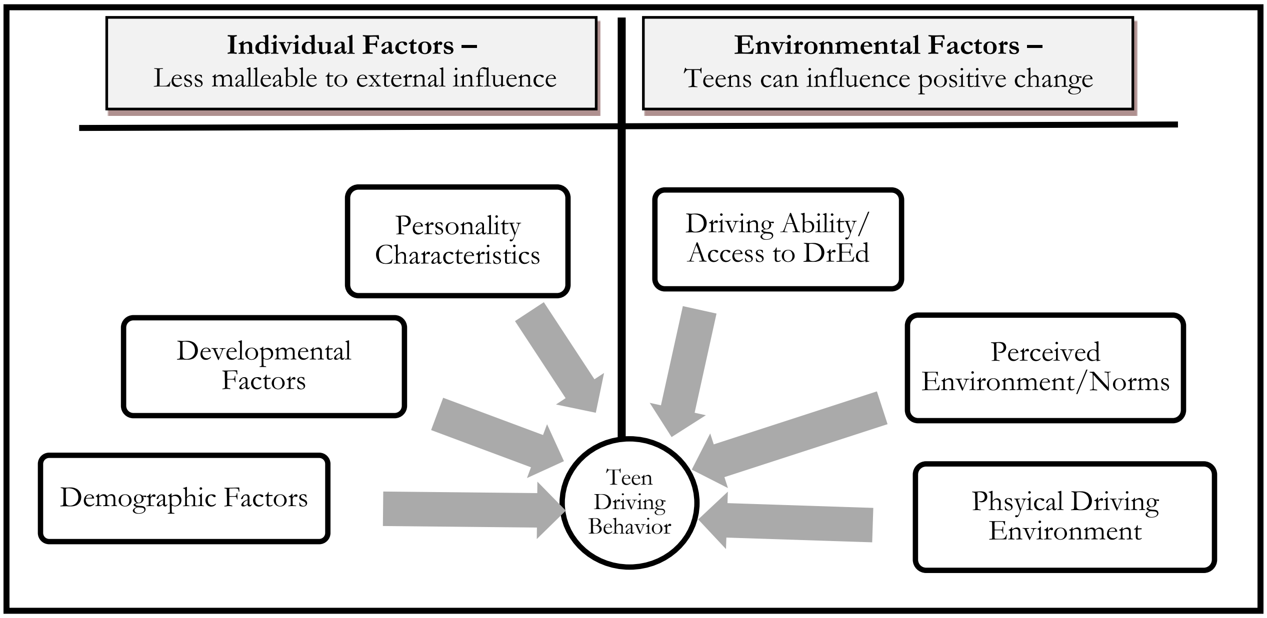

**Table 7: Common teen-led strategies for environmental change to promote highway safety**

| Change Strategy | Descriptions and Examples |
|---|---|
| **Providing Information** | Information sharing strategies including educational presentations, brochures, flyers, websites, social media, public service announcements, etc. Sharing information about issues, local data, and potential interventions. Targeted information to appropriate groups, such as for parents, teens, law enforcement, physicians, etc. |
| **Enhancing Skills** | Hands-on workshops designed to increase skills of participants such as behind the wheel training, driving simulators, hazard recovery training, coached driver training, and other hands-on skills such as inspections for proper use of seatbelts, etc. |
| **Providing Support** | Creating opportunities to help people participate in activities that reduce risk of crashes and promoting safe driving such as town halls and public meetings, regular opportunities for teens to become involved in leadership, support for people who have been in crashes, and ensuring transportation alternatives for non-drivers. |
| **Enhancing Access/ Reducing Barriers** | Improving access/reducing barriers to increase the ease, ability, and opportunity for people to access support services, such as Driver's education, parent training, safety equipment, transportation alternatives, and affordable cars with safety features, quality auto insurance, and auto maintenance. |
| **Changing Consequence** | Increasing incentives for protective factors (rewarding safe drivers, recognizing leaders, rewarding businesses for making teen safety a priority, etc. Decrease risk factors such as increasing the likelihood for peer passengers to speak up for safety. |
| **Physical Design** | Changing the physical design or structure of the environment to reduce risk or enhance protection, which includes road design, maintenance, speed bumps, lighting, development of auto safety technologies, presence of pedestrian and bike friendly routes, integration with public transit, etc. |
| **Modifying/ Changing Policies** | Formal changes in written procedures, by-laws, voting procedures, or policies guiding how families, organizations, cities, states, and countries operate. This could include family contracts with teen drivers, teen pledge cards to support peer norms, ensuring training in GDL policies for law enforcement, the court system, and teachers, and the actual modification of local, state, or national laws related to seatbelts, GDL laws, child passenger safety, road design, etc. |

**Vita**

Cynthia is a former teen leader from Nashville, Tennessee. She earned her Bachelor's of Science in Sociology in 2002 from Tennessee Technological University, her Master's of Science in Social Work from the University of Tennessee in 2008, and her Doctorate in Philosophy in 2016 from Virginia Commonwealth University School of Social Work. Cynthia has extensive experience in community-engaged intervention planning and evaluation across multiple community-level safety issues. She currently works to improve teen-led planning and evaluation in peer to peer youth safety education across the country. Cynthia has been recognized by the Tennessee Department of Safety and Homeland Security, Tennessee Highway Safety Office with the Tennessee Lifesaver Award for her work towards improving teen driver safety programs. Her interest areas include the philosophy of science, social theory, research methods, engaged research, youth leadership, social advocacy, and service learning. Cynthia also sings for the punk band Graduates Rise.