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An application of a modified theory of planned behavior model to investigate adolescents' job safety knowledge, norms, attitude and intention to enact workplace safety and health skills

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Abstract

Introduction: For many reasons, including a lack of adequate safety training and education, U.S. adolescents experience a higher rate of job-related injury compared to adult workers. Widely used social-psychological theories in public health research and practice, such as the theory of planned behavior, may provide guidance for developing and evaluating school-based interventions to prepare adolescents for workplace hazards and risks.

Method: Using a structural equation modeling approach, the current study explores whether a modified theory of planned behavior model provides insight on 1,748 eighth graders' occupational safety and health (OSH) attitude, subjective norm, self-efficacy and behavioral intention, before and after receiving instruction on a free, national young worker safety and health curriculum. Reliability estimates for the measures were produced and direct and indirect associations between knowledge and other model constructs assessed.

Results: Overall, the findings align with the theory of planned behavior. The structural equation model adequately fit the data; most path coefficients are statistically significant and knowledge has indirect effects on behavioral intention. Confirmatory factor analyses suggest that the knowledge, attitude, self-efficacy, and behavioral intention measures each reflect a unique

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Ethical approval

The NIOSH Institutional Review Board (IRB) issued a research exempt determination for this project under 45 CFR 46.101(b)(1). This research was conducted in accordance with the ethical standards of the NIOSH IRB and with the 1975 Helsinki declaration as revised in 2000.

Informed consent

The NIOSH IRB waived the documentation of informed consent because the project occurred within a regularly established educational setting, used a publically available curriculum adopted by the school district as part of established and ongoing classroom studies, presented no risk of harm to participants and involved no procedures for which written consent is normally required outside of the research context.

Disclaimer

The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health.

dimension (reliability estimates = 0.86), while the subjective norm measure did not perform adequately.

Conclusion: The findings presented provide support for using behavioral theory (specifically a modified theory of planned behavior) to investigate adolescents' knowledge, perceptions, and behavioral intention to engage in safe and healthful activities at work, an understanding of which may contribute to reducing the downstream burden of injury on this vulnerable population—the future workforce.

Practical application: Health behavior theories, commonly used in the social and behavioral sciences, have utility and provide guidance for developing and evaluating OSH interventions, including those aimed at preventing injuries and promoting the health and safety of adolescent workers in the U.S., who are injured at higher rates than are adults.

Keywords

Occupational safety and health; Young worker; Injury prevention; Theory of planned behavior; Item response theory; Structural equation modeling

1. Introduction

For adolescents in the United States, work is an important part of the transition to adulthood (Mortimer, 2010; Staff, Messersmith, & Schulenberg, 2009; Vuolo, Mortimer, & Staff, 2014). While formal, paid work has benefits for young people, it also has risks. In 2017, U.S. young workers aged 15–17 years experienced a rate of occupational injury (treated in hospital emergency departments) that was an estimated 1.4 times higher than the injury rate for adult workers (ages 25–44 years; National Institute for Occupational Safety and Health [NIOSH], 2019). The reasons for this disproportionate injury risk experienced by working adolescents are myriad, and include: heightened vulnerability to risk-taking behaviors when compared to adults (Steinberg, 2008); inexperience with work and short job tenure (Breslin, Polzer, MacEachen, Morrongiello, & Shannon, 2007b; Breslin & Smith, 2006; Frone, 1998; Tucker & Turner, 2014); and work overload and exposure to physical hazards (Breslin et al., 2007a; Frone, 1998; Mardis & Pratt, 2003; Suruda, Philips, Lillquist, & Seseck, 2003). Furthermore, a lack of high quality, work safety and health training, inadequate supervision, and safety skills, are noted contributors of the high burden of injury among this age group (Chin et al., 2010; Runyan, Dal Santo, Schulman, Lipscomb, & Harris, 2006; Zierold & Anderson, 2006; Zierold, Welsh, & McGeeney, 2012). Working in violation of child labor laws¹ has also been shown to be detrimental to the health and well-being of adolescent workers (Rauscher, Myers, & Miller, 2016; Suruda et al., 2003).

To design effective interventions that protect and promote the health and safety of all workers, including vulnerable groups such as adolescents, the use of behavioral change theories and a clear understanding of their potential application to occupational safety and

¹The Fair Labor Standards Act of 1938 (FLSA) child labor laws prohibit employment of minors in jobs and under conditions harmful to their health or well-being. These restrictions include limits on hours of work for youth under age 16 and define hazardous occupations (“hazardous orders”) for farm and non-farm jobs. Most states have enacted additional protections for adolescent workers. Information on the FLSA provisions is available from: <https://www.dol.gov/whd/regs/compliance/hrg.htm#9>.

health (OSH) research is warranted (DeJoy, 1996). This is because, broadly speaking, public health interventions based in theory are more likely to be successful than those lacking a theoretical foundation (Simons-Morton, McLeroy, & Wendel, 2012). At the individual-level, behavioral change theories, such as the theory of planned behavior (Ajzen, 1991) and its precursor, the theory of reasoned action (Fishbein & Ajzen, 1975), have been used extensively in public health research and practice to improve human health (Glanz & Bishop, 2010). Despite calls for the use of behavioral theories in OSH (DeJoy, 1996; Fogarty & Shaw, 2010), relatively few published studies apply individual level, behavior change theories to safety research generally (Fugas, Silva, & Meliá, 2012) and to OSH specifically (DeJoy, 1996). Moreover, there is currently a gap in research related to adolescents' perceptions and knowledge of workplace safety and health, which are important to take into account when designing interventions to address the high burden of work-related injury among youth, in the United States and internationally (Breslin et al., 2007a; Hanvold et al., 2018). Health behavior theories, such as the theory of planned behavior, may provide guidance for developing and evaluating school-based interventions to prepare adolescents for the hazards and risks they may face in the workplace.

The theory of planned behavior, one of the most widely-cited psychosocial theories in the social and behavioral sciences (Montaño & Kasprzyk, 2015), has been shown through meta-analyses (McEachan, Conner, Taylor, & Lawton, 2011; Topa & Moriano, 2010; Webb & Sheeran, 2006) to be predictive of a variety of health and risk-related behaviors (Montaño & Kasprzyk, 2015), including those that contribute to unintentional injury among adolescents (Buckley, Sheehan, & Shochet, 2010; Kroshus, Baugh, Daneshvar, & Viswanath, 2014). Although the theory of planned behavior has been used in occupational safety and health (OSH) research related to adults (e.g., Brosseau & Li, 2005; Fogarty & Shaw, 2010; Fugas et al., 2012; Prussia, Willis, & Rao, 2019), its use to investigate adolescents' perceptions and actions related to workplace safety and health is limited (Guerin, Toland, Okun, Rojas-Guyler, & Bernard, 2018; Guerin et al., 2019). Thus, little is currently known about how or whether the theory has utility in this population for examining behavioral beliefs and attitudes related to OSH.

2. Theory of planned behavior

The theory of planned behavior reflects an expectancy-value approach, whereby health actions result from a complex, decision-making process (Gibbons, Kingsbury, & Gerrard, 2012). In the context of adolescent health and safety research, the underlying assumption of expectancy-value theories is that decisions derive from young people's expectations about the outcomes of a particular behavior (Johnson, 2002). According to Ajzen's theory, factors that may influence the cognitive-affective processes associated with these decisions include: (1) attitude toward the behavior, as determined by "behavioral beliefs" about outcomes of engaging in an action, and the positive/negative evaluations of these outcomes; (2) subjective norms, determined by a person's "normative beliefs" about whether important people (such as friends, parents, teachers, co-workers) approve or disapprove of a particular behavior, and the person's willingness to comply with other important people's appraisals of the behavior; and (3) perceived behavioral control, the perceived ease or difficulty of engaging in an action/activity (Ajzen, 1991; Montaño & Kasprzyk, 2015). These factors in combination

influence a person's intention to engage in a behavior, which the theory posits as a proximal predictor of actual behavior (Ajzen, 1991; Gibbons et al., 2012; Montaña & Kasprzyk, 2015).

According to the theory of planned behavior, attitude has demonstrated to be a strong predictor of adolescent behaviors (Buckley et al., 2010; Kroshus et al., 2014). However, there is a dearth of evidence related to how adolescents' attitude related to workplace safety influences their decision-making.

The subjective norms construct has been found to be the weakest predictor in the theory of planned behavior model (Armitage & Conner, 2001). However, adolescents' behavior is affected by what their peers think or do and are the source for adopting personal beliefs about shared social expectations (Gibbons et al., 2012). Thus, subjective norms among adolescents, when peer influences are especially salient, may be an important behavioral influence. For example, research from Cestac, Paran, and Delhomme (2011) suggests that subjective norms influence beginning drivers' risk-taking on the road. Park, Klein, Smith, and Martell (2009) found that subjective norms were the strongest predictor of intention (to engage in risky drinking behaviors among college-aged youth). However, there is limited evidence related to how adolescents' perceived workplace safety and health norms may potentially predict their actions and activities, especially among adolescents who are not yet integrated into the formal labor force.

Self-efficacy, often considered as synonymous with perceived behavioral control (Fishbein & Azjen, 2010; Montaña & Kasprzyk, 2015), is the confidence in one's ability to take action and successfully execute the behavior required to produce the desired outcomes (Bandura, 1997). Self-efficacy is frequently one of the most significant predictors of both intention and behavior (Armitage & Conner, 2001), according to the theory of planned behavior. Moreover, a substantial evidence base suggests the role of self-efficacy in mitigating adolescent health risk behaviors (see for e.g., Kroshus et al., 2014; Malmberg et al., 2012). This evidence provides a useful corollary for investigating young workers' risk activities. In adolescent health research, self-efficacy is important to shaping behavioral intention (Johnson, 2002), and evidence suggests that behavioral intention may be the most important determinant of variation in health behavior among this population (McEachan et al., 2011; Webb & Sheeran, 2006).

Prior research supports the value of designing interventions to target intention as a means to change behavior (Conner, 2015). Behavioral intention has also been indicated as an important predictor of health behavior among young people, including related to prevention of unintentional injuries (Kroshus et al., 2014) and risky driving behaviors (Lee, Geiger-Brown, & Beck, 2016), among others. The current research seeks to explore behavioral intention as a proximal indicator that may predict future work safety-related action among adolescents, once they enter the formal labor force.

In addition, knowledge may be viewed as an influential variable with both direct and indirect effects on behavioral outcomes (Guerin et al., 2018; Kaiser & Fuhrer, 2003). Knowledge and skill are required to successfully perform health enhancing actions (Montaña & Kasprzyk,

2015), including in the workplace (Neal, Griffin, & Hart, 2000), and by young workers (Westaby & Lee, 2003). Limited evidence suggests that occupational safety and health knowledge may be increased among adolescents through school- and community-based educational programs (Linker, Miller, Freeman, & Burbacher, 2005; Rohlman, Parish, Elliot, Hanson, & Perrin, 2016). Adolescents' knowledge of occupational safety and health alone, however, cannot be assumed to lead to safer, work-related behaviors and job injury reductions (Pisaniello et al., 2013), and should be considered in the context of other salient cognitive-affective processes. In summary, a modified theory of planned behavior that investigates (direct and indirect) relationships between knowledge and other model constructs could potentially be a useful framework for gaining insight on adolescents' perceptions and intentions related to workplace safety and health behaviors.

The primary study aim was therefore to explore the utility of the theory of planned behavior for examining knowledge, attitude, self-efficacy, subjective norm and behavioral intention related to OSH among a sample of adolescents in a large, urban school district who received instruction in their eighth grade science classes on a free, foundational curriculum in workplace safety and health, *Youth@Work-Talking Safety* (NIOSH, 2018). A secondary aim was to investigate the psychometric properties of the measures developed for the current study based on theory of planned behavior constructs.

3. Study hypotheses and anticipated model linkages

In the present study, based on the theory of planned behavior model modified to include a knowledge construct, we hypothesized that: (1) the theory of planned behavior model, that included a knowledge measure as an antecedent to attitude, subjective norm, self-efficacy and behavioral intention, would demonstrate adequate fit to the sample data; (2) each of the pretest variables/- constructs would predict their respective variable at posttest (e.g., pretest attitude would predict posttest attitude); (3) at both pretest and posttest, OSH attitude, subjective norm, and self-efficacy would positively predict behavioral intention to enact workplace safety and health skills; and (4) OSH knowledge would have a positive, indirect effect on behavioral intention.

4. Method

4.1. Participants

Study participants included eighth grade students ($N = 1,748$, aged 12–13 years) attending one of 131 classes taught by 42 eighth-grade science teachers, across 33 middle schools in a large, U.S. school district in the Southeastern United States. Approximately 54% of students in the sample self-reported their sex as female, while approximately 69% of respondents self-identified their ethnicity as Hispanic. For race (more than one category could be selected), 65% self-identified as White, 24% as Black, 5% American Indian/Alaska Native, 5% Native Hawaiian/other Pacific Islander, and 4% Asian. Approximately a third of students in the sample ($n = 494$) indicated having worked for pay. In the sample, and consistent with the district average, the mean percentage of students within study schools receiving free and reduced-price lunch was 68% (range 6% to 97%). (Note that intervention

effectiveness and implementation outcomes related to teacher and student demographics are reported elsewhere; Guerin et al., 2019).

4.2. Measures

Our study used novel measures (developed by the research team) of students' workplace safety and health attitude, subjective norm, self-efficacy, and behavioral intention to enact job safety skills, and knowledge of safety concepts, before and after receiving the *Youth@Work-Talking Safety* curriculum intervention (NIOSH, 2018).

4.3. Knowledge

To measure students' occupational safety and health (OSH) knowledge, we used 14, multiple-choice items, developed and psychometrically tested previously under a rigorous process (Guerin, Okun, & Kelley, 2016). The *Talking Safety* test includes items that assess fact-based and applied learning gained through the NIOSH *Talking Safety* curriculum, as it relates to essential workplace safety and health concepts (such as how to recognize hazards in the work environment). The sample internal consistency of reliability (coefficient ω) estimate was $\omega_{\text{pre}} = 0.85$ and $\omega_{\text{post}} = 0.92$.

4.4. Attitude

To assess OSH attitude at pretest and posttest, participants indicated their perceived importance of performing specific workplace safety skills (e.g., *How important do you feel it is to understand workers' rights for workplace safety?*). Attitude was measured on eight items using a 5-point Likert-type response format ranging from 1 (*not important at all*) to 5 (*extremely important*). The sample internal consistency of reliability estimate was $\omega_{\text{pre}} = 0.91$ and $\omega_{\text{post}} = 0.94$.

4.5. Subjective norm

To investigate participants' subjective norm, students indicated their perceived importance of workplace safety to others, including friends and parents (1 = *not important at all*, 5 = *extremely important*). The internal consistency of reliability estimate for this measure was not be estimated because factor analyses failed to provide evidence to support a single structure/dimension for the items within the measure.

4.6. Self-efficacy

To measure self-efficacy at pretest and posttest, students indicated their perceived certainty/confidence in their ability to successfully perform eight specific job safety skills (e.g., *How confident are you that you could report safety concerns to people in charge?*). Items were measured using a 5-point Likert-type response format ranging from 1 (*not confident at all*) to 5 (*extremely confident*). The sample internal consistency of reliability estimate was $\omega_{\text{pre}} = 0.91$ and $\omega_{\text{post}} = 0.94$.

4.7. Behavioral intention

To assess behavioral intention at pretest and posttest, students indicated their perceived likelihood to perform eight specific workplace safety skills (e.g., *How likely is it that*

you will detect hazards that could injure workers?). Items were measured with a 5-point Likert-type response format ranging from 1 (*not likely at all*) to 5 (*extremely likely*). The sample internal consistency of reliability estimate was $\omega_{\text{pre}} = 0.90$ and $\omega_{\text{post}} = 0.94$.

4.8. Procedure

District administrators adopted the *Talking Safety* curriculum in 2014 and implemented it in eighth-grade science classes. *Talking Safety* provides middle and high school students a foundation of essential work safety and health concepts (core competencies) that are relevant to all jobs and industries (Guerin et al., 2016). These competencies pertain to: understanding the risk of work-related injury; recognizing risk and hazard control in the workplace; identifying employer responsibilities and worker rights and roles; taking action in a work-related emergency; and communicating with others, including bosses and supervisors, when feeling unsafe or under threat (Okun et al., 2016). During this time, the curriculum was also tailored (in collaboration with teachers and administrators from the district) to be delivered in four, 55-minute blocks (versus six, 45-minute sessions). No core content was removed from this adapted curriculum version, but some lessons were condensed to fit into the allotted time. In spring 2015 and 2016, the research team was invited by the district to train eighth grade science teachers on the curriculum during a mandatory professional development day. A total of 94 eighth grade science teachers attended one of the four-hour training sessions, and 42 teachers agreed to participate in the evaluation study in 2016, the second year of the study. All students in the classrooms of study teachers received a pretest, instruction on the *Talking Safety* curriculum, and a posttest during six class periods over three weeks at the end of the 2015–2016 academic year. Teacher participants collected the tests, which were administered in paper and pencil using customized bubble sheets. A district administrator scanned the forms, linking pretests and posttests with a unique identifier (tied to student identification numbers), and shared the deidentified student data with the research team.

5. Data analyses

Although data are nested (students within teachers), the current research questions do not pertain to the cluster (i.e., teacher, classroom, or school) level. Thus, based on recommendations from Stapleton, McNeish, and Yang (2016), we addressed the violation of the assumption of independence of multilevel regression analysis by using cluster-robust standard errors—also referred to as a design-based approach—as implemented in *Mplus* 8.2. Prior to addressing the primary research hypotheses, we first examined the internal structure (dimensionality) of each instrument using confirmatory factor analysis (CFA) at both pretest and posttest. Next, item response theory (IRT) analyses were used to further inspect the item and total measure level performance of each measure. We then examined the adequacy of a combined measurement model for all pretest and posttest measures using structural equation modeling (SEM, Anderson & Gerbing, 1988; Williams, Vandenberg, & Edwards, 2009), which is a common approach for investigating the mediated relationships implied by the theory of planned behavior model, including in safety-related research (see for example, Prussia et al., 2019). All CFAs and the final SEM were estimated with the weighted least squares with mean and variance correction (WLSMV) estimator because it: (1) appropriately

accounts for the categorical nature of the item response data; (2) provides an exact fit test and approximate fit indices (AFIs); and (3) the amount of item level missing data was minimal (1% to 4%). Latent variable scaling and identification were accomplished by fixing the first indicator on each latent variable to 1.0 and freely estimating the latent variable variances (Kline, 2016). CFAs and the final SEM were assessed for exact fit with the χ^2 and approximate fit with the standardized root mean square residual (SRMR) according to the guidelines from Asparouhov and Muthén (2018). Specifically, exact fit was determined with a non-significant ($p > 0.05$) χ^2 value. Otherwise, approximate fit was concluded if SRMR 0.08 and absolute standardized residual correlations were small (i.e., there are no large residuals). According to Kline (2016), small absolute residual correlations may be defined as <0.10 . In addition, we report the root mean square error of approximation (RMSEA) and its associated 90% confidence interval, comparative fit index (CFI), and Tucker-Lewis Index (TLI), which have the following fit criteria and benchmarks for continuous indicators: for good fit, RMSEA 0.06, CFI 0.95, TLI 0.95; and for acceptable fit, RMSEA 0.10, CFI 0.90, TLI 0.90 (Weston & Gore, 2006). It should be noted, however, that no universal guidelines or cutoff values are available for the above-mentioned AFIs when categorical indicators are used. For the IRT analyses, we fit Samejima (1969) graded-response (GR) model to each of the modified theory of planned behavior measures. The GR model is a common approach for handling Likert-type item responses (Toland, 2014). Broadly speaking, the major benefits of IRT (when assumptions are tenable; Lord & Novick, 1968) over classical test theory (CTT) include the ability to: treat the relationship between item response behavior and the underlying latent trait as nonlinear; better estimate latent variable correlations; calculate more precise scoring (De Ayala, 2009; Embretson & Reise, 2000; Toland, 2014).

Because no item fit statistics are available in *Mplus* for IRT applications, the fit of the GR model to each item was assessed by visually inspecting item-fit plots estimated in MODFIT version 3.0 (Stark, 2008). Specifically, we used a cross-validation sampling approach proposed by Drasgow, Levine, Tsien, Williams, and Mead (1995) to evaluate fit (i.e., a visual inspection of the alignment between the empirical functions, based on posttest data and the predicted functions, based on pretest data). A close correspondence between the predicted and empirical functions indicates acceptable fit. In addition, the quality of the item parameters and information curves were assessed for usefulness of the response categories and precision of the measure across the range of the latent trait (knowledge, attitude, subjective norm, self-efficacy, and behavioral intention) being assessed.

6. Results

6.1. CFA results for the TPB measures and the workplace safety knowledge test

Table 1 provides the CFA one-factor model results for the remaining pretest and posttest measures.

Results indicate that each model has approximate fit to the data for each of the 8-item importance, self-efficacy, and behavioral intention scales, and the 14-item knowledge measure at both pretest and posttest. Absolute residual correlations for all measures at both pretest and posttest are close to zero (<0.10 as recommended by Kline [2016]), except

for a few item pairs that had absolute residual correlations between .11 and .15, indicating reasonable local fit. Furthermore, all standardized pattern loadings are positive, statistically significant, and ranged from .66 to .85 for self-report measures at both pretest and posttest, whereas the knowledge test standardized pattern loadings range from .33 to .70 at pretest and .41 to .81 at posttest. In general, all measures at pretest and posttest are sufficiently unidimensional.

Also, a CFA including all pre and post measures was fit to the data (i.e., a combined measurement model). Results indicate the model has approximate fit to the data, $\chi^2(2,746) = 3,227.621, p < .001, p < .001, SRMR = .038, RMSEA = .010, 90\% \text{ CI } [0.008, .011], CFI = .987, TLI = .986$. In addition, local fit was deemed reasonable based on an inspection of absolute residual and modification indices.

6.2. IRT results for the TPB measures and the workplace safety knowledge test

IRT results were consistent with CFA findings, but provided a more in-depth look at the quality of each item and scale level properties. Based on these results, we determined that the GR model had acceptable fit to each item within each respective scale. Thus, evidence was provided to support the use of each measure (with the exception of the subjective norm measure, which did not perform adequately to be included in the final model) within the SEM analyses used to address the primary aim of this study. Detailed IRT results are provided in Appendix A.

6.3. Testing the theory of planned behavior model

SEM results demonstrate the modified theory of planned behavior model had approximate fit to the sample data, $\chi^2(2,760) = 3329.59, RMSEA = .011, 90\% \text{ CI } [.009, .012], CFI = .984, TLI = .984, SRMR = .040$, which is consistent with hypothesis one. In general, all direct paths are statistically significant ($p < .001$) and positive, but posttest attitude onto posttest behavioral intention is not significant. At pretest (posttest in parentheses), the model explains 40% (50%), 23% (41%), and 82% (84%) of the latent variable variance in perceived attitude, self-efficacy, and behavioral intention to enact workplace safety and health skills learned through the *Talking Safety* curriculum, and 47% of the variance in posttest knowledge. Fig. 1 displays the standardized path coefficients and R^2 estimates for the latent variables included in the final model. These results are consistent with hypothesis two, except for the posttest attitude onto posttest behavioral intention path, which is not statistically significant.

6.4. Indirect effects

Tests for indirect effects of knowledge to behavioral intention at pretest and posttest suggest that the total effect of knowledge on intention is significant at pretest ($b = 0.91, p < .001, \beta = .48$) and posttest ($b = 0.45, p < 0.001, \beta = .28$). A statistically significant indirect effect for knowledge to intention through attitude at pretest is evident, $b = 0.23, p < .01, \beta = .12$, but no significant indirect effect is found at posttest for the indirect path of knowledge to intention through attitude, $b = 0.02, p = .461, \beta = .01$. A significant indirect effect is also found for knowledge to intention by way of self-efficacy at pretest, b (unstandardized) =

0.68, $p < .001$, β (standardized) = .36, and posttest, $b = 0.43$, $p < .001$ $\beta = .27$. Thus, results are consistent with hypothesis three.

7. Discussion

The primary study aim was to explore the utility of the theory of planned behavior (Ajzen, 1991) for examining eighth grade adolescents' knowledge, attitude, self-efficacy, subjective norm and behavioral intention related to OSH after receiving instruction in their eighth-grade science classes on a U.S., young worker curriculum, *Youth@Work–Talking Safety*. A secondary aim was to investigate the psychometric properties of the measures developed for the current study based on theory of planned behavior constructs. Overall, the present study supports findings from previous research (Guerin et al., 2018) and our direct model supports linkages specified by the theory of planned behavior model, with the exception of the posttest attitude onto posttest behavioral intention path, which was not significant.

The model used in this study explains a higher proportion of variance than did other adolescent health research that uses the theory of planned behavior (see for example, Kroshus et al., 2014). Moreover, results from the indirect effect analyses are consistent with limited research that suggests that knowledge may be a predictor of behavioral intention, mediated by other variables (Guerin et al., 2018; Kaiser & Fuhrer, 2003; Kroshus et al., 2014). Overall, except for the subjective norms measure, CFAs demonstrate that pretest and posttest measures each have three, unique dimensions that reflect the theory, with the knowledge measure consisting of a separate factor. Good reliability (ω) for these measures is suggested by pretest and posttest estimates that are .86. IRT results also demonstrate the three modified theory of planned behavior measures, attitude, self-efficacy, and behavioral intention enact workplace safety and health skills, have adequate reliability. Although, the knowledge measure does not sufficiently assess higher performers on the test, it provides future directions for research in terms of designing tailored items that access the full-range of test-takers' abilities. The present study addresses the gap in research related to U.S. adolescents' perceptions of workplace safety and health, but lessons learned through this research may be applicable to international contexts when designing interventions to address the high burden of work-related injury among youth (Breslin et al., 2007a; CDC, 2010; Hanvold et al., 2018).

For young people, the school-to-work transition is a critical stage in the life course that is influenced by numerous social-ecological factors, including economic and policy conditions, structural and environmental facilitators and constraints, and individual-level determinants such as gender, race, ethnicity, socioeconomic status, and personal motivation and aspirations (Schoon & Silbereisen, 2009; Vuolo et al., 2014). In terms of macro forces, with the rise of globalization, technological innovation, and automation, the nature and organization of work is changing rapidly. The historic "tripartite division of the life course" in the United States (and in other industrialized nations) of prework (education), career, and retirement, is outmoded (Mortimer, 2009). Whether engaged in formal or informal work, part-time or full-time employment, young workers just entering the formal labor force can expect to change jobs and employers many times during their working lives (Staff et al., 2009). These shifts will result in an increased likelihood of encountering new workplace risk

scenarios, requiring the ongoing application of foundational OSH competencies (Schulte, Stephenson, Okun, Palassis, & Biddle, 2005), such as those promoted through the current study. More broadly, the competencies described previously could be applied to other health-related circumstances where risk-based decisions are made and used to improve people's health, safety and well-being within multiple, societal contexts (Cammarota, 2011; Okun et al., 2016). While the primary study aim was to explore the utility of the theory of planned behavior for examining eighth grade adolescents' knowledge, attitude, self-efficacy, subjective norm and behavioral intention related to OSH through a school-based, curriculum intervention, the theory could also be used to evaluate the application and utility of the competencies through other interventions and community-based programs.

Limitations of the current research are important to note. First, the subjective norm measure developed for this study was removed from the analysis because of a lack of evidence for the internal structure of the measure. It is possible that students in the sample are too young, at age 12 to 13 years, to develop normative beliefs on the topic of workplace safety and health. Limited evidence exists on this topic, but one example is available from Pek, Turner, Tucker, Kelloway, and Morrish (2017). The authors examined injunctive norms—which are closely related to and often included as a component of subjective norms (Armitage & Conner, 2001)—in a large sample of Canadian young workers ($N = 11,986$; $M_{age} = 17.90$). Their results suggest that study participants' injunctive safety norms—perceptions of parents', supervisors', and coworkers' expectations of safety-related conduct—were related to fewer workplace injuries via less frequent work-related risk-taking behaviors. In addition, safety norms from supervisors and siblings were directly associated with fewer workplace injuries. Moreover, injunctive safety norms among friends were associated with more frequent work-related risk-taking and work injuries via more work-related risk-taking (Pek et al., 2017). Future research is needed to shed light on how and if a subjective norm measure is appropriate for younger workers (aged 12–13 years). In general, more formative work, as suggested by Ajzen (2006) and Montañó and Kasprzyk (2015), should elicit an understanding of who the relevant normative referents are for working adolescents.

Another limitation of the current research is that behavioral outcomes could not be assessed. Yet, prior research supports the value of designing interventions to target intention—as was the case with the current study—as a means to influence future behavior (Webb & Sheeran, 2006). It has been noted by other researchers that objective measures of behavior for young workers in a real-world setting are rare, which may be why research evaluations often assess behavioral intention, or self-reported safety behaviors (Smith, Purewal, Macpherson, & Pike, 2018). These self-report measures provide valuable information about the impact of interventions related to occupational safety and health education, but they do not establish a direct link to reducing job-related injuries (Smith et al., 2018). Future research, including longitudinal studies, are needed to understand how adolescents apply their learning from *Talking Safety* in their workplaces and to investigate how changing adolescents' knowledge, attitude about, self-efficacy, and intention to enact occupational safety and health skills will lead to distal reductions in work injuries among this high-risk group. Research from France is instructive in this respect. Boini and colleagues report that students who received occupational safety and health education while in school reported two times fewer

workplace injuries than those who did not get this preparation (Boini, Colin, & Grzebyk, 2017).

Discussed in previous research (Collins & Carey, 2007) a limitation of the present study is the inclusion of a single, self-efficacy factor for the perceived behavioral control construct (that did not separately capture the dimensions of perceived behavioral control and controllability beliefs). Moreover, in the current study, attitude is also assessed as a direct measure, and therefore does not examine other dimensions of the construct, a limitation of studies that analyze the psychometric properties of theory of planned behavior measures developed for and used with youth (Davison, McLaughlin, & Giles, 2017). Finally, even though the measures were developed iteratively and collaboratively with stakeholders, more work is needed to adapt the measures to target communities (Montaño & Kasprzyk, 2015).

Finally, it bears noting that the theory of planned behavior has proven effective at predicting “rational” health promoting behavior among adults, but that it may be less effective when applied to health risk behavior, especially among adolescents (Albert & Steinberg, 2011; Webb & Sheeran, 2006). Teens have less experience with different kinds of health-enhancing and risk-taking activities, including in the workplace, and the consequences (such as a job-related injury) of these behaviors. Thus, young people’s health-risk behavior is often the result of a “decision-making process that is abbreviated and based as much on heuristics as on conscious deliberation” (Gibbons et al., 2012, p. 175).

With respect to the knowledge measure, future work should be focused on writing more difficult items. For example, most items were easy for students to endorse, with the exception of item 9, which was related to the content of safety data sheets (SDSs) which is a more complex, technical topic that may have required students to possess prior exposure to this content. Additional psychometric analyses of all study measures are also needed to test for measurement invariance—whether items have the same meanings for members of different groups (e.g., those who work vs. those who do not, sex, race, ethnicity)—using both confirmatory factor analysis (e.g., Cheung & Rensvold, 2002) and item response theory techniques, such as differential item functioning (Osterlind & Everson, 2009). Importantly, a multilevel perspective (Zohar & Luria, 2005), in which individual actions are considered within a context of organizational, community, and regulatory dimensions, is needed when designing young worker interventions (Okun et al., 2016). Given the interplay between individual and organizational factors in the workplace, and the numerous vulnerabilities of young workers such as their inexperience and lack of job control (Breslin et al., 2007b; Tucker and Turner, 2014), even well-designed interventions to influence hazard-related beliefs and actions are likely to be unsuccessful if the environment (which includes management and safety culture) is not supportive (Beus, Payne, Bergman, & Arthur, 2010; DeJoy, 1996; Zohar & Luria, 2005).

8. Conclusions

In the United States, workforce participation for adolescents is common. Over the past several decades, OSH researchers have established a compelling evidence base related to the enduring problem of work-related injuries experienced by U.S. teens. Workplace

injuries are needless, tragic, and can often be predicted and prevented. Schools may be an important setting for preparing youth for entry into the labor force by providing foundational, workplace safety and health education. Health behavior theories, such as the theory of planned behavior, may provide guidance for developing and evaluating school-based interventions, such as the foundational curriculum in workplace safety and health from NIOSH and its partners, *Youth@Work-Talking Safety* (NIOSH, 2018), to prepare adolescents for the potential hazards and risks they will encounter in the workplace.

This paper presents results of research that suggest that a modified theory of planned behavior that assesses direct and indirect relationships between knowledge and other model constructs has utility as a framework for gaining insight on eighth graders' perceptions and intentions related to workplace safety and health behaviors. The findings presented contribute to safety research because they provide support for using behavioral theory to investigate adolescents' knowledge, perceptions and behavioral intention to engage in safe and healthful activities at work.

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Appendix A

Model-data fit assessment.

Visual inspection of the fit plots suggests a close correspondence between the predicted (using the preassessment data) and empirical (using the post-assessment data) response functions for all items across the modified theory of planned behavior self-report measures and the work safety knowledge test.

Item properties and standard error of precision functions.

Tables A1 provides the item parameter estimates for the GR model fit to each self-report measure (knowledge, attitude, self-efficacy, behavioral intention) at pretest. An inspection of the GR model results indicate item discrimination parameters for the self-report, pretest measures ranging from 1.61 to 2.29 on attitude, 1.66 to 2.29 on self-efficacy, and 1.84 to 2.17 on behavioral intention, which indicates all items have reasonable discrimination values (with a reasonably "good" range being 0.7 to 3.0, Baker, 2001; De Ayala, 2009; Hambleton et al., 1991; Toland, 2014). Across all self-report measures, the lowest threshold to highest threshold ranged from -2.63 to 0.88, respectively. Although thresholds within the GR model

are not a reflection of a category location such as in other dichotomous IRT models, they do give a sense of how well categories cover the latent trait continuum (a reasonable range for thresholds is from -3.0 to 3.0 , which assumes the intention to measure a wide range of the continuum). This suggests the self-report items in general are easy to moderately difficult to endorse, and respondents are not choosing the middle to upper categories with high frequency.

The bottom portion of Table A1 provides the item parameter estimates for the GR model fit to each knowledge item at preassessment. Of note, when a dichotomous item is fit by the GR model, this model simplifies to the two-parameter logit (2PL) model. Discrimination parameters range from 0.63 to 1.64 , suggesting that a common item slope is not appropriate for the set of items. This can be interpreted as items having different relationship strength to the latent construct. An inspection of the item thresholds (difficulty) suggests all items are easy to endorse, given that their difficulty values were all below the average location (zero, which is similar to a z-score), -1.48 to -0.14 . The only exception was item 9 (*A safety data sheet tells you _____*), which had a difficulty value of 1.02 . Overall, these results suggest items on the *Talking Safety* knowledge test require less than average knowledge to answer the questions correctly.

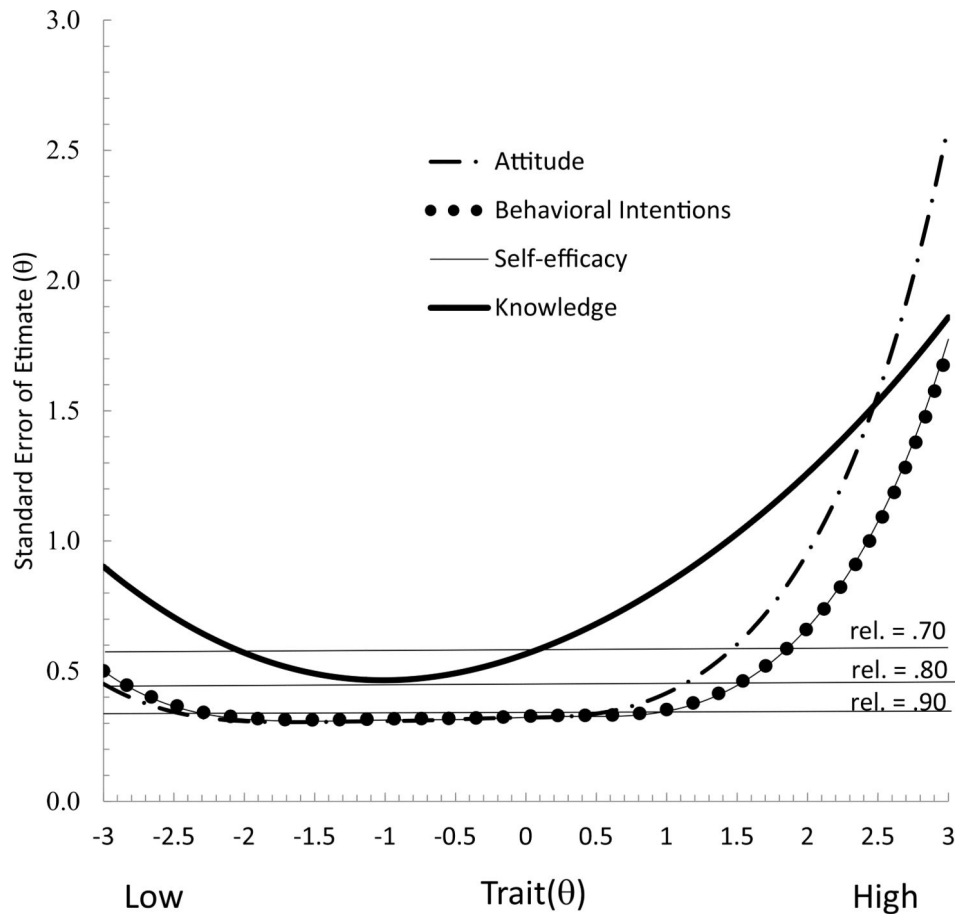
Table A1

Graded response model results by measure.

Item	Discrimination	Threshold 1	Threshold 2	Threshold 3	Threshold 4
ATT1	1.61	-2.63	-1.99	-1.27	-0.25
ATT2	1.94	-2.38	-1.66	-0.62	0.66
ATT3	2.10	-2.33	-1.57	-0.75	0.34
ATT4	2.42	-2.15	-1.53	-0.84	0.19
ATT5	2.21	-2.18	-1.62	-0.78	0.37
ATT6	2.06	-2.21	-1.55	-0.56	0.48
ATT7	2.29	-2.16	-1.45	-0.62	0.49
ATT8	2.12	-2.16	-1.51	-0.67	0.38
SE1	1.66	-2.30	-1.55	-0.53	0.50
SE2	1.97	-2.22	-1.44	-0.40	0.84
SE3	2.23	-2.16	-1.33	-0.35	0.80
SE4	2.29	-2.03	-1.30	-0.43	0.73
SE5	2.16	-2.07	-1.32	-0.44	0.67
SE6	2.16	-2.19	-1.40	-0.38	0.69
SE7	2.18	-2.04	-1.29	-0.38	0.79
SE8	2.00	-2.04	-1.35	-0.51	0.53
BI1	1.84	-2.16	-1.43	-0.53	0.57
BI2	2.10	-2.08	-1.40	-0.42	0.80
BI3	2.15	-2.08	-1.36	-0.39	0.88
BI4	2.17	-2.06	-1.32	-0.35	0.84
BI5	2.17	-2.02	-1.31	-0.44	0.70

Item	Discrimination	Threshold 1	Threshold 2	Threshold 3	Threshold 4
BI6	2.00	-2.19	-1.41	-0.43	0.76
BI7	2.00	-2.05	-1.34	-0.33	0.86
BI8	1.94	-2.22	-1.40	-0.50	0.53
KNOW1	0.73	-0.91			
KNOW2	0.64	-1.48			
KNOW3	1.27	-1.04			
KNOW4	0.92	-0.93			
KNOW5	1.10	-0.49			
KNOW6	0.92	-0.14			
KNOW7	1.62	-1.02			
KNOW8	1.42	-1.28			
KNOW9	0.62	1.02			
KNOW10	1.17	-0.82			
KNOW11	1.17	-0.95			
KNOW12	1.63	-1.06			
KNOW13	1.64	-1.07			
KNOW14	0.63	-0.76			

Note. ATT = attitude; SE = self-efficacy; BI = behavioral intention; KNOW = knowledge. IRT analyses used a logit link function.



v

Figure A1.

Standard error of estimate (SEE) functions for the Attitude, Behavioral Intention, Self-efficacy, and Knowledge measures fit by the graded response model. Rel. = marginal reliability for selected levels. Of note, the SEE functions for self-efficacy and behavioral intention are nearly identical.

In addition, the total standard error of estimate (SEE) functions for each self-report measure and the knowledge test are provided in Figure A1.

SEE can be thought of as akin to standard error of measurement from a classical test theory (CTT) perspective. However, the SEE in the IRT context is conditional on the latent trait location and not assumed constant as in CTT. Figure 1 shows the SEE as a function of trait location for the three, modified theory of planned behavior self-report measures and knowledge test. To aid in the interpretation of the SEE, we identified selected reliability levels (as often used in CTT). An inspection of Figure A1 indicates reliability is about 0.90 on the trait continuum between about -2.5 and 1.0 for the three, self-report measures. As

for the Knowledge test, reliability ranges between approximately 0.70 and 0.80 on the trait continuum (−2.0 to 0.0), but reliability falls below 0.70 when moving outside this range.

Biography

Rebecca J. Guerin, is a Research Social Scientist with the National Institute for Occupational Safety and Health (NIOSH), part of the Centers for Disease Control and Prevention (CDC). Dr. Guerin serves as the program coordinator for the NIOSH Safe-Skilled-Ready Workforce (SSRW) program. Her major research interests include young worker safety and health, adolescent health, health promotion and education, curriculum and training design and evaluation, dissemination and implementation science, and quantitative research and analytical methods.

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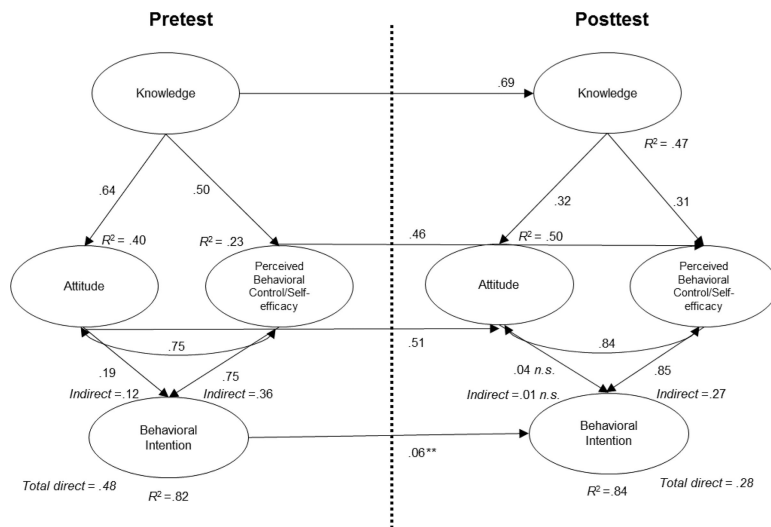


Fig. 1. Standardized structural equation modeling results for proposed modified theory of planned behavior model for adolescents' ($N = 1,748$) workplace safety and health knowledge, attitude, self-efficacy and behavioral intention. R^2 = explained variability in latent outcome variable. Unless noted (n.s. = not significant; ** = significant at $p < 0.01$) all paths are statistically significant at $p < 0.001$.

Chi-Square and Approximate Fit Indices for Confirmatory Factor Analyses fit to Measures of Workplace Safety and Health Knowledge, Perceptions, and Behavioral Intention at Pretest and Posttest in a sample of Adolescents (N = 1,748).

Table 1

Measure	χ^2	df	SRMR	CFI	TLI	RMSEA	RMSEA 90% CI
Pre-ATT	120.188	20	.020	.985	.978	.054	[.045, .063]
Post-ATT	95.867	20	.014	.988	.983	.047	[.038, .057]
Pre-SE	79.120	20	.015	.994	.992	.041	[.032, .051]
Post-SE	91.440	20	.011	.988	.984	.046	[.036, .055]
Pre-BI	133.200	20	.018	.988	.984	.057	[.048, .067]
Post-BI	114.380	20	.013	.983	.976	.052	[.043, .062]
Pre-KNOW	166.270	77	.048	.953	.954	.026	[.020, .031]
Post-KNOW	134.300	77	.043	.976	.972	.021	[.015, .026]

Note. Measures of adolescents' pretest and posttest attitude, self-efficacy and behavioral intention related to workplace safety and health. Pre = pretest; Post = posttest; ATT = attitude; SE = self-efficacy; BI = behavioral intentions; KNOW = knowledge. WLSMV = weighted least squares with mean and variance correction estimation; SRMR = standardized root mean square residual; CFI = comparative fit index; TLI = Tucker-Lewis index of incremental fit; RMSEA = root mean square error of approximation. All models were statistically significant ($p < .001$).