

Evaluation of toolbox safety training in construction: The impact of narratives

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Abstract

Background: Construction is a dangerous industry with a large number of small businesses. Because they require minimal resources to deliver, toolbox talks may be an ideal training format for small construction contractors.

Methods: Eight toolbox talks were developed, each with two versions. One version of each toolbox talk was standard and one version included a narrative and discussion questions.

Keywords

construction; knowledge gain; narratives; safety climate; toolbox talks

1 | INTRODUCTION

Construction is one of the most dangerous industry sectors in terms of mortalities and morbidities. In 2015, roughly 9 million workers were employed in construction in the United States, representing 6% of the total workforce.¹ There were more fatal injuries in construction than any other industry in the United States, accounting for 19% of the 4836 work-related deaths that year.² The rate of injuries requiring days away from work in the construction industry was 134.8 injuries per 10 000 FTEs in 2015, a rate higher than all private industries combined (93.9 injuries per 10 000 FTEs).³

From an occupational safety and health (OSH) perspective, one of the most prominent characteristics of the construction industry is the large number of contractors involved in nearly any project. Most of these contractors are very small enterprises. It is estimated that approximately 90% of construction contractors employ 20 or fewer workers.⁴ Smaller construction firms experience higher rates of fatal injuries than larger firms.⁵ For example, in 2010, 56.3% of construction deaths occurred in establishments with fewer than 20 employees, yet such establishments employed just 41.4% of the construction workforce.⁵ Among the challenges to meeting the OSH needs of small businesses is that they typically have very limited resources to apply to OSH training needs.⁶ There are often no dedicated safety staff in these firms, rather it is among the several “hats” worn by the owner, who is often also the office manager, a field supervisor, and works alongside employees on projects. Because they require minimal resources and no professional training to deliver, *toolbox talks* may provide an ideal OSH training format for small construction contractors.

2 | LITERATURE OVERVIEW

Toolbox talks are brief (10–15 min) OSH instructional sessions held on the worksite or at the contractor’s office. A number of sources^{7–9} recommend that toolbox talks should focus on a specific topic that is relevant to the immediate worksite and which can be fully discussed in the limited amount of time available. Some sources have suggested that toolbox talks can be made more effective by including short narratives describing relevant scenarios (typically OSH failures) and questions about the scenarios.¹⁰ Unfortunately, the rationale for the inclusion of narratives does not go far beyond suggesting that workers will find

testing how to tailor them for greater effectiveness. Olson et al found that using line drawings as opposed to photographs significantly increased the distance from which workers could identify hazards. In addition, they developed a new format for toolbox talks that was preferred by supervisors and decreased the amount of preparation time required for the trainings. Kaskutas et al¹⁴ investigated the impact of having foremen participate in an 8-h fall prevention and safety communication training focusing on brief safety interventions such as toolbox talks. Worksite evaluations of both foremen and crewmembers found significant improvements in fall prevention knowledge, safety behaviors, and safety communications that lasted for at least 6 months following the training. Although this study showed that improving the communication skill sets of foremen can increase the effectiveness of the training they provide for their crewmembers, it did not directly address the effectiveness of toolbox talks as a stand-alone teaching device.

This paper presents the findings of a study that investigated the effectiveness of toolbox talks to increase OSH knowledge, to increase the impact of training safety, and to improve worksite safety climate. This study also investigated whether the addition of narratives with discussion questions increased the effectiveness of toolbox talks in terms of knowledge gain, behavioral intentions, and safety climate.

3 | MATERIALS AND METHODS

3.1 | Materials development

Toolbox talks on eight common construction OSH concerns were developed by NIOSH researchers for the purposes of this study. A list of the most high-risk activities was generated by consulting mortality and injury statistics for the construction industry. This list

had a sign-in list for attendees. See Figure 1 for an example of a toolbox talk containing a narrative. The non-narrative toolbox talks looked the same, but without the narrative paragraph and discussion questions.

3.2 | Participants

Participants were recruited from among the employees of general construction companies operating in the Greater Cincinnati Metropolitan Area. Potential companies were suggested by NIOSH subject matter experts and local construction industry stakeholders. Each company was contacted by NIOSH researchers and the purpose of the study was explained. The companies were asked to review the toolbox talks to ensure the safety topics were relevant to their workers and worksites. Companies agreeing to participate were asked to identify individuals who would be trained as toolbox talk presenters and to select worksites for training and data collection. The presenters received 1-h of training to familiarize them with the toolbox talks and the data collection requirements of the study. This training was intended to standardize presentation and data collection across all sites participating in the study. Companies were randomly assigned to study conditions. To prevent contamination between worksites, it was decided that all worksites from participating companies needed be assigned to the same treatment condition. Working within this constraint and the need to balance the number of workers assigned to each condition, the companies were randomly assigned to either the control (toolbox talk alone) condition or the treatment (toolbox talk and narrative) condition. This approach is sometimes referred to as *urn randomization* in the clinical trials literature.¹⁸

Nine companies with 16 worksites agreed to participate in this study. Seven companies with eight worksites were assigned to the control condition and two companies with eight worksites were assigned to the treatment condition. A total of 351 individuals completed the baseline questionnaire (163 in the control group and 188 in the treatment group). At the end of the 8th week, a total of 207 individuals completed the post-intervention questionnaire (107 in the control group and 100 in the treatment group). This represents an attrition rate of 41.0% for the entire sample (34.4% for the control group and 46.8% for the treatment group).

3.3 | Intervention

The toolbox talks were presented one per week, for 8 consecutive weeks. Typically, the talks were given at the beginning of the work shift on Monday mornings. Prior to the first toolbox talk presentation, to establish a baseline, the workers were asked to complete a brief questionnaire. The questionnaire began with six basic demographics items. Workplace safety climate was assessed using a short three-item scale (Cronbach's alpha 0.75) developed for the purposes of the study. A sample question is "If an inspector showed up today, how well would your site do?" Response choices were a five-point Likert scale ranging from (1) poor to (5) excellent. Scores ranged from 3 (participant only responded "poor") to 15 (participant only responded "excellent"). OSH knowledge was assessed with eight multiple choice items. These items reflected the content of the toolbox talks used in the study and were developed for the purposes of this study. A sample question is "Which of the following is NOT a correct way to use an extension ladder?" There were four response options for each

question, and answers were coded as either correct or incorrect. Scores ranged from 0 (all incorrect) to 8 (all correct). After the presentation of the 8th toolbox talk, the participants were asked to once again complete a questionnaire to assess post-intervention changes related to participating in the study. The post-intervention questionnaire included the same demographics, safety climate, and knowledge items from the baseline assessment. In addition, participants were asked about current training impact. A five-item scale assessing training impact (Cronbach's alpha 0.73) was developed for the purposes of this study. A sample question is "My coworkers work more safely than they did before the training." Response choices were a four-point Likert scale ranging from (1) strongly disagree to (4) strongly agree. Scores ranged from 5 (participant only answered "strongly disagree") to 20 (participant only answered "strongly agree").

at baseline on OSH knowledge and training impact and no differences were found. However, the groups did differ significantly on safety climate. The control group rated the safety climate of their worksites significantly lower than the treatment group (2-tailed $t = -2.250$, $P = 0.026$). See Table 1 for relevant pre-intervention demographics.

4.1 | Hypothesis testing

Hypothesis 1: As compared to baseline, all participants will show significant gains in OSH knowledge. The mean baseline knowledge score for the entire sample was 6.97 (SD = 1.05), as compared to a post-intervention mean knowledge score of 7.46 (SD = 0.749). This

4.2 | Additional analyses

Given the mixed findings from the initial hypothesis testing, additional analyses were conducted to further understand the findings from this study. Anecdotal accounts of previous

5. | DISCUSSION

The results from testing Hypothesis 1 indicate that toolbox talks, both with or without a narrative, facilitate learning. This learning occurs across all levels of worker experience. The results from testing Hypothesis 3 indicate that adding a narrative with discussion questions increases knowledge gain as compared to toolbox talks without a narrative. One possible explanation for the narrative effect may be found in the concept of *engagement*,¹¹ which refers to the extent to which an individual is actively involved in any given training activity. Burke conducted a meta-analysis of occupational safety and health training studies and concluded that, holding content constant, training that is higher in engagement is more effective than training that is lower in engagement. A traditional classroom lecture with little opportunity for interaction between student and instructor would provide low levels of engagement. In contrast, a “hands on” training with close mentorship by the instructor would provide a high level of engagement. The toolbox talks alone, presented without any discussion, would represent a training with a relatively low level of engagement. The short narrative with discussion questions that was used in this study would represent a training with a medium level of engagement. Therefore, the findings of this study are consistent with Burke.

While the groups were divided this way to get an equal number of worksites for each, the statistical validity may have been impacted.

It is also unknown how similar the companies that were willing to participate in this study are to those that were unwilling or simply construction companies in general. As discussed earlier, it is possible that the participating companies had more positive safety climates than construction businesses in general. The elevated baseline safety climate scores indicate it is possible that failure to find significant improvements in safety climate may be attributable to a ceiling effect. Similarly, the knowledge baseline scores were also relatively high, indicating that the workers had a good OSH knowledge prior to the intervention. Although significant differences (in the hypothesized directions) were found in the knowledge scores, a similar ceiling effect might actually lead to an underestimating of the efficacy of toolbox talks as a training device. Another limitation of this study is that it did not continue to track study impact beyond the immediate postintervention assessment. Therefore, it is not known whether any positive treatment effects were sustained and, if so, for how long. Finally, all of the participants in this study were native English speakers. Given that an increasing number of construction jobs are performed by Latin American immigrants,⁵ English language interventions, no matter how effective with native English speakers, are not likely to be of much use to native Spanish speakers.

5.2 | Summary

The findings of this study are consistent with the guidance provided in much of the literature discussing toolbox talks. However, it has not previously been empirically demonstrated. Toolbox talks are an effective teaching device for all construction workers and are particularly effective for newer workers. Including a narrative and discussion questions increases their effectiveness. It is important to note that both explanations provided for the increased effectiveness of the narrative condition toolbox talks emphasize not just the narrative, but also the discussion questions as being key to increasing engagement and processing of information. Calculation of Cohen's D for the findings of this study suggest that these effect sizes are meaningful and robust. There is a need to continue to demonstrate effectiveness among other samples within the construction industry to investigate not only knowledge gain and behavior change, but also the impact on safety climate.

5.3 | Future directions

The most obvious next research steps are those addressing the study limitations. Although logistically more demanding than the method used by this study, future studies that use workgroups rather than worksites for data collection. Attrition may be reduced by following workgroups from site to site. Opportunities should be sought for testing the effectiveness of toolbox talks with the employees of companies with less positive safety climates to address concerns of possible ceiling effects. In addition, it would be of great interest to assess the effectiveness of the toolbox talks for at least several months after the intervention. This assessment would not only speak to the robustness of the treatment effect, but could guide recommendations for frequency of trainings. Spanish language toolbox talks should be developed and tested with native Spanish-speaking construction workers to determine if this

approach is effective with them, and whether narrative toolbox talks are more effective than non-narrative toolbox talks.

Supplementary Material

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FIGURE 1.
Sample toolbox talk containing narrative and discussion questions

TABLE 1

Demographics reported on the pre-intervention questionnaire

Characteristic	Control group		Intervention group		Total sample	
	N	%	N	%	N	%
Age						
Less than 22 years	8	7.7	9	9.1	17	8.4
23–30	25	24.0	27	27.3	52	25.6
31–40	28	26.9	27	27.3	55	27.1
41–50	30	28.8	23	23.2	53	26.1
51–60	12	11.5	8	8.1	20	9.9
Over 60 years	1	1.0	5	5.1	6	3.0
Total	104	99.9	99	100.1	203	100.1
Length of time in trade						
Less than 1 year	9	8.7	12	12.2	21	10.4

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