



## Original Article

# An Analysis of Trainers' Perspectives within an Ecological Framework: Factors that Influence Mine Safety Training Processes



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## ABSTRACT

**Background:** Satisfactory completion of mine safety training is a prerequisite for being hired and for continued employment in the coal industry. Although training includes content to develop skills in a variety of mineworker competencies, research and recommendations continue to specify that specific limitations in the self-escape portion of training still exist and that mineworkers need to be better prepared to respond to emergencies that could occur in their mine. Ecological models are often used to inform the development of health promotion programs but have not been widely applied to occupational health and safety training programs.

**Methods:** Nine mine safety trainers participated in in-depth semi-structured interviews. A theoretical analysis of the interviews was completed via an ecological lens. Each level of the social ecological model was used to examine factors that could be addressed both during and after mine safety training.

**Results:** The analysis suggests that problems surrounding communication and collaboration, leadership development, and responsibility and accountability at different levels within the mining industry contribute to deficiencies in mineworkers' mastery and maintenance of skills.

**Conclusion:** This study offers a new technique to identify limitations in safety training systems and processes. The analysis suggests that training should be developed and disseminated with consideration of various levels—individual, interpersonal, organizational, and community—to promote skills. If factors identified within and between levels are addressed, it may be easier to sustain mineworker competencies that are established during safety training.

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## 1. Introduction

One component of mineworker preparedness is the possession of competencies needed to self-escape from a mine quickly and safely during an emergency [1]. One way in which the mining industry prepares employees to respond to emergencies is via standards developed by the Mine Safety and Health Administration (MSHA) that include provisions on who needs to be trained, how much training is needed, who can provide training, and subject areas to be covered [2]. These requirements are included in the Code of Federal Regulations (30 CFR, section 48) on the training and retraining of mineworkers.

Although mine safety training occurs frequently and includes a vast amount of information that mineworkers need to know,

documents that analyze previous coal mine disasters indicate that improvements in training content and assessment are needed to better prepare the mining workforce to self-escape from emergencies [3–9]. These analyses, such as a report by the Mine Safety Technology and Training Commission, often assert that assessment of self-escape competencies is lacking in the current system of mine emergency preparedness [5]. Most recently, a comprehensive document compiled by the National Academy of Sciences about methods through which to improve self-escape indicated that current safety training is more focused on frequency and duration rather than on mastery of the knowledge, skills, abilities and other attributes (KSAOs) needed by mineworkers to sustain personal safety in the mining industry [3]. Research also illustrates that content about mine-specific knowledge is not included nor

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assessed enough during mine safety training sessions to guarantee the mastery of individuals' skills [10].

These comprehensive reviews determined that resources for the implementation and evaluation of realistic mine safety training are insufficient. A recent analysis of 12 mine rescue training facilities supports these findings in their conclusion that realistic scenarios, such as those within simulated mine settings where mineworkers can practice applying self-escape skills, is most desirable for accurate and sustainable learning [11]. The authors indicate, however, that these specific resources are not available to all mine organizations, and as a result classroom settings are used more often to teach and practice the necessary safety topics. Due to the abundance of literature that notes the problems with current mine training processes, it is especially important for the mining industry to be conscious of additional or innovative training strategies that may improve and maintain mineworkers' KSAOs while working underground. Subsequently, assessing and making feasible changes to training processes may increase the ability of mineworkers to self-escape during mine emergencies.

To probe the content and assessment of current mine safety training, researchers from the National Institute for Occupational Safety and Health interviewed nine mine safety trainers between November 2012 and March 2013 [12]. These safety trainers were considered to be subject matter experts (SMEs) in the area of mine safety training. When trying to elicit knowledge in a specific area, such as training assessment, engaging SMEs in issues related to the domain of interest is a common empirical approach [13]. Importantly, trainers noted problems similar to those identified in the prior documents including a lack of individual-level assessments and the need for more hands-on practice to master and maintain KSAOs.

As similar problems and recommendations were reiterated in the above-cited documents, a new analysis of the data was considered to further examine the trainers' interview content. This article focuses on the results of this analysis, which applied a five-level ecological framework in an effort to reveal training deficiencies and provide practical recommendations to improve training processes. The social ecological model (SEM; Fig. 1) considers this interplay between intrapersonal, interpersonal, organizational, community, and societal factors to better understand and target specific behaviors [14,15]. Using this specific analysis on trainers' perspectives is novel in the mining industry and the factors that may influence stronger training processes warrants exploration.

It should be noted that this paper does not address the current regulatory practices that define mine safety training. Rather, we analyze training by way of an established model grounded in an ecological perspective. This new viewpoint may provide a means to help recognize and expose limitations that exist in mine safety training and to understand why individual mastery and maintenance of self-escape KSAOs continues to be identified as a problem in follow-up reports of mine disasters.

### 1.1. Applying an ecological perspective to safety training

Although individuals are responsible for developing and maintaining behaviors that reduce safety and health risks, individual behaviors are simultaneously influenced by factors at external levels. Some experts argue that an ecological approach is better suited for at-risk populations [16], such as mineworkers whose environment increases their vulnerability to certain injuries and diseases [17]. In the case of mine safety training and skill maintenance, the SEM is an informative framework because mineworkers first learn and then apply competencies in different environments (i.e. the training facility and actual mine site, respectively). The SEM therefore allows for a focused analysis of how these various environments might influence the mastery and maintenance of critical skills. Each level of the SEM is discussed below.

The intrapersonal or individual level includes characteristics that influence behavior, such as knowledge, attitudes, skills, and beliefs [18]. Current mine safety training takes an intrapersonal level approach in which the individual is the target for developing competencies [14,19]. The interpersonal level provides role definitions and personal relationships, such as contact with family, friends or coworkers, which may influence behavior [19]. For example, because mineworkers often work together in crews on a consistent basis, whether peers encourage or discourage safety behaviors could have a significant influence on behavior. The organizational level also can facilitate and support individuals' willingness to change behaviors [14]. The organization itself can be a target for many health and safety initiatives, including local rules and policies to ensure employees' safety and health. An example includes adopting worksite practices that support preventative care, such as a smoking cessation program to assist in the prevention of respiratory problems. The community level includes social norms and values that exist among collective groups that can impact structures and the behaviors within those structures, such as the propensity to take risks and willingness make safer decisions [18,19]. Strategies at this level are typically designed to impact the processes and proximal rules within a given work system. Examples specific to the mining community include nonverbal communication signals with cap lamps or task training for a particular machine. Last, the societal level includes cultural context and regulatory policies that facilitate healthier behaviors [19]. State mining agencies and the MSHA are societal-level factors that influence worksite policies and ultimately the work behaviors of mine site personnel. For instance, the required training we discuss throughout this paper is one of the regulatory factors within the mining industry.

Some researchers argue that, although theoreticians often express interest in and use the SEM, practitioners rarely take advantage of this model's utility [14,15,20]. Using the SEM to consider potential shortcomings in self-escape training processes is an applicable and novel approach within the mining industry. The

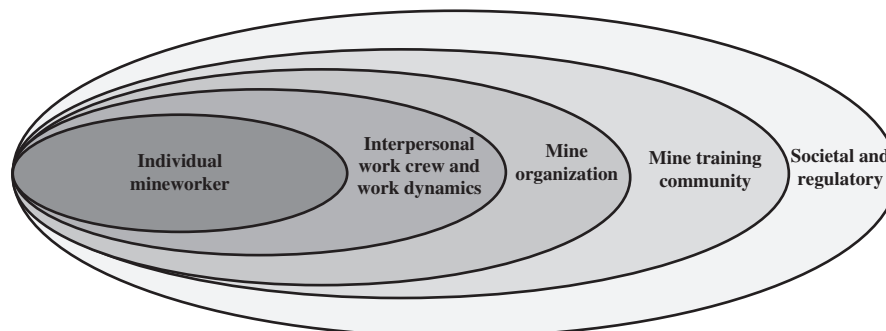


Fig. 1. Social ecological model for mine safety training.

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