2.1.4. Persuasive Technologies

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2.1.4. Persuasive Technologies

As world industries, including mining, increasingly rely on automated, mechanized, and technologically advanced systems to manage their production, there are increasing opportunities to utilize digital technologies. For example, digital technologies may be used to optimize occupational training and performance or to addresses the needs and inclinations of a younger generation of employees who want to be trained in a modern digital way. *Persuasive technologies* are systems, devices, or applications designed to change the attitudes or behaviours of users in a predetermined way (Vernero & Montanari, 2007, 2010). This chapter aims to review applications of these technologies, their effectiveness and applicability to the mining industry.

The question that guided our scoping review was: "Which persuasive technologies, if any, markedly enhance organizational safety?"

Method

Search strategy. A scoping search of the literature was undertaken using the following key words:

1. Persuasive technology (persuasive technolog*, persuasive intervention*, persuasive strateg*, persuasive system*, persuasive system design*, industrial persuasive technolog*, behavio*r change support system*, persuasive design*, gamification)
2. Safety engagement (see General Methods section)

This search was completed in August, 2015. Articles obtained through other searches were also added to this chapter if deemed relevant to persuasive technologies.

Screening strategy. The screening process was similar to other topics such that articles were excluded for publication date (e.g., published before 2010), irrelevant records (e.g. non English), irrelevant medium (e.g., book reviews, letters to editor, etc.), irrelevant safety domain (e.g., sexual risk taking, gambling, etc.), or other irrelevant content based on the inclusion/exclusion criteria listed below. The inclusion and exclusion criteria were kept broad in that we did not specify the types of research methods to be included or excluded in order to capture as many research articles on the topic as possible. Articles were only added to this chapter if they were specifically relevant to persuasive technologies and safety; no further screening was needed and inclusion/exclusion criteria were not developed.

Results

Description of included articles. A brief summary of each article including its location, population studied, main issue addressed, comparison group, and primary outcomes is provided in Appendix G. The following is an overview of the included articles.

Table 1. Persuasive Technologies Number of Articles by Databases Searched

Database	Articles found from search	Articles Selected for Review	Final article selection
Academic Search Complete	1	36	24
Inspec	2		
Compendex	3		
MEDLINE	1		
ProQuest Dissertations & Theses	0		
PsycINFO	2		
Scopus	23		
Web of Science	4		

Table 2. Persuasive Technologies Number of Articles by Type, Country, and Population

Type of Publication:	Country of Publication:	Population Studied:
- 18 original research articles - 5 summary discussions **Type of Original Research:** - 7 program evaluations - 5 experimental designs - 3 qualitative studies - 2 surveys - 1 program design (not evaluated)	- 5 Italy - 4 USA - 3 China - 2 Canada - 1 Australia - 1 Sweden - 1 France - 1 Germany - 1 Belgium - 1 Brazil - 1 Mexico - 1 South Africa - 1 Jordan	- 5 Motorists - 4 Unspecified Industrial workers - 4 Construction workers - 2 Miners - 2 Aviation pilots and superintendents - 1 Firefighters - 1 Sailors - 4 general employees (i.e., did not distinguish between job type or industry)

Although only two research studies included a mining population, knowledge obtained in other industries/workplaces may be generalized to this population.

Description of identified factors. Based on a descriptive analysis of the selected articles, seven factors emerged: virtual reality technologies, computer- and internet-based training programs, simulation training videogames and gamification of training programs, multi-media technologies. visual feedback systems, other digital technologies, and issues associated with development and implementation of these technologies. The primary results and potential applications of each identified factor are discussed. All definitions of concepts as used in the current literature are provided in Appendix D.

Virtual reality technologies (VRT). Four articles were related to virtual reality technologies. Virtual reality immerses users in a realistic and functional simulated environment, allowing a seemingly real experience for members of at-risk industries without associated personal or environmental hazards or travel time.

VRT has been adopted by French industrial organizations as the safety training tool: Virtual Reality for Safe Seveso Sub-contractors (V3S; Barot, Lourdeaux, Burkhardt, Amokrane, & Lenne, 2013).

The V3S system projects 3D environments through a 75-inch stereoscopic screen and tracks user movement with infrared cameras. In their study, Barot et al. placed users in a virtual oil depot and tasked them with installing a loading arm on their truck to allow the loading of hazardous material. To facilitate learning, the V3S system allows users to commit errors so that they can see the repercussions (e.g., the spilling of hazardous material due to improper loading arm installation). Performance data indicated a significant learning effect wherein users improved on task-related skills as they completed more V3S trials. Post-intervention surveys indicated that the V3S system was perceived by employees as both effective and realistic. In light of these promising results, these systems are a robust option for situations where hands-on learning is costly, dangerous, or impossible (e.g., mine collapse, operation of dangerous equipment, incident reconstruction, etc.).

A recent review of virtual reality trainers in the South African mining industry suggests that VRT decrease the overall time spent on training and enhance health and safety awareness on mines (Webber-Youngman & van Wyk, 2013). Additionally, researchers suggest that virtual reality trainers easily identify safety-related employee weaknesses (e.g., repetitive failure to apply safety glasses before initiating machinery; Chan, 2012; Webber-Youngman & van Wyk, 2013). Management can review employee records from a database of training records, compare results, and generate graphs of individual or group performance, a feature unattainable in traditional forms of training. (Colombo, Manca, Brambilla, Totaro, & Galvagni, 2011). Thus, organizations may increase workplace safety by incorporating VRT into their training routine as it has shown to effectively teach program content, reduce training time, and enable error tracking to help identify employees or work areas in need of improvement without personal or environmental hazards. .

Computerized- and internet-based training programs. Five articles were related to utilizing computer and internet technologies for general and safety training. Recent research has also explored the utility of automatizing organizational risk management through computer programming. However, similar to virtual reality, organizational computerized- and internet-based programs have been primarily studied for safety training purposes, improving safety through effective training at a reduced time and cost compared to traditional hands-on methods.

For instance, Kearns (2011) examined the feasibility of adding guided mental practice to computer flight simulator training. *Computer-based guided mental practice* (CBGMP) adds an animated avatar to computer-based training to guide the learner through practice scenarios and visual imagery exercises (Kearns, 2011). To improve safety, two antecedents to safety were specifically targeted by CBGMP: *situation awareness* and cognitive workload management. *Situation awareness* is the perception and comprehension of all environmental elements at a given time (Colombo et al., 2011) and its absence is the most common causal factor of pilot error accidents (Kearns, 2011). *Cognitive workload management* is also critical to safety as it organizes the numerous cognitive actions being simultaneously performed by an individual (e.g., communication, flight monitoring, lowering landing gear, etc.; Kearns, 2011). The study trained 36 private pilots in three separate groups: using CBGMP, using hands-on practice (e.g., in-flight emergencies, standard operating procedures, etc.), and no practice (control) group. Post-training results showed no significant difference between the two training groups in either situation awareness or cognitive workplace management, though both training groups improved significantly more on situation awareness than the control group. These results indicate that CBGMP is equally as effective as hands-on training in improving pilot safety performance. Yet, computer-based learning holds advantages over hands-on learning such as less training time and fewer costs (Kearns, 2011).

Another study moved beyond computer programs to more accessible internet-based trainers, effective due in part to their engaging and easy-to-use nature (Hong, Eakin, Feld & Vogel, 2012). An internet-based training program was developed by Hong et al. (2012) to combat noise-induced hearing loss in American firefighters. The program, dubbed Safety Instruction to Reduce Exposure to Noise (SIREN), was a 30 minute self-directed online course presented though interactive content tailored to individual firefighters (e.g., each users answered a serious of questions prior to the intervention; their personal responces dictated the scenarios and stories of role-playing activities). Eighty-eight percent of SIREN users indicated in a post-intervention survey that they would take future precautions to protect their hearing, compared to only 69% of the control group participants. Additionally, SIREN users rated the program as easy to use, well-organized, effective, and engaging.

Additionally, computer- and internet-based training offers unique benefits such as reduced instructor or institutional bias and temporal and geographical flexibility (Kearns, 2011; Vilela et al., 2012). Thus, when using internet-based training programs, trainees can complete at least a portion of their training in a relatively unbiased environment at any time or place. For example, if a training program is 12 hours but an organization wishes to allocate only one work day to training, several hours could be completed by the trainee at home. Regardless of when or where the user accesses materials, he or she can perceive they are in another place or time (e.g., underground for a night shift), known as *telepresence*, which increases associated behavioural intentions (Panić, Cauberghe, & De Pelsmacker, 2011). A potential worry of at-home training is that trainees may not pay attention to content. However, Hong et al. (2012) report that internet-training sufficiently holds user attention. User attention may be further maintained by utilizing interactive components such as periodic quizzes, puzzles, or games

In addition to training, internet-based technologies may be used to influence safety culture through public webpages that facilitate social engagement such as online message boards. Vilela et al. (2012) found that a company webpage accessible to employees offsite containing summaries of on-site safety meetings and a message board to discuss meeting material received over 18,000 views in one year and resulted in increased attendance at on-site safety meetings. Professionals from outside the company (e.g., university faculty, physicians, etc.) were also asked to engage in message board conversations. In another study, a risk management program was developed to improve and assess safety, allowing for early-warning prompts in unsafe situations. In response to regular input of safety data (e.g., hazards, incidents, observed behaviours), early-warning and alert prompts automatically appear on employee computers, offering an automatic risk management system (Qing-gui, Yejiao, Qi-Hua, & Jian, 2012). This system was tested in 2010 at a Chinese coal mine and demonstrated promising results. Risk management was easier to carry out and the severity and total number of unsafe behaviors declined each month following implementation (Qing-gui et al., 2012).

Available data indicates that computer- and internet-based training programs aid in training employees to behave safely in an effective, easy-to-use, accessible, inexpensive, and timely manner. The limited amount of research of these programs suggests that further studies are needed to establish their positive effects in the mining industry.

Simulation videogames and gamification of training programs. Seven articles were related to the application of videogame and gamification technologies to occupational training. Videogame-based technologies approach organizational safety similarly to virtual reality systems in that they strive to immerse users in a simulated environment with the distinguishing feature being that they focus on a specific goal, a set of rules, and feedback organized as a videogame to facilitate learning progress (Albert et al., 2014).

Videogame technology has successfully improved occupational safety in the Chinese construction industry by training employees to safely dismantle cranes (Li, Chan, & Skitmore, 2012). A multiuser virtual safety training system (MVSTS) was developed to allow multiple users to cooperatively and simultaneously dismantle a construction crane using game controllers to manipulate game character movements in a simulated real-time environment. To evaluate the system, 30 workers participated in one of three groups: participants who used the MVSTS with no previous crane experience (Group A), participants who used the MVSTS with previous crane experience (Group B), and participants who did not use the MVSTS but were previously trained through traditional means (e.g., lecture format) to dismantle cranes (Group C). Results revealed that Group B attained the highest average score (87%) on a post-intervention crane dismantling procedure quiz while average scores for Groups A and C were identical (81%). As well, post-intervention interviews indicated the MVSTS, compared with traditional training, was more interesting, easier to understand, and capable of identifying areas for improvement. These results indicate that both methods of safety training (i.e., videogame and traditional) are similarly effective while a combination of the two offers optimal training results (Li et al., 2012). This coincides with research demonstrating that videogame trainers improve hazard recognition (Albert et al., 2014), retention of related safety knowledge (Chittaro, 2012, 2014; Li & Tay, 2014), and users' feeling of self-efficacy (Chittaro, 2012).

Positive findings on videogame trainers could be applied to safe-room procedure training. The trainer could place users in a simulated environment during a critical hazard (e.g., fire, cave-in, etc.), where they must follow proper procedure to locate the safe room despite various obstacles (e.g., tending to an injured coworker, poor ventilation, smoke, etc.) that require user decisions (e.g., spotting smoke, choosing to either investigate the source or notify a supervisor). The simulation could offer feedback via in-game tips or evaluation. In line with the current literature, such a game would likely aid in learning safe-room procedure (Chittaro, 2012, 2014; Li et al., 2012) and bolster confidence during real situations (Chittaro, 2012, 2014).

One reason for training videogames effectiveness is that the gaming elements intrinsically motivate users (Albert et al., 2014). Intrinsic motivation is motivation driven by internal desires such as enjoyment and interest which results in self-directed and self-inspired learning (Albert et al., 2014). This is juxtaposed with extrinsic motivation which motivates through external rewards and punishments. Thus, trainees effectively learned safety-related skills and information because they enjoyed the technology through which safety was being taught. This is in contrast to traditional classroom training which may induce boredom or discrepancy between what one wants to be thinking about and what he or she is thinking about (e.g., one's mind wandering to sports, TV, or games because an instructor's speech is monotonous and expressionless; Schroeter et al., 2014).

The success of videogames has inspired a novel approach to organizational safety known as gamification. *Gamification* implements game design elements (e.g., goals, reward, competition, etc.) to non-game contexts with the aim of increasing related safety knowledge and user motivation toward achieving a specified goal (Rodríguez et al., 2014; Schroeter et al., 2014). Rodríguez et al. (2014) seek to encourage safe driving behaviour using an in-vehicle device to gamify driving, currently in development. The proposed device relays driving performance feedback primarily through a rearview-mirror heads-up display with simple pictures or text during full stops (e.g., at a red light). The pictures and text indicate traffic rule infringements and progress toward daily safety challenges (e.g., "stay within school zone speed limits to receive 800 coins"). Completing challenges and avoiding rule infringements contributes to scores in an accompanying mobile phone application where users are encouraged to compete with their social network. Although gamification provides an interesting avenue for improving organizational safety, most literature on the topic has yet to move beyond a conceptual stage, meaning the technology must be developed and evaluated before their effectiveness can be empirically tested (e.g., Rodríguez et al., 2014; Schroeter et al., 2014).

Given the current literature on videogames, videogame trainers may make a positive contribution to industry safety training, at least as effective as traditional training but more interesting and comprehensible to new trainees. Promise is also shown in gamification research conceptualizing the addition of game elements into real-time environments (e.g., driving) to regulate personal behaviours. However, this approach to safety is thus far based on undeveloped technology, requiring further study to draw definitive conclusions.

Multi-media programs. Three articles were related to multi-media training technologies. Multimedia programs are cheaper than alternative technologies, such as virtual reality or video games, and can address various learning styles through audio and video content, animation, student participation, and instructed lessons (Webber-Youngman & van Wyk, 2013). For example, safety training may include a video tour as well as video or audio footage of related interviews, news clips, or actual emergencies, which form topics for an ensuing instructor-guided group discussion or quiz.

One study has shown how multimedia programs were effectively used to train flight attendants in airline safety. Employees of Jordanian Royal airline took part in a multimedia training program consisting of two units: safety information and emergency procedures (Bani-Salameh et al., 2011). The units were introduced to half of participants in an instructor-guided walkthrough and details taught through a slideshow combining text, pictorial, and audio information. The other half of participants, the control group, were trained with the airline's traditional method of lecture-styled class sessions. To evaluate the multimedia intervention, both groups completed safety knowledge and problem solving quizzes before and after each unit, as well as a final comprehensive exam after the two-month programs. Results of the pre-unit quizzes showed no significant differences in scores between groups. However, post-unit and comprehensive exams showed the experimental group scored significantly higher than the control group in both safety knowledge and problem solving. This study suggests multimedia safety training to be more effective than a traditional lecture-style format. Although the researchers did not conduct a follow-up assessment, high recall rates of safety information were found to sustain for one week following a multimedia training program for maritime water vessel safety (Blomé & Ek, 2012). Further studies are need to examine recall rates beyond one week. Regardless, organizations can easily create a multimedia training program similar to Bani-Salameh et al. (2011) by rendering company safety information (e.g., safety manual, previous training materials, etc.) as audio, visual, and textual content for a slideshow presentation. Regarding employee training, multimedia training programs are inexpensive, effective, and cover many approaches to learning.

Visual Feedback Systems. Two articles were related to visual feedback systems. Visual feedback systems are designed to persuade employees to increase safe behaviours through visual cues. For example, Hartwig and Windel (2013) relayed employee feedback through a digital computer screen in an attempt to increase personal protective equipment (PPE) use. Participants were asked to build 10 electrical circuits by following an instruction manual and offered a $6 bonus for fast performance (in reality, each participant received the same remuneration). Performance was hampered by insulated gloves (i.e., PPE) that participants were asked to wear in order to avoid an electric shock. Participants were in one of three groups that varied by the type of feedback given on a digital screen: text (i.e., "gloves used" vs. "please wear gloves"), traffic light (a green or red light), or on-screen avatar (a virtual human displaying either joy or sadness/anger). After participants had built 30% of circuits, they received a message that they were performing slower than the average time, meant to tempt them into removing their PPE. Results revealed no significant difference between a control group and participants in the text condition. In contrast, groups receiving feedback with visual (i.e., traffic light) or visual-humanistic (i.e., on-screen avatar) components committed 60% less violations than the control group. It is quite possible that visual stimuli were more effective than plain text because they appeal more to personal attention and mental associations (e.g., red implies danger and green implies safety; Hartwig & Windel, 2013). Interestingly, the two experimental groups reduced violations even when participants believed it would forfeit their financial bonus. This finding suggests the potential of visual feedback technology to function beyond a behavioural reminder, influencing an individual's decision-making (Hartwig & Windel, 2013).

Similarly, Steiner, Burgess-Limerick, Eiter, Porter, & Matty (2013) found that despite an insignificant decrease in errors, visual feedback (i.e., directional LED lights activated by slight lever pressure to signify direction of machine component movement) was perceived by mine employees as helpful in correcting potential mistakes and enhancing overall work performance. Similar visual feedback technology could be applied elsewhere in the form of a digital screen installed on machinery that presents emotions from an on-screen agent in response to safety performance (e.g., happy expression in response to shutting a machine down when it is in danger of overheating, etc.).

Other digital technologies. Two articles were related to persuasive technologies that have received insufficient research to warrant their own factor. For example, Vernero and Montanari (2010) introduced a production process management system (PPMS) in a high-risk chemical processing plant to enhance user performance and coordination during chemical processing steps. For instance, the PPMS forced polyurethane synthetization to be completed by employees through a step-by-step and start-to-end execution of required tasks, a strategy known as *tunneling* (Vernero & Montanari, 2010). Following PPMS implementation, factory production errors decreased even in the face of increasing production volumes. Additionally, users indicated the PPMS to be comprehensible, an important prerequisite to persuasion (Vernero & Montanari, 2010).

A final persuasive technology for consideration is a new infrared camera monitoring system that can capture and recognize unsafe actions and postures among employees (Han, 2013). Safety behavior observation provides a more accurate reflection of an organization's safety culture than self-report questionnaires; however, assessment through observation is time-consuming and requires a great deal of training for the observer. This new monitoring system can be used to observe safe and unsafe actions in the workplace in a more efficient manner without the need to train observers (Han, 2013). Although less researched than other forms of persuasive technologies (i.e., virtual reality or videogames), employee tracking technology can monitor employee safety in a reasonably cost- and time-efficient manner.

Issues associated with persuasive technologies. Three articles discussed issues associated with developing and utilizing digital technologies. First, development of software and purchasing equipment to use digital technologies is expensive and time consuming. The conceptual stage of developing a digital technology involves workshops, focus groups, and prototyping (Rodríguez et al., 2014) while software and hardware development require intricate details, especially in gaming and virtual reality applications (e.g., programming the motion and posture of each virtual character, Chan, 2012). Involvement of experts or programming professionals is also often needed.

Software and hardware development also pose a second issue: associated costs (Chan, 2012). For example, virtual reality and videogames reviewed in this chapter involve advanced heads-up displays, mobile phone applications, and wireless connection interfaces (e.g., Rodríguez et al., 2014; Schroeter et al., 2014). However, these costs are less troublesome when considering that software and hardware are reusable, meaning costs should largely reduce following initial implementation (Chan, 2012).

A third issue inherent in persuasive technologies is the need for advanced programming knowledge to adjust applications as organizational needs change (Chan, 2012). For example, an organization may incorporate a videogame into emergency procedure training. Years later, the organization may wish to incorporate the same technology into emergency training for a new site. However, a programming specialist would be needed to add the new site's spatial layout to the videogame trainer.

Thus, the utility of persuasive technologies is limited by several factors and companies are advised to assess the cost effectiveness of such innovations. However, these limitations do not inhibit intervention effectiveness as long as an organization can afford the associated solutions. Ultimately, organizations may benefit from including persuasive technologies in their safety framework. Opportunities to pool resources may also allow the development of a standard platform for digital technologies that can later be customized by each company for its unique needs. In addition, organizations can benefit from relatively inexpensive persuasive technologies such as multimedia presentations.

Discussion

As Western society becomes increasingly reliant on digital technologies, researchers and practitioners focus their attention on using these technologies for improving employees' training and safety. Virtual reality (VRT) offers a realistic training experience without exposing users to the dangers or travel time that traditional hands-on training requires. Less immersive and more simple, computer- and internet-based training programs tend to relay safety content more akin to course-based training programs and can be accessed virtually anywhere at any time. Videogames and gamification encourage behavioural change by presenting safety-related content to users through captivating and intrinsically motivating elements (e.g., specific goal, a set of rules, user control, feedback, etc.). Commonly presented in the classroom, multimedia programs may be less entertaining than videogames but shine in their versatility by addressing different learning preferences through audio, video, animation, student engagement, and instructor-guided lessons. Visual feedback systems mold users into safer operators by providing simple visual feedback in response to their actions (e.g., red light signifying incorrect action; green signifying correct). Finally, infrared camera monitoring tracks employee behaviours, incurring less time and cost than training human observers. While each persuasive technology holds distinct pros and cons, organizations must take into account the notable degree of time, money, and specialist programming required for implementation.

Gaps in the literature. Digital technology research has been directed primarily toward full applications with few studies examining particular components of successful applications. In applying persuasive technologies to organizational safety, Hong et al. (2012) suggest emphasizing sophisticated content (e.g., do not patronize users as if they completely lack safety knowledge), real-life examples and testimonials, individual tailoring (e.g., surveying employees to identify common interests and hobbies that can be incorporated into the content of training materials), participant interaction (e.g., inclusion of games or quizzes), and an appealing interface (e.g., inclusion of a syllabus and navigation menu). These suggestions provide some helpful leads to organizations but are not yet supported by empirical literature. This gap in the literature must be addressed if persuasive technologies are to reach their full safety-enhancing potential while remaining and cost-effective as possible.

Recommendations. Digital technologies aim to increase safety by influencing individual behaviours through using modern computer-based programs and systems computer or digital means (e.g. computer systems, videogames, digital screens, etc.). The technologies presented in this chapter have enhanced workplace safety primarily through their training applications; some applications also provide behavioural feedback or identify employee errors. Based on the current scoping review, future efforts may include an integration of the following persuasive technology strategies:

- **Replace hazardous or expensive hands-on scenario training with virtual reality training.** Virtual reality training sessions effectively train employees (Barot et al., 2013; Chan, 2012; Webber-Youngman & van Wyk, 2013) and reduce workplace injuries (Webber-Youngman & van Wyk, 2013); they also support recognition of hazard signs (e.g., improper use of a cutting torch; Albert et al., 2014) recall of evacuation procedure (Chittaro, 2012, 2014; Li & Tay, 2014), perceived control (i.e., internal locus of control; Chittaro, 2014), and confidence in real situations (i.e., self-efficacy;

Chittaro, 2012). Compared to traditional hands-on training, virtual reality procedures minimize associated hazards (Webber-Youngman & van Wyk, 2013), training costs (by decreasing training time and the need for various other training equipment; Chan, 2012; Webber-Youngman & van Wyk, 2013), measurement time, and subjectivity (Colombo et al., 2011). Of course, virtual reality incurs initial expenses for software and hardware development but their reusability means few subsequent costs (Chan, 2012).

- **Utilize the ability of virtual reality systems to track errors.** Most virtual reality trainers are capable of tracking user errors; use this data to identify common errors, safety violations, and areas for employee improvement (Chan 2012; Webber-Youngman & van Wyk, 2013)
- **Enable online access to educational and training content.** Online content enables a unique geographical and temporal flexibility for users, allowing employees to access online educational or training materials at any place or time (Kearns, 2011; Vilela et al., 2012). An organization's training program could offer online self-directed safety training, to be completed at home, presented through interactive content (e.g., quizzes) tailored specifically to company employees. Including a message board to supplement on-site safety meetings and encourage related discussion may also be valuable (Vilela et al., 2012)
- **Incorporate gamification into training procedures.** *Gamification* implements game elements (e.g., goals, reward, competition, etc.) to non-game contexts to increase user motivation through heightened attention, interest, and enjoyment which leads to increased related safety knowledge (Albert et al., 2014; Rodríguez et al., 2014; Schroeter et al., 2014). Thus, employees effectively learn safety-related skills and information because they enjoy the technology through which safety is being taught.
- **Incorporate multimedia programs into safety training.** Multimedia programs (e.g., visual and audio content, animation, student participation, instructed content, etc.) are economical alternatives to other training programs (e.g., virtual reality; Webber-Youngman & van Wyk), and can produce better safety information retention and problem-solving skills than traditional lecture-styled programs (Bani-Salameh et al., 2011). Multimedia programs produce high recall rates (Blomé & Ek, 2012) and facilitate student learning through easily relatable scenarios and group safety discussions (Blomé & Ek, 2012). Multimedia programs may include a video tour, video and audio clips of interviews, news clips, or footage of actual emergencies on which students are later quizzed on or discuss in an instructor-guided group discussion.
- **Provide employees with visual feedback.** Adding visual feedback to computer interfaces (e.g., red light to indicate hazardous operations in progress) or machinery (e.g., directional lights emitted when hand pressure is sensed on machine controls to give users a brief adjustment period prior to actual machinery movement) could reduce unsafe employee behaviours (Hartwig & Windel, 2013) and aid in mistake correction and work performance (Steiner et al., 2013).
- **Automatize risk management.** Recently developed software allows for risk management and automatized early-warning mass communication to all employees. Use of this system has shown to be easier to carry out than previous systems in a Chinese coal mine and the total number and severity of unsafe behaviors declined each month following implementation (Qing-gui et al., 2012).

- **Include guided mental practice in computer/digital training programs.** Adding an animated avatar to guide users through training scenarios and visual imagery exercises could likely improve safety performance equally as well as hands-on training, primarily by improving situation awareness, an antecedent to workplace safety (Kearns, 2011).
- **Proactively address the most common issues associated with persuasive technologies.** Implementing persuasive technologies requires time, money, and specialist programming (Chan, 2012; Rodríguez et al., 2014). The resources needed for implementation of persuasive technologies should be determined well in advance of the desired implementation date.

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