Modern training methods and technique in the field of occupational safety – a literature review

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Abstract. The growing diversity of the workforce and the changing context of employment in the world present significant challenges for developing and implementing occupational safety and health training. New approaches to content development, format, and implementation need to be developed, as traditional training methods are often not effective with workers or do not account for changes in employment patterns and the way work is organized today. This paper reviews modern training methods from computer games to virtual reality, as found in the specialized literature published in the last 10 years. The article presents the results of a state of art literature review realized with the new version of PRISMA methodology, for systematic reviews, as a part of National Institute for Research and Development for Occupational Safety INCDPM Alexandru Darabont ongoing project "Development of informative content and online training system of occupational safety and health information in the context of intelligent specialization".

1 Introduction

The term "occupational health and safety training" covers many range of different realities because it applies to the content of part of the training of a student in vocational education as well as to that of an executive who is perfecting their health and safety management techniques [1]. It concerns highly specialised training in driving self-propelled forklifts or in managing electrical risks (without which an employer will not authorise work) as well as general training for technicians or engineers responsible for implementing occupational risk prevention in companies. It can correspond to sessions during which a young worker will acquire the rules of safe working knowledge at the same time as professional gestures, or to other sessions carried out entirely remotely.

In a context of strong technological changes, the question of access to training will be of particular importance. Increasing automation, the development of remote working, and the continued development of new technologies (linked in particular to the use of artificial intelligence) will disrupt the working environment, cause occupational risks to evolve, and

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even give rise to new ones. It will therefore be necessary to train workers in appropriate occupational risk prevention [2], [3].

In Romania, the National Institute for Research and Development for Occupational Safety INCDPM „Alexandru Darabont" is an organisation whose vocation is to develop and promote a culture of prevention of accidents at work and occupational diseases. To this end, it offers a wide range of training activities: direct training of prevention workers, implementation of initial training schemes and now is developing a new approach by design of continuous training materials allowing for a high degree of multiplication, with remote learning for example.

There are a growing number of articles that point to significant changes in training in the next few years. Needs are expected to change significantly, as are teaching methods [4],[5]. It was for this reason that the decision was taken to carry out a project "Development of informative content and online training system of occupational safety and health information in the context of intelligent specialization". The scope of this project is broad, since it corresponds to the various training actions and methods mentioned earlier in this introduction. This paper presents a part of this ongoing project findings.

2 Methods

The method used for this paper was the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) [6] statement, that was first published in 2009, being designed to help systematic reviewers transparently report why the review was done, what the authors did, and what they found. Over the past decade, advances in systematic review methodology and terminology have necessitated an update to the guideline. The PRISMA 2020 statement replaces the 2009 statement and includes new reporting guidance that reflects advances in methods to identify, select, appraise, and synthesise studies. The structure and presentation of the items have been modified to facilitate implementation. In this article, we used the PRISMA 2020 27-item checklist, an expanded checklist that details reporting recommendations for each item, the PRISMA 2020 abstract checklist, and the revised flow diagrams (fig.1) for original and updated reviews.

This method includes three phases: literature search, articles selection, data extraction. First, the database of Web of Science - Core Collection was utilized to search the literature since it is a generally accepted database, which contains abstracts and references of highquality and influential scientific papers and can conduct in-depth analysis of the literature. To ensure the quality and reliability of data, only journal papers written in English were considered: reviews, textbooks, doctoral dissertations and conference papers were also included in this study. In order to obtain comprehensive and reliable results related to the subject modern techniques of health and safety training, a two-level keyword structure shown in Table 1 was adopted. The time span of the literature search was restricted to 2000–2023.

A total of 25 academic papers retrieved from the ScienceDirect Freedom Collection, Elsevier database, Web of Science - Core Collection, Clarivate Analytics, Scopus, SpringerLink Journals databases were identified and analyzed. The main objectives of this review was to answer the following question: What are the major modern techniques and methods of health and safety training?

For the first step, following the flow diagram (fig.1), once the topic has been clearly defined, there were set up limits by language and date of publication. Then there were defined the search terms by running a couple of wide searches on the most commonly used databases in our subjects. We found some relevant articles and read through them highlighting key words or phrases. Then we used them as the basis for our search strategy. We made a list of the core terms and any synonyms and spelling variations.

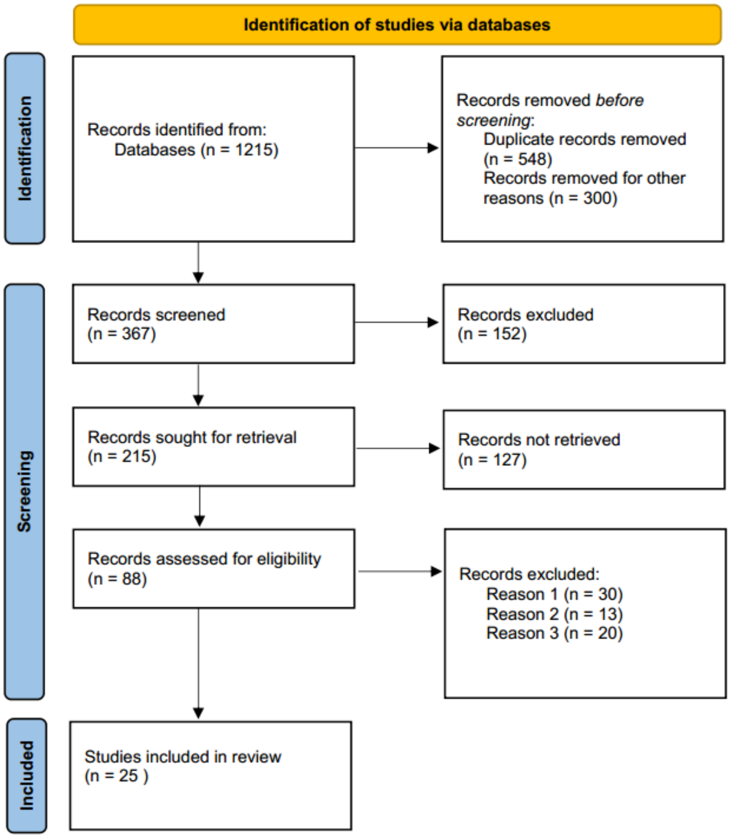

Fig. 1. PRISMA flow diagram

Because the most precise way to search any database was to use the words included in the thesaurus for the individual database, as new articles were added to a database, they were indexed using a list of approved keywords or thesaurus. This is why we always searched one database at a time - remembering that thesauri vary from database to database. Even natural language words can vary in the way they are used. Using this type of search produced very focused results. Also, because the research protocol required to widen out the search to ensure that is not miss out any research and many grey literature sources and search engines do not use thesauri, we used a combination of terms, alternative keywords when searching.

To complete the PRISMA diagram it was printed out a copy of the diagram to use alongside our searches. It is most efficient to search databases individually, so we printed out a copy for each database searched, plus a copy for the totals.

For each database we entered each key search term individually. This included all our search terms. We combined all the search terms in the different combinations using Boolean operators like AND OR as appropriate. We applied all our limits (such as years of search, full-text only, English language only and so on). Once all search terms have been combined and we have applied all relevant limits, we obtained a number of records or articles and entered this in the top left box of the PRISMA flow chart for each database. Because we have searched databases individually, we added all the 'records identified' up and fill this total number in the PRISMA flow diagram. This process of adding up the number of records in individual database searches to a total was repeated at each step.

For the articles identified through other sources than databases (like manual searches through reference lists of articles found, or search engines like Google Scholar), we entered the total number of records in the box on the top right of the flow diagram.

To avoid reviewing duplicate articles, it was removed manually any articles that appear more than once by going through all the records or articles found in the database. The number of records left after the removal of the duplicates was entered in the second box from the top.

The next step was to add in the number of articles that we have screened. This is the same number as we have entered in the duplicates removed box. In this step we screened the titles and abstracts for articles which were relevant to our research question. Any articles that appeared to help us provide an answer to our research question it was included. The number of articles excluded based on this screening process it was recorded in the appropriate box (next to the total number of screened records) with a short reason for excluding these articles.

Then it was subtracted the number of excluded articles following the screening phase from the total number of records screened and entered this number in the box titled "Fulltext articles assessed for eligibility". The full text for these articles was reviewed for eligibility.

We reviewed all full-text articles for eligibility to be included in the final review. At this stage we checked in our guidelines how many articles we should be left with. The number of articles that were excluded at this point was entered in the box titled: „Records excluded" and we write in a short reason for excluding the articles (it may be the same reason used for the screening phase).

The final step was to subtract the number of excluded articles or records during the eligibility review of full-texts from the total number of articles reviewed for eligibility. The number obtained (25) was entered in the final box.

3 Results and discussions

The deployment of information and communications technologies has profoundly changed the way that OSH training is delivered: e-learning, multi-media training materials, simulation tools, etc. [7], [8]. Learning techniques have also evolved: from a top-down mode from the teacher to the student, they have moved to an accompanying approach to knowledge acquisition. However, regardless of the contribution of information and communications technologies, a significant part of OSH training involves an application dimension that can hardly be totally dematerialized and handled remotely: occupational lifesaving, risk prevention (accidents and occupational diseases) related to physical activity or driving forklifts.

The need to strengthen safety training in general, and occupational risk prevention in particular, has been recognised for years by almost all the actors involved [9],[10]. However, according to the same actors, insufficient progress has been made in the past years: the question is therefore the same for the years to come. This type of training is essentially provided in the classroom rather than through remote learning.

The methods of continuing professional education are more diversified: short courses, e-learning, work-study, on-the-job training, blended learning, etc. Self-training (through

MOOCs) has played an increasing role in recent years. Overall, the role of internet should continue to grow. Logically, this raises the question of the level of control of the content provided by these different methods and of their evaluation.

OHS experts have a few training strategies accessible to them. Some are suited for specific sorts of instruction, and each has its advantages. Diverse techniques require more prominent or lesser participation, and training officers can utilize one or more of these strategies. From the study of OSH literature, we identified four central training systems.

1. *Instructor-Led Training*. Instructor-led training stays a standout amongst the most prevalent training systems. Teachers, frequently called facilitators, convey exercises in a classroom, e-learning, or self-managed workshops. Handouts and other intelligent techniques can be utilized together with PowerPoint introductions and recordings to clarify work health and safety subjects.

2. *Interactive Procedures*. Some creative training techniques include:

- *Small Gathering Dialogs*: Members are isolated into small gatherings and offered subjects to examine, this being a very good method to share learning.

- *Contextual analyses*: Breaking down occupation-related circumstances enables employees to handle comparable situations.

- *Questions & Answers Sessions*: Question and answer sessions are compelling with little gatherings of specialists for refreshing and fortifying aptitudes.

- *Re-Enactment*: Accepting jobs and carrying on situations causes employees to figure out how to handle different situations they encounter with work.

3. *Hands-On Training*. Another technique that is often tried out is Cross Training and enables employees to encounter different occupations in the work environment. Features include: training through an exhibit, which is excellent for instructing employees to utilize new hardware securely, spotlights on enhancing execution by tending to the necessities of individual employees, shapes unpracticed specialists to fit into particular occupations. Also, cross training is a very good approach to rehearse or practice skills and abilities most employees wouldn't know even existed.

4. *E-Learning*. Numerous organizations have employees in various areas, making eyeto-eye training unfeasible. Everybody approaches the web today making it workable for organizations to prepare on the internet. To do this successfully, a company will need to use a learning management system that include: *online training* (this technique benefits PC constructed training modules concerning the web that is accessible using the organization's intranet or site), *video conferencing* (coach in one area and trainees scattered in a few areas and associated either using phone or web talk), *sound conferencing* (like video conferencing, however, includes sound and members can call or email the moderator).

Whithin the four central training systems mentioned above thare are a large number of modern mehods and techique used, such as:

Virtual Reality (VR) technology. Virtual reality, that uses control mechanisms, challenges, interest, cooperation and competition as learning techniques has been developing rapidly since 2012 [11]. Through virtual reality, computer games are increasingly used in occupational safety training. The essence of games with the use of VR is that the worker sees on the display of the goggles a simulated environment, and the device tracks its movements and reflects them in virtual reality. For the purposes of training in safety, VR can be used to simulate the evacuation of employees during life-threatening situations, e.g. fire, first aid. In addition, they can be used for a virtual tour of the production hall, learning how to use machines and devices.

A research conducted in 2009 showed that trainings conducted using *games* from the perspective of efficiency are above other traditional adult teaching methods (lecture, discussion, case study) and the effectiveness of training using this type of tool is from several to several dozen percent higher than the traditional form, depending on the group structure, training theme, individual characteristics of the participants and the style of conducting classes [12].

An effective tool for OSH trainers is *Risk Mapping* to engage participants in an active process of hazard identification that is centered on what the trainees themselves view as significant hazards [13-17]. In this modern training method trainees are asked to create a schematic drawing of their workplace and, armed with various colored markers, to note the specific hazards they identify in each area, associated with each process, machine, and so forth. Different colors are used for chemical, physical, ergonomic, safety, and stress hazards.

Also like risk mapping, *body mapping* allows participants to identify work-related health symptoms through a process of graphic representation by given them an outline of the human body, on which they place dots indicating where they experience pain in their bodies in order to see common patterns of health symptoms that may be.

Another very effective methods of engaging participants actively in a training program and requiring them to apply knowledge gained in real-life situations are hands-on exercises and *simulations*. This method can be used to practice relatively simple tasks, such as fittesting a respirator, or for more complex operations, such as putting into practice an emergency response plan for a hazardous chemical release. These methods are particularly effective in reinforcing training messages because they require trainees to reflect on lessons learned, “leading to the development of strategies for handling unforeseen events” [18].

Role plays that can be used to present a problem to a group of trainees and to engage them in an active way in a process of reflection and development of possible solutions to the problem [19, 20]. For example, in a typical role play, trainers might seek volunteers from among the trainees to read a simple script that presents a situation in which a worker faces a serious safety hazard at work, but fears losing her job if she raises her concerns to her employer. The trainer would then turn to the full group and ask them to give their opinions on how the worker should respond in this situation.

Widely used in OSH training, *Computer-based instruction*, can range from entirely passive programs that simply put lectures into a computer presentation format to highly engaging, interactive programs requiring trainees to reflect on messages and to apply new information to solve problems [21, 22]. Also, effective computer-based instruction should provide feedback to trainees in order to enable them to evaluate their progress and learn from mistakes.

Arts-based approaches such as “photovoice,” theater, video, and other arts-based approaches can engage trainees in creative processes to identify problems and reflect on solutions in ways that often feel more “real” to participants than traditional training. “Photovoice” is a creative approach that can been used as a method of participatory hazard identification in which, for example, workers are equipped with cameras and asked to photograph hazardous situations on their jobs, then the photos to be used as the basis for group discussion and reflection on solutions to these safety and health hazards [23, 53].

Storytelling is yet another creative method of training that can be a powerful learning tool because many workers in highly hazardous trades learn job- and safety-related skills and information more from their peers than from professional trainers. A study of the use of storytelling as a training technique among mineworkers argues that one of the most compelling methods of getting young miners’ attention is to have experienced miners tell them stories of workplace disasters that led to deaths and injuries of friends and co-workers [24].

A study was realized in United State on a sample of 1,436 dairy workers that received safety awareness training on a mobile device platform. Training participants rated their training experience favorably, and applied knowledge gained in their daily work activities three months after training. The findings of this study suggest the utilization of mobile learning techniques is an effective means to deliver safety awareness training content to workers and also that worker safety training should be culturally, linguistically, and literacy appropriate and comprehensive in nature to include all applicable safety hazards. The study observations support the use of mobile devices as just one component of a more comprehensive health and safety management program on farms [25].

Also, artificial intelligence (AI) finds increasingly growing applications in the working environment. The development of AI brings with it many opportunities, but the serious risks arising from it should not be forgotten either. Artificial intelligence is having an increasing impact on employee health and safety.

Artificial intelligence can be used in many ways in the work process. The literature indicates that the impact of AI on human labour comes down to the use of computational methods that rely on collecting and processing data to undertake specific actions. It can be applied, among other things, to coordinating machinery and industrial processes, managing the workforce (especially from an HR perspective), assessing customer risks and benefits, and analysing staff safety [26].

Assessing employee performance using technological processes is one example of a new approach to work [27]. Assessing an employee's potential future illness or the occurrence of an occupational disease after examining the employee's genes is also an example of the new goals for which AI is used.

4 Conclusions

The deployment of information and communications technologies has profoundly changed the way that OSH training is delivered: e-learning, multi-media training materials, simulation tools, etc. Learning techniques have also evolved: from a top-down mode from the teacher to the student, they have moved to an accompanying approach to knowledge acquisition. The methods of continuing professional education are more diversified: short courses, e-learning, work-study, on-the-job training, blended learning, etc. Self-training (through MOOCs) has played an increasing role in recent years. Overall, the role of internet should continue to grow.

OHS experts have a number of training strategies accessible to them. Some are suited for specific sorts of instruction, and each has its advantages. Diverse techniques require more prominent or lesser participation, and training officers can utilize one or more of these strategies. From the study of OSH literature, we identified five central training systems: Instructor-Led Training, Interactive Procedures, Hands-On Training, E-Learning.

We hope that our findings, given the multiple needs, goals, and intentions of occupational safety training, will represent a significant foundation that practitioners and researchers can test, challenge, and build upon. Contrasts and seeming contradictions emerge when we consider how one training application, such as the use of computer-based technology, may both enhance and detract from occupational health learning and practice. Also, we found that there are many gaps in knowledge and practice which present opportunities for further progress.

The results presented in this paper are partial results from the project PN 23 45 03 03 „Development of informative content and online training system of occupational safety and health information in the context of intelligent specialization”.

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