

DESIGNING THE TRAINING OF CONSTRUCTION WORKERS THROUGH THE USE OF AI AND AUGMENTED REALITY

PROGETTARE LA FORMAZIONE DEI LAVORATORI EDILI ATTRAVERSO L'UTILIZZO DELL'IA E DELLA REALTÀ AUMENTATA

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ABSTRACT

Emotional Artificial Intelligence (EAI) is being studied for its effectiveness in the educational inclusion of migrants in professional training. This research will analyze the implications of EAI in pedagogical design, learning paths, and the evaluation of training courses for migrant construction workers. The goal is to assess, using grounded and evidence-based methodologies, the contribution of EAI in enhancing empathy, learning specific languages, and focusing attention on critical phases of the training process.

L'Intelligenza Artificiale Emozionale (AEI) è studiata per l'efficacia nell'inclusione educativa di migranti in formazione professionale. Si analizzeranno le implicazioni dell'AEI nella didattica, percorsi di apprendimento e valutazione di corsi per operatori edili migranti. L'obiettivo è valutare, con metodologie grounded e evidence-based, il contributo dell'AEI nell'empatizzare, apprendere linguaggi specifici e concentrarsi su fasi critiche del processo formativo.

KEYWORDS

Emotional Artificial Intelligence; Inclusive education; vocational training

Intelligenza Artificiale; Inclusività; Formazione professionale

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1. The main challenges of entry-level training for workers in the construction sector in Italy.

This paper aims to analyze the main challenges associated with the vocational training of construction workers in Italy, particularly focusing on safety training targeting young migrants. Additionally, it proposes an experimental training design utilizing AI and augmented reality applications to mitigate these challenges. Safety concerns in the workplace are particularly remarkable in Italy. According to 2022¹ INAIL information, the construction sector ranks third in the number of workplace accidents (28,653) and first in the number of fatal incidents (84), with 20% of accidents involving migrants. The leading cause of fatal accidents is falls from height.

The need to quickly recruit and train human resources for construction sites results several challenges for training design experts:

- The complexity and difficulty in standardizing construction site operations, which vary over time, by location, and according to the type of work performed²;
- Rigid, predefined knowledge packages aimed at certification requirements;
- Fragmentation and inadequate scheduling of labor demands, influencing the timing and setting of training activities with a focus on cost-efficiency and the need for rapid certification of workers for deployment at sites;
- Trainees' habits of established work practices learned informally or non-formally, often non-compliant with regulations;
- Non-uniform education levels among trainees, predominantly low;
- Linguistic and cultural heterogeneity within the learning group;
- Inadequate knowledge of a common vehicular language.

This research opportunity is linked to training activities outlined in a memorandum of understanding for the training of migrants in construction, signed between the CFS Training Center for Safety (now Formedile³) and the LESS Social Cooperative. In

¹ INAIL, Annual Report 2022, Accidents and Occupational Diseases – Data from 2022.

² In this regard, see the rationalization contribution proposed with the matrix for the use of artificial intelligence (from Becker, Spöttl, and Windelband, 2022) and the difficulty of applying AI to complex processes with machinery and operations that are not easily standardized.

³ The CFS Napoli (Training and Safety Center Naples) is a joint body for training and safety in construction in Naples and its province, managed by the social partners in the construction sector, Acen, the Association of Building Constructors of Naples and Province,

2023, this circumstance led to an experimental training course for developing skills related to a versatile construction worker. The 180-hour course was conducted face-to-face, with 120 hours in a workshop setting focusing on main construction tasks. The training involved 20 participants aged between 17 and 32, from Central Africa, the Maghreb region, and Egypt, speaking three main vehicular languages (Arabic, English, French). To enhance training effectiveness a 25-hour Italian language enhancement module was added at the beginning, and a cultural-linguistic mediator was involved throughout to facilitate group dynamics and training engagement. The 35-hour module dedicated to workplace safety regulation and best practices was delivered in a lecture format. Despite the resistance from the training entity regarding the pedagogical design of this phase, concerns primarily related to the standards set by reference teachers and compliance with mandatory legal requirements.

Final feedback from course participants showed promising outcomes despite the highlighted challenges. Thirteen trainees completed the activities, with a dropout rate of 35%. No significant correlations were found between participants' age, country of origin, or vehicular language concerning the dropout group. Furthermore, from the analysis of qualitative monitoring questionnaires administered at the end of the course, the main issues emerged primarily in linguistic content and safety and prevention delivered in a lecture format. The workshop component, despite being led by expert craftsmen lacking specific linguistic skills, was recognized as an effective knowledge transfer mechanism through imitative learning (Fraunfelder, 2001). This was further enhanced by the use of videos shot by participants on various specific work phases, assisted by the cultural-linguistic mediator.

In this context, significant literature has shown that the activation of mirror neurons is independent of the observer (whether a human or a monkey and can even be the observer themselves). This neural activation selectively discriminates between types of actions based on their intentional meaning, referred to as “action vocabularies” embedded in the premotor cortex (Rizzolatti, Sinigaglia, 2006): different groups of mirror neurons correspond to different types of practical actions, each characterized by the specific motor intention it aims to achieve. The underlying assumption is that the meaning of these “lemmas” in the vocabulary is accessible to multiple subjects, albeit through different modes (perceptual for

and the trade union organizations of the category in Naples and Province, Feneal Uil, Filca Cisl, and Fillea Cgil. It focuses on training construction workers with a particular emphasis on the themes of safety and health protection in the workplace.

observers and performative for actors), providing the basis for shared cognitive and gestural performance complexes among multiple subjects (Cappuccio, 2008)

2. Designing a professional training pathway through the integrated use of AI and augmented reality with a focus on emotional engagement.

The analysis of the outcomes from the 2023 course led the signatory entities of the memorandum to consider a second edition incorporating some innovations, already from the planning stage aimed at improving overall training performance. These enhancements focus on individual motivation for learning, greater involvement of the learning group during formal learning stages, and the use of new specific technologies⁴ along with a greater emphasis on non-formal and informal educational modes. Accordingly, the design of the training activity has developed the following advancements to more effectively address some of the challenges highlighted in the previous paragraph.

Centering on emerging training needs and methodological innovations in the educational field, there is a recognized need for an inevitable paradigmatic shift from traditional methodological-educational models to a teaching methodology that assumes a cyclic inversion/rotation of educational action, respecting individual timelines (Corona, De Giuseppe, 2017). Through 'Flipped Inclusion', the concept of inclusion as a systemic process of ecological development (Bronfenbrenner, 2002) is combined with the value of flipped educational logic as a transformative non-directive alternative regarding timings and roles, focused on individuals and educational contexts, whether formal, informal, or non-formal.

In this 'simplicity' logic (Berthoz, 2011), during the planning phase, it was preferred to define in parallel, rather than sequentially, the delivery of linguistic enhancement content and the modules related to safety and prevention in the workplace. For the implementation of both formal learning modules, a 'flipped inclusion classroom' formula will be tested, supported by an artificial intelligence application specialized in linguistic translation⁵, available at low cost. This application allows for the creation of short videos that can be translated and edited in over 130 languages, reproducing speech through the sampling of the image and voice of the subject recorded. This application is particularly effective for learning specialized languages and for linguistic learning connected to specific situations or tasks. Alongside traditional Italian language lessons, learners will create short video

⁴ In this regard, see the interesting contribution by G. Attwell, L. Deitmer, V. Tütlys, S. Roppertz (2020) on the skills of trainers in relation to the use of AI and digital technologies.

⁵ <https://it.rask.ai/ai-video-translator>.

clips where they can learn correct forms of expression from their own avatars (Iavarone 2022), which will also become their benchmark for effectiveness in video curriculum presentations, in an interview, or in typical scenarios. Similarly, the formal learning module dedicated to safety and prevention at work will use short video clips, featuring teachers and participants, to summarize and focus on the main contents of the lessons. The teachers will be translated by AI into vehicular languages, thus also providing valuable support material for studying the content. Learners, in turn, will be involved in video clips created by AI in Italian, where they will present the learned content in appropriate language.

Additionally, in connection and support of the safety and prevention module, during the laboratory phase, slots of content delivered through augmented reality simulators equipped with visors and gloves will be activated for learning safe work procedures on scaffolding and related to the management of suspended loads. This methodology allows for learning through emulative processes (Bandura 2001) with features of 'embodied cognition' (Araujo, 2020). Finally, the training course will include specific ongoing monitoring with the support of the Chair of Experimental Pedagogy at DiSMMeB of the *University of Naples Parthenope*, to ensure a third-party assessment of training effectiveness.

Conclusions

The discussion on the use of Artificial Intelligence in the construction sector, in contexts characterized by complexity and the challenging standardization of task organization, coupled with the variability of setups over time, locations, and types of work performed, currently resides in a gray area. External constraints imposed by the demand fragmentation particularly in the absence of public construction expenditures, and the difficulty of using advanced machinery and tools controlled by AI that can balance preventive needs with market competitiveness, necessitate solutions in training and human resources development that can creatively interpret the complexity of contexts and the cost-effectiveness and sustainability of proposals.

In this sense, the reported experimentation innovates through the use of linguistic AI, leveraging intuitive technologies that directly overcome linguistic barriers and activate emulative learning processes. The instructional design revisits models already tested in other contexts and based on Flipped Inclusion enhanced by the use of technologies. For these reasons, mirroring in one's competent avatar can increase motivation for learning and significantly disambiguate conveyed content,

while simulation technologies can activate, through gaming and informal education, behaviors and new perspectives capable of identifying risk behaviors according to different contexts. Furthermore, the use of AI in participatory teaching will help reduce gaps related to the cultural heterogeneity within groups, improving the sense of self-efficacy in learning processes. The challenge of training young migrant construction workers relies on a balanced mix of easily replicable teaching methodologies and low-cost technologies, capable of meeting the labor demand with effective results and in a timely manner.

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