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DESIGN OF A LEARNER-CENTRED OCCUPATIONAL SAFETY AND HEALTH TRAINING PROGRAM FOR THE MINING SECTOR (OSHTP)

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ABSTRACT

Background: In Angola and Mozambique, the growth of the geological mining sector reinforces OSH training requirements in remote and high-risk operations, highlighting vulnerabilities in prevention and safety culture. **Objectives:** To describe the design of the Occupational Safety and Health Training Program (OSHTP) and the trainee-centred methodology. **Methodology:** The program consists of 180 hours and is worth 6 ECTS credits, comprising five modules that are designed using a constructive alignment approach (linking skills to outcomes, activities, and assessment evidence), which includes technical visits. Each class follows a structured cycle: a 45-minute presentation, a 15-minute reflection period, 90 minutes of group problem-solving, and a 30-minute individual assessment conducted in an e-learning format. **Results:** OSHTP combines occupational hygiene/safety and health at work (OSH), risk assessment and control, technical safety, and fieldwork to produce evidence of learning. **Conclusions:** The design aims to reinforce applied skills (hazard identification, control selection, and emergency preparedness) and align assessment with diagnosis, feedback, and digital portfolio.

Keywords: Occupational Safety and Health, Mining Industry, Learner-Centred Learning.

1. INTRODUCTION

The geological-mining sector has grown significantly in recent years in Mozambique and Angola, driven by increased investment, project expansion, and greater demand for specialised technical services across the mineral production and processing chain (MIREME, 2023; International Trade Administration, 2024; Kirshner & Power, 2015; Chuvambe, 2025). In Mozambique, recent developments in the sector (including industrial operations and artisanal and small-scale mining contexts) highlight the pressure on technical capacities, regulation, and work organisation, with direct impacts on operational management and risk control (Hilson *et al*., 2021; Kirshner & Power, 2015).

At the same time, mining activity poses additional challenges to OSH: operations in demanding environmental conditions, geological and geotechnical instability, remote locations that hinder emergency response, and a high diversity of deposits, which implies different technological choices (e.g., underground vs open-pit methods and different support/stability solutions) (Li *et al*., 2022; Cheng & Hou, 2025; Manjate *et al*., 2024). These factors materialise in relevant hazards and exposures, both in underground mines (e.g., atmosphere control and emergency/self-rescue management) and open pit mines (e.g., slope instability/rockfall and accidents associated with operations and equipment) (Marchelli *et al*., 2023; Li *et al*., 2022; Cheng & Hou, 2025; Qi *et al*., 2025). The consequences include a high risk of accidents and occupational diseases, the performance of tasks without systematic risk analysis and consistent implementation of preventive measures, and, in many contexts, a weak safety culture and institutional gaps in the organisation of OSH services (Masekameni *et al*., 2020; Ncube *et al*., 2018).

Despite the availability of technical and higher education courses in geological engineering, mining, and mineral processing, OSH is often treated as a partial component, with insufficient depth to equip students and professionals with the necessary skills to intervene effectively in mining contexts. Added to this is the shortage of qualified professionals and installed capacity in occupational health/OSH services in countries in the region, including limitations in training, coverage, and service integration, which contributes to operational decisions with inconsistent critical controls and a higher probability of serious events (Masekameni *et al*., 2020; Rantanen *et al*., 2012; Ncube *et al*., 2018).

In this context, a short, structured, competency-based program—the Occupational Safety and Health Training Program (OSHTP)—aims to bridge the gap between general training and the specific requirements of the sector, strengthening hazard identification, risk assessment and control, emergency preparedness, and daily operational control, seeking alignment with international best practices and a culture of prevention. The OSHTP design is modular, responds to local needs, and incorporates technical visits to production and processing units, reinforcing the link between risk/control concepts and the reality of work.

This article describes the design of the OSHTP and its learner-centred teaching-learning methodology (Bremner *et al*., 2016). It presents (i) the target audience and the skills to be developed; (ii) the course structure (five modules, 180 hours/6 ECTS); (iii) an active classroom cycle, with 180 minutes divided between theoretical presentation (45 min), reflection break (15 min), problem solving in small groups (90 min; maximum three trainees per group) and individual assessment (30 min), supported by real cases and problems; and (iv) an assessment approach, integrating formative and summative components, with an initial diagnostic questionnaire (aimed at adjusting some aspects of the course to the participants' knowledge), assessment tests per class, assessment and feedback throughout the course on the group work carried out, and a reflective summary that includes the report on the technical visit to a production unit.

2. Materials and Methods

2.1 Foundations and concepts

The OSHTP was designed according to a constructive alignment logic, in which competencies and learning outcomes are defined upstream and then mapped to module-level results, teaching-learning activities, and assessment evidence. This ensures consistency between what trainees are expected to achieve and what is actually taught, practised, and assessed.

This option reflects a competency-based and backward design approach, prioritising the demonstrable development of applied skills such as recognising hazards, selecting and justifying

controls, communicating risks, and acting safely in operational contexts. The course also adopts a learner-centred pedagogical orientation, in which participants are expected to actively construct knowledge through engagement with authentic situations rather than passively receive content.
Conceptually, the program is anchored in occupational safety and health practice in mining and quarrying, while pedagogically it assumes that meaningful learning is strengthened when concepts, activities, and evidence of performance are intentionally aligned.

2.2 Learner characteristics and context

The OSHTP is aimed at two complementary learner profiles: (i) students and graduates in Mining Engineering and related geological fields, and (ii) professionals and supervisors in mining operations or associated activities, such as prospecting, processing, and support services.
This dual target audience requires attention to different entry profiles, previous knowledge, professional experience, and motivational drivers. Accordingly, access requirements may include relevant prior training, interest in OSH, and access to digital devices and connectivity to support portfolio work and experimentation with 3D, AR, or VR-enhanced scenarios.
The occupational profile addressed by the course spans the mining cycle, including extraction, processing, support services, and audit or inspection contexts. The competency framework therefore integrates knowledge, know-how, and attitudes or behaviours, including work organisation, risk communication, and the promotion of a culture of prevention and zero harm.

2.3 Curriculum design and planning

The course was discussed and planned by a team comprising experts in the fields of education, mining engineering, and health and safety from four European (Portugal and Turkey) and African (Angola and Mozambique) countries. To define the course content and design, interviews were also conducted with stakeholders from industry, universities and the sector's legal and regulatory bodies.
The course architecture follows a modular structure of 180 hours (6 ECTS), combining contact hours and guided self-study. The revised organisation is structured into six pedagogical blocks, allowing curriculum planning to reflect both technical content progression and the learner-centred logic of the program.
Planning decisions were guided by alignment between expected competencies, module-level outcomes, teaching-learning activities, and assessment evidence. This means that the selection of content, sequencing of blocks, workload distribution, and classroom cycle were all designed to support progressive development from conceptual understanding to situated application and reflective consolidation.
Structured contact with industry, including technical visits, remains a critical planning feature because it connects classroom learning with real operational contexts and strengthens transfer to practice.

2.4 Learner-centred methodologies

The teaching-learning methodology is learner-centred, active, and practical. It is based on problem-solving and case studies anchored in work situations, with guided discussion and collaboration in small groups to explore solutions in realistic contexts.
The design promotes engagement, guided reflection, and risk-based decision-making, especially in relation to hazard recognition, control selection, and communication. Hybrid resources may

also be used where available, including digital tools that support collaborative activities, evidence collection, and self-directed learning.

Complementarily, immersive experiences such as VR, AR, or smartphone-compatible 3D scenarios can simulate dangerous situations in a controlled way, allowing trainees to practise cognitive and operational decision-making without exposure to unacceptable risk.

At lesson level, the standard 180-minute class cycle is maintained: 45 minutes of theoretical presentation, 15 minutes of guided reflection, 90 minutes of small-group problem solving, and 30 minutes of individual assessment. This repeated structure supports active participation, distributed practice, and consistent opportunities for evidence generation.

The use of immersive experiences strengthens *Learner-Centred Pedagogy* by placing the learner at the centre of more active, contextualised, and meaningful learning situations.

Resources such as simulations, virtual reality, augmented reality, or interactive scenarios make it possible to bring content closer to real-world problems and to foster exploration, decision-making, and critical reflection.

These approaches increase engagement, motivation, and participation, while also respecting different learning paces and styles.

At a methodological level, they align well with competency-based curriculum design, active learning methods, and formative assessment grounded in evidence of performance.

In addition, they can create safe environments in which learners can experiment, make mistakes, receive feedback, and reformulate their strategies for action.

Thus, immersive experiences constitute a relevant means of promoting meaningful learning, self-regulation, and the development of competencies in educational and professional contexts.

2.5 Formative assessment and feedback

Assessment is continuous and learner-centred, combining formative assessment throughout the course with summative components that demonstrate competence. The design follows a formative-first logic, in which diagnosis, rapid feedback, and timely pedagogical adjustment play a central role.

Individual assessment at the end of each session functions as a recurring mechanism for checking understanding, identifying gaps, and guiding subsequent self-study and reinforcement. Evidence can include participation, micro-checks or quizzes, performance in simulations, group outputs, individual assignments, and a Digital Safety Portfolio.

A typical weighting scheme integrates Continuous Assessment (40%), Assignments or Reports (20%), and the Digital Safety Portfolio (40%). Standardised tools such as a diagnostic pre-test, mid-course feedback, and post-test with final feedback support both learner progression and course quality improvement.

2.6 Implementation, inclusion, and reflection on practice

Implementation of the course requires attention to operational feasibility, access to devices and connectivity, and the adaptation of activities to diverse learner profiles and workplace realities. The learner-centred orientation therefore includes an explicit concern with inclusion, ensuring that participation is viable for both early-stage learners and experienced professionals.

Reflection on practice is embedded in the pedagogical design through guided reflection moments, evidence-based portfolio work, and analysis of authentic mining scenarios. These elements help learners connect conceptual knowledge with professional judgement and with the real constraints of mining operations.

At program level, implementation is also supported by digital questionnaires, a Learning Management System, and analytics dashboards used to report progress and support continuous improvement. In this sense, reflection is not limited to the learner; it also applies to the course itself, which is designed to evolve through feedback and evidence.

Table 1: *Revised course blocks, indicative content, and workload distribution*

Block	Indicative content	Hours (C/SA/T)
1	Foundations of OSH in mining; constructive alignment; competency-based design; learner-centred pedagogical principles.	8/16/24
2	Target audience, entry profiles, prior knowledge, learner diversity, access requirements, and occupational profile.	6/12/18
3	Curriculum architecture; module sequencing; planning logic; integration of technical visits and workplace-linked learning.	12/22/34
4	Problem-solving, case studies, collaboration in small groups, guided reflection, hybrid resources, and immersive scenarios.	16/26/42
5	Continuous assessment, micro-checks, individual session assessments, portfolio evidence, and feedback mechanisms.	12/18/30
6	Implementation conditions, inclusion, reflection on practice, LMS support, analytics, and continuous improvement.	16/16/32
	Total	**70/110/180**

Table 2: *Standard session cycle and pedagogical function*

Stage	Duration	Pedagogical function
Theoretical presentation	45 min	Establish common concepts and references.
Guided reflection	15 min	Consolidate learning and clarify doubts.
Group resolution (cases/problems)	90 min	Apply knowledge, make decisions, and justify control choices.
Individual assessment	30 min	Generate individual evidence and provide a basis for rapid feedback.

Note. C = Contact hours; SA = Self-directed study; T = Total hours.

3. Results

3.1 OSHTP design product: structure and content

Program overview

The resulting OSHTP is a short 180-hour (6 ECTS) course, organised into five modules, designed to balance (i) the fundamentals of Occupational Safety and Health (OSH) and occupational hygiene and (ii) the specific challenges and hazards of geological and mining activities. The modular architecture integrates core themes (safety culture, prevention by design, applicable legislation, occupational hygiene, and risk assessment) with operational domains typical of the sector (underground and open-pit operations, processing/refining, auxiliary services, and contexts such as quarries/sand pits and artisanal/small-scale mining). The course design combines theoretical content with systematic application to realistic scenarios, reinforcing the link between concepts (hazard, risk, control) and operational decision-making. The course load combines 70 hours of contact time with 110 hours of guided independent study, supporting a pace compatible with heterogeneous audiences (students, recent graduates, and active professionals) without losing methodological consistency between modules.

Rationale for module sequencing

The sequence of the five modules follows a logic of progression from the general to the specific and from the conceptual to the applied. Module 1 establishes the fundamentals of OSH and occupational hygiene in a mining context, including safety culture, prevention through design, typical exposures (e.g., dust, noise, vibrations, and contamination), and the legal framework. Module 2 contextualises the particularities of the mining industry, emphasising human-machine-environment interactions, equipment types, operational challenges, and technical, environmental, and community factors that condition preventive performance. Module 3 constitutes the core of risk assessment, integrating concepts and standards (including the ISO 31000 family), qualitative and quantitative approaches, hazard identification techniques, selection of preventive measures, and structured analysis of chemical, biological, physical, ergonomic, and psychosocial risks (including the logic of control by hierarchy). Module 4 consolidates technical safety areas, covering facilities, storage, lifting equipment, working at height, ergonomics, personal protective equipment (PPE), and hazardous biological agents, with a focus on operationalising controls and barriers. Finally, Module 5 anchors learning through technical visits to production and service units, including observation of mining operations, mineral processing, and safety and environmental management services, reinforcing the integration of theory and practice. In terms of distribution, the modules have workloads (contact/independent study/total) of 48 hours (18/30), 21 hours (6/15), 59 hours (24/35), 32 hours (12/20), and 20 hours (10/10), respectively, totalling the planned 180 hours.

Integration of technical visits

Technical visits were designed as structured learning events, rather than informal observational moments. The design explicitly links concepts worked on in the classroom (e.g., hazard identification, risk assessment, and control selection) to workplace realities, promoting (i) guided observation of critical tasks and areas, (ii) identification of dominant hazards and exposures, (iii) verification of critical controls (technical and organizational barriers), and (iv) reflective debriefing to consolidate lessons and reduce discrepancies between "procedure" and "practice." To enable this component, the design provides minimum implementation requirements: formal access authorisation, a safety briefing, adequate supervision during the visit, and the use of PPE compatible with the site and activity, ensuring compliance with the host operator's operating rules.

3.2 OSHTP delivery model: trainee-centred format and assessment evidence

Standardised class format as an implementation tool

A key outcome of the design is the definition of a standardised 180-minute lesson cycle, applied consistently throughout the modules: 45 minutes of theoretical presentation, 15 minutes of guided reflection break, 90 minutes of small group problem solving (with a maximum of three trainees per group), and 30 minutes of individual assessment. This format serves as an operational implementation tool: it stabilises the pace, ensures that each session contains (i) a minimum of conceptual explanation, (ii) a formal moment of consolidation/reflection, and (iii) recurring practice in applied tasks. At the same time, the final individual assessment segment introduces a regular mechanism for accountability and evidence collection, reducing reliance on a single moment of assessment at the end of the course.

Case studies and problem-solving tasks (examples without excessive detail)

Problem-solving tasks were designed to reflect typical OSH decision points in the mining sector, requiring trainees to justify choices and communicate decisions concisely. Examples of task *prompts* compatible with the OSHTP design include:

- Selection of controls by hierarchy: “Given a scenario of exposure to respirable dust at a work site, identify hazards, estimate the risk, and propose a package of prioritised measures (engineering/organisational/PPE), including verification of effectiveness.”
- Interpretation of exposures (noise/dust/vibrations): “Given monitoring results (or lack of measurements) and task descriptions, define exposure assumptions, additional measurement needs, and immediate operational control measures.”
- Elements of emergency and response plan: "For a plausible event (e.g., fire, ventilation failure, falling blocks/instability, accident with mobile equipment), outline response sequence, roles, communications, means, and control points, integrating evacuation and rescue."

These tasks are compatible with the risk assessment core, the technical safety domains, and the visit component, allowing reuse/adaptation to different types of operation.

Assessment evidence produced by the delivery model

The design generates recurring evidence at three complementary levels: (i) individual, through individual assessment at the end of each session (30 minutes), which produces regular indicators of mastery and allows for rapid feedback; (ii) small group, through outputs from 90 minutes of problem solving (justified solutions and control proposals), which demonstrate applied reasoning and collaboration skills; and (iii) at the course level, through the development of a digital safety portfolio (which includes technical visit reports). The final grade has three weighted components — Continuous Assessment (40%), Group work/reports and outputs (20%), and Digital Safety Portfolio (40%) — in which the portfolio replaces a logic centred on a single final exam and aggregates evidence selected by the trainee (cases solved, contributions to work, and final reflection).

Although they do not contribute to the final assessment of trainees, three other instruments play a structuring role in monitoring and continuous improvement during the implementation of the course, and are applied in a standardized manner: (i) a diagnostic questionnaire (pre-test) at the beginning of each module; (ii) an intermediate feedback survey, aimed at identifying constraints and making timely pedagogical adjustments; and (iii) a post-test with final feedback, revisiting items from the pre-test to estimate learning gains throughout the training course.

Thus, the evidence collected throughout the classes feeds both the formative progression and the evidence-based summative synthesis, maintaining alignment among objectives, activities, and assessment, and allowing for timely pedagogical adjustments when necessary.

4. Discussion

Expected benefits and educational value

The OSHTP design seeks to address a recurring gap between the theoretical coverage of OSH and the applied competence required in geological-mining contexts, particularly in countries where the sector has expanded and diversified (MIREME, 2023; ITA, 2024; Kirshner & Power, 2015; Hilson *et al*., 2021). By combining fundamentals (occupational hygiene, prevention principles, legal framework) with content and tasks focused on hazards and controls typical of mining, the course promotes learning transferable to operational decisions in high-energy, high-risk environments (Li *et al*., 2022). The emphasis on real-world scenarios (underground/open pit; processing; ancillary services) is consistent with the fact that exposures and accident mechanisms are heterogeneous: ventilation and confined spaces underground (Reho *et al*., 2018), slope instability and rockfall/rolling in open pit mining (Cheng & Hou, 2025; Marchelli *et al*., 2023), and relevant exposures (e.g., dust) with occupational disease potential (Masekameni *et al*., 2020). A distinctive feature is the systematic incorporation of repeated problem solving and structured reflection within a fixed lesson cycle (teach–reflect–solve–evaluate), which operationalises deliberate practice and reinforces risk-based decision-making skills (Trullàs *et al*., 2022). In particular, this design supports recurrent training in hazard identification, selection of measures according to the hierarchy of control, and technical justification of decisions, including critical dimensions such as emergency preparedness, evacuation, and escape/rescue routes (Qi *et al*., 2025; Rodrigues, 2017).

Implementation requirements (people, processes, and resources)

The effectiveness of OSHTP, as designed, depends on implementation conditions consistent with its learner-centred nature. From a human resources perspective, trainers/facilitators capable of moderating case- and problem-based learning (not just exposition) are needed, conducting guided discussion and formative feedback. This is particularly relevant because problem-based approaches tend to require greater investment in pedagogical coordination and human resources to maintain quality and consistency (Trullàs *et al*., 2022). From a process perspective, standardising the 180-minute cycle requires operational discipline: planning with clear objectives, short materials for the presentation component, cases calibrated for 90 minutes, and consistent instruments for individual assessment and feedback. From a resource perspective, a library of contextualised cases (underground/open pit, quarries/sand pits, processing, auxiliary services, and different scales) is crucial, aligned with the diversity of technologies and mining methods (Manjate *et al*., 2024). Technical visits, in turn, add authenticity and favour the "on-the-ground" validation of critical controls, but require minimum requirements (authorisations, briefing, supervision, PPE, and risk management during the visit) to prevent the experiential component from introducing additional risk.

Assessment and continuous improvement requirements

The sustainability of a trainee-centred model benefits from digital support for diagnosis and feedback, especially when resources are limited and standardisation is essential to reduce variability between classes. In line with evidence-based assessment systems, the structured collection of pre/post-tests, interim feedback, and evidence records (including digital portfolios) can be supported by LMS and simple monitoring dashboards; Recent reviews indicate that learning analytics dashboards (including AI approaches) have been used to monitor performance, identify patterns, and support data-driven pedagogical adjustments (Cabral *et al*., 2025). The inclusion of a digital portfolio as a reflective summary is consistent with the literature, which describes the e-portfolio as an instrument of evidence and reflection, useful for consolidating learning and documenting progress (Zhang & Tur, 2024). When resources are available, immersive tools (VR/AR) can enrich assessment with evidence of performance in hazardous scenarios, reducing actual exposure to risk; reviews in the mining/construction domain discuss VR applications for training, simulation, and hazard awareness (Strzałkowski *et al*., 2024).

Limitations and next steps.

This article describes the design product and its internal alignment (skills–modules–methodology–assessment), but does not demonstrate training effectiveness or transfer to the workplace. This limitation is particularly important in OSH, where the value of training depends on behavior change and the robustness of the "transfer climate"; richer models of engagement and transfer in safety training underscore the need to prepare pre-training conditions, optimize the organizational context, and maximize adherence during training (Casey *et al*., 2021). Recommended next steps include: (i) piloting OSHTP in representative contexts (types of operation and trainee profiles), (ii) evaluating gains with pre/post instruments and portfolio evidence, (iii) analyzing transfer (quality of control decisions, risk communication, implementation of emergency plans), and (iv) iteratively refining the case library and rubrics based on observed performance. These steps are consistent with the need to strengthen local capacity and OSH systems, which are often insufficient in contexts with a shortage of qualified professionals and limited-service coverage (Ncube *et al*., 2018; Moodley & Bachmann, 2002).

5. Conclusions

This article presented the design of the Occupational Safety and Health Training Program (OSHTP), a short 180-hour (6 ECTS) course structured into five modules and operationalised through a consistent, trainee-centred pedagogical cycle (theoretical exposition + reflection + problem-solving in small groups + individual assessment). The design focuses on building skills applied to geological and mining contexts, with an emphasis on hazard identification, risk assessment, selection and prioritisation of controls (including hierarchy of measures), and emergency preparedness, integrating dimensions of occupational hygiene and technical safety relevant to underground, open-pit, and mineral processing operations.

Key implementation facilitators include coherent modular sequencing, a structured classroom format that generates frequent evidence of learning, and an assessment approach aligned with a formative-first quality culture and (high-level) standards. Technical visits reinforce the theory-practice link, allowing critical tasks and controls to be observed in a real context, provided that clear safety and logistical requirements are met (access authorisation, briefing, supervision, and PPE).

Future work should focus on piloting OSHTP, validating learning gains and transfer to practice, and supporting continuous improvement cycles through simplified feedback and monitoring tools.

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References

Bremner, N., Zahedi, S., Venkat, P., Iyer, A., & Jaffer, R. (2026). Enablers and constraints of learner-centred education: Perspectives from two Indian schools. Pedagogy, Culture & Society, 34(1), 45–65. https://doi.org/10.1080/14681366.2024.2446737

Cabral, L., Pinto, R., & Gonçalves, G. (2025). *AI-powered learning analytics dashboards: A systematic review of applications, techniques, and research gaps*. *Discover Education, 4*, 525. https://doi.org/10.1007/s44217-025-00964-y

Casey, T., Turner, N., Hu, X. W., & Bancroft, K. (2021). *Making safety training stickier: A richer model of safety training engagement and transfer*. *Journal of Safety Research, 78*, 303–313. https://doi.org/10.1016/j.jsr.2021.06.004

Cheng, Y., & Hou, K. (2025). *Open-Pit Slope Stability Analysis Integrating Empirical Models and Multi-Source Monitoring Data*. Applied Sciences, 15(17), 9278. https://doi.org/10.3390/app15179278

Hilson, G., Maconachie, R., McQuilken, J., & Hilson, A. (2021). *Formalizing artisanal and small-scale mining in rural Mozambique: Issues, challenges, and ways forward*. Resources Policy, 71, 102001. Hilson-et-al-June-2021-Final-report.pdf

Hong, K. J. (2024). Effects of a problem-based learning education program for occupational health nursing using smart learning on occupational health knowledge and nursing professionalism. *Healthcare, 12*(7), 737. http://dx.doi.org/10.3390/healthcare12070737

International Trade Administration. (2024). *Angola—Mining and minerals* (Market intelligence webpage). https://anrm.gov.ao/

Karlsson, S., Saveman, B.-I., Hultin, M., Eklund, A., & Gyllencreutz, L. (2020). *Expansive learning process of exercise organizers: The case of major fire incident exercises in underground mines*. Sustainability, 12(14), 5790. https://doi.org/10.3390/su12145790

Kirshner, J., & Power, M. (2015). *Mining and extractive urbanism: Postdevelopment in a Mozambican boomtown*. Geoforum, 61, 67–78. https://pure.york.ac.uk/portal/en/publications/mining-and-extractive-urbanism-postdevelopment-in-a-mozambican-bo/

Li, S., Zhao, Z., Hu, B., Yin, T., Chen, G., & Chen, G. (2022). *Hazard Classification and Stability Analysis of High and Steep Slopes from Underground to Open-Pit Mining*. International Journal of Environmental Research and Public Health, 19(18), 11679. https://doi.org/10.3390/ijerph191811679

Mani, Z. A. (2025). Transitioning to competency-based education in nursing: A scoping review of curriculum review and revision strategies. *BMC Nursing, 24*, 1111. https://doi.org/10.1186/s12912-025-03319-y

Manjate, E. P. A., Okada, N., Ohtomo, Y., Adachi, T., Bene, B. M., Arima, T., & Kawamura, Y. (2024). *An AI-Based Approach for Developing a Recommendation System for Underground Mining Methods Pre-Selection*. Mining, 4(4), 747–765. https://doi.org/10.3390/mining4040042

Marchelli, M., Peila, D., & Giacomini, A. (2023). *Rockfall in open pit mines: Management of the pit geometry and protection measures design*. International Journal of Rock Mechanics and Mining Sciences, 170, 105551. https://iris.polito.it/handle/11583/2980755 ; https://doi.org/10.1016/j.ijrmms.2023.105551

Masekameni, M. D., Moyo, D., Khoza, N., & Chamdimba, C. (2020). *Accessing Occupational Health Services in the Southern African Development Community Region*. International Journal of Environmental Research and Public Health, 17(18), 6767. https://doi.org/10.3390/ijerph17186767

Chuvambe, Isabel (coordinator) (2025). *Independent Report of the Extractive Industry Transparency Initiative Year 2022*. EITI Mozambique_12th Report_I2A Consultoria (1)_Version 04 March 2024_0.pdf

Miranda, S., Marzano, A., & Vegliante, R. (2023). *An investigation of learning needs in the mining industry*. Education Sciences, 13(10), 1036. https://doi.org/10.3390/educsci13101036

Moodley, P. P., & Bachmann, M. O. (2002). *Inequity in occupational health services for government hospital workers in South Africa*. Occupational Medicine, 52, 393–399. https://doi.org/10.1093/occmed/52.7.393

Ncube, F., Kanda, A., & France, N. (2018). *Commentary on the Organization of Occupational Health and Safety in Southern Africa, the International Labor Organization, and Policies in General*. Annals of Global Health, 84, 500–503. https://doi.org/10.29024/aogh.2333

Paulsen, L., & Lindsay, E. (2024). Learning analytics dashboards are increasingly becoming about learning and not just analytics: A systematic review. *Education and Information Technologies, 29*, 14279–14308. http://dx.doi.org/10.1007/s10639-023-12401-4

Pireddu, A., Innocenti, A., Lusuardi, L. M., Santalucia, V., & Simeoni, C. (2025). The impact and effectiveness of virtual reality applied to the safety training of workers in open-cast mining. *International Journal of Environmental Research and Public Health, 22*(2), 151. http://dx.doi.org/10.3390/ijerph22020151

Qi, Y., Yu, K., Li, X., Wang, W., Cui, X., & Bai, C. (2025). *Mine fire emergency path planning based on hybrid strategy improved WOA algorithm*. PLOS ONE, 20(5), e0323789. https://doi.org/10.1371/journal.pone.0323789

Reho, T. T. M., Atkins, S., Talola, N., Viljamaa, M., Sumanen, M. P., & Uitti, J. (2018). *Frequent attenders in occupational health primary care: A cross-sectional study*. Scandinavian Journal of Public Health, 47, 28–36. https://doi.org/10.1177/1403494818777436

Rodrigues, C. U. (2017). *Configuring the living environment in mining areas in Angola: The case of the Lunda provinces*. The Extractive Industries and Society, 4(1), 23–30. https://doi.org/10.1016/j.exis.2017.10.001

Stamov Roßnagel, C., Lo Baido, K., & Fitzallen, N. (2021). Revisiting the relationship between constructive alignment and learning approaches: A perceived alignment perspective. *PLOS ONE, 16*(8), e0253949. https://doi.org/10.1371/journal.pone.0253949

Strzałkowski, P., Bęś, P., Szóstak, M., & Napiórkowski, M. (2024). *Application of virtual reality (VR) technology in mining and civil engineering*. *Sustainability, 16*(6), 2239. https://doi.org/10.3390/su16062239

Tichon, J., & Burgess-Limerick, R. (2011). A review of virtual reality as a medium for safety related training in mining. *Journal of Health & Safety Research & Practice, 3*(1), 33–40. https://www.burgess-limerick.com/download/a54.pdf

Trullàs, J. C., Blay, C., Sarri, E., & Pujol, R. (2022). *Effectiveness of problem-based learning methodology in undergraduate medical education: A scoping review*. *BMC Medical Education, 22*, 104. https://doi.org/10.1186/s12909-022-03154-8

Townsend, V., & Urbanic, J. (2013). Industrial field trips: An integrated pedagogical framework of theory and practice. *International Journal of Engineering Education, 29*(5), 1155–1165. https://www.ijee.ie/articles/Vol29-5/13_ijee2758ns.pdf

World Health Organization. (2004). *Occupational health and safety in the African region: Situation analysis and perspectives* [Report]. https://iris.who.int/handle/10665/93116

Woźniak, J., Strzałkowski, P., Pactwa, K., Bęś, P., & Szalek, M. (2025). *Occupational health and safety employees and emerging competences in environmental field in mining and other sectors in Poland*. Scientific Reports, 15, 41724. https://doi.org/10.1038/s41598-025-26141-7

Zhang, P., & Tur, G. (2024). *A systematic review of e-portfolio use during the pandemic: Exploring adoption, experiences, and learning outcomes*. *Open Praxis, 16*(3), 656–677. https://doi.org/10.55982/openpraxis.16.3.656