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20 years of integrated engineering courses in the three-year Degree in Environment and Workplace Prevention Techniques at the University of Turin

The Bachelor of Science in Environmental and Workplace Prevention Techniques (TPALL) of the University of Turin (UniTo) has also been training technical experts in occupational and environmental safety and health since 2003. Among the total 180 training credits, 24 credits are dedicated to specific engineering content, and deal with both plant design basics, and up-to-date Hazard Identification, Risk Assessment and Management techniques.

Since 2018, the teaching approach and organization have been managed within a framework focused on system quality, in collaboration with the International Training Centre (ITC) of the International Labour Organization (ILO). This made a timely adjustment possible at the time of the COVID-19 pandemic which involved a review of the entire degree course, with the introduction of solutions consistent with the UniTo guidelines, and, what is more, sustainable over time.

The paper summarizes the approach of the courses with engineering content in the Bachelor of Science in Environmental and Workplace Prevention Techniques, and the results in terms of effectiveness of the revised organizational and management approach, specifically adapted to engineering courses, to create a system as resilient as possible in terms of quality, sustainability and educational outcomes.

Keywords: university and higher education, engineering courses, OS&H and Environmental protection, quality management, resilient system.

1. Introduction

1.1. Integrated engineering courses within the Bachelor's Degree Programme in Environmental and Workplace Prevention Techniques

The Culture of Safety – result of a close synergy of integrated knowledges free from external conditioning – is paramount for the ethical and economic sustainability of preventing risks in production systems. In the context

of spreading this culture across all levels of education, the role of universities has become increasingly important (De Cillis *et al.*, 2017), as underscored by the EU report 'Mainstreaming Occupational Safety and Health Document into University Education' (EUOSHA, 2017). Within the present regulatory framework, the importance of highly educated experts capable of identifying hazards, risk assessment, and multidisciplinary risk management throughout the project lifecycle cannot be overstated.

The professional figure of the Engineer is characterized by a securistic culture (in terms of Occupational and Environmental Risk Assessment and Management) necessarily interpenetrated in its

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basic training. It is not conceivable – all the more so if we consider the need for a total quality vision, increasingly necessary due to the impressive progress of techniques and technologies – a design disregarding the conditions of implementation, and the results' characteristics. Neither the maintenance of efficiency of what has been achieved can lose sight of such criteria (Patrucco, 1997).

The three-year Bachelor's Degree Programme in Environmental and Workplace Prevention Techniques (TPALL) at the University of Turin (UniTo), started in 2003 in collaboration with the Local Health Authority (ASL-TO3) at the prestigious premises of Certosa Park (Fig. 1) and comprises 180 "Crediti Formativi Universitari (CFUs)¹".

¹ Roughly, one Italian CFU is equivalent to one European Credit Transfer and Accumulation System (ECTS).

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Fig. 1 – Location of the TPALL Bachelor's Degree Programme.

The successful completion of this Programme is designed to shape the professional profiles of healthcare providers responsible, within their respective competencies, for overseeing environmental hygiene and safety in both residential and occupational settings, food and beverage safety, as well as public health and veterinary hygiene (Bangieri and Fustinoni, 2022). A notable feature of the Turin Programme (Costa G, 2022), unique in Italy, is the inclusion of 24 CFUs of engineering educational content – equivalent to 240 hours of on-site teaching – structured

into 4 integrated courses with exclusive engineering content (Tab. 1). These courses are meticulously overseen to ensure quality² (ISO

² Quality management systems – Fundamentals and vocabulary – 3.6.2 quality: degree to which a set of inherent characteristics (3.10.1) of an object (3.6.1) fulfils requirements (3.6.4)., as also referred to in ISO 9000:2015 Quality management systems – Requirements (QMP 1 – Customer focus, P 2 – Leadership, QMP 3 – Engagement of people, QMP 4 – Process approach, MP 5 – Improvement, QMP 6 – Evidence-based decision making, QMP 7 – Relationship management).

9000:2015), which is governed since 2018 within a formal agreement between ITC-ILO and ASL-TO3.

1.2. The shock of COVID-19 on educational systems

The lockdown resulting from the COVID-19 emergency led to a temporary disruption of numerous activities (Sathishkumar *et al.*, 2020; Khalid and Ali, 2021), with a detrimental effect on the education system, resulting in an unprecedented change (Widi Winarso *et al.*, 2020) also for all Italian students. To ensure teaching continuity and mitigate the spread of the virus, most universities adopted e-learning as a solution (Chung *et al.*, 2020).

While e-learning had already been available at many universities for several decades, the rapid shift to widespread distance learning became a necessity, presenting significant challenges, stemming from the limited availability of user-friendly hardware and software for both professors and students,

Tab. 1 – Engineering courses within the Bachelor's Degree Programme in Environmental and Workplace Prevention Techniques.

Integrated course	Years	CFU	Teaching modules of the integrated courses
<i>Physical risk factors</i>	1 st y; 2 nd sem	5	Electrical and electromagnetic fields – 1 CFU, 10 h Ionizing radiations – 1 CFU, 10 h Occupational exposure to noise and vibrations – 1 CFU, 10 h Technological risk assessment I – 1 CFU, 10 h Technological risk assessment II – 1 CFU, 10 h
<i>Industrial and construction site risk assessment 1</i>	2 nd y; 1 st sem	6	Risk due to gas and vapours – 2 CFU, 20 h Risk due to fire and explosions – 2 CFU, 20 h Risk due to pollutants at workplaces – 2 CFU, 20 h
<i>Industrial and construction site risk assessment 2</i>	2 nd y; 2 nd sem	7	Electrical and electromagnetic fields: safety aspects – 2 CFU, 20 h Risk construction sites and infrastructure – 2 CFU, 20 h Prevention techniques: figures and official documents in yards – 1 CFU, 10 h Exposure assessment I: common environment – 1 CFU, 10 h Exposure assessment II: working environment – 1 CFU, 10 h
<i>Risk management</i>	3 rd y; 2 nd sem	6	Decision tree – 2 CFU, 20 h Prevention through design I: common environment – 1 CFU, 10 h Prevention through design II: working environment – 1 CFU, 10 h Risk control approaches – 1 CFU, 10 h Prevention techniques in a quality approach – 1 CFU, 10 h

y: year; sem: semester

along with heavy workloads and mounting pressure on education providers to balance teaching, research, services, and remote work.

This sudden transformation compelled educational institutions to harness existing technical resources to create web-based educational materials (Anwar and Adnan, 2020). As a result, faculty members and lecturers had to swiftly adapt the course's contents into new formats for online delivery, using tools that had been sparingly utilised before. All this coincided with the need for straightforward e-learning approaches, focused on reassuring students, which took precedence over introducing new pedagogical methods, flashy technologies, or complex online learning plans (Daniel, 2020). It is important to note that the urgency of responding swiftly to the lockdown situation was not solely rooted in the need to uphold students' education: more critically, it was driven by the imperative of safeguarding their psychological well-being. This became particularly critical due to the anxiety surrounding the transition to a new learning environment, and apprehensions about future employability.

The 'mandatory transition' to e-learning, officially enacted in Italy with a Decree issued by the President of the Council of Ministers on March 4, 2020, not only authorised the implementation of e-learning, but also exempted students from attendance requirements, and subsequent decrees continued to uphold distance education until the conclusion of the 1st semester of the following Academic Year (AY) 2020-21.

1.3. Our experience during the lockdown

Recognizing the critical situation that unfolded in early 2020, we initiated substantial organizational

efforts to optimize and implement online teaching. This undertaking proved to be particularly challenging given the prevailing circumstances, resource constraints, and the absence of established guidance models. All the same, as the formal lockdown measures were put into place, our approach was further refined to ensure the seamless start of the 2nd semester curriculum 2019-2020 (throughout this process, we remained in full compliance with the evolving guidelines issued by the university authorities, and the coordinator overseeing the Bachelor's and Master's Degree Programs in TPALL played a crucial role in the comprehensive management of all the TPALL courses, including the project here discussed).

The successful implementation of our new approach was made possible through a dual-pronged strategy. On the one hand, it relied on the well-established and rigorous framework defining the organisation and management protocols for the integrated engineering courses, alongside their corresponding assessment phases, unique within the TPALL programme, as highlighted in the minutes of two pivotal Bachelor's Degree Programme meetings held on November 6, 2007 and December 12, 2016. On the other hand, it capitalised on a pre-existing Moodle platform available at UniTo, an open-source software specifically designed to foster a user-friendly modular learning environment, ensuring accessibility even for individuals with limited digital expertise (Oproiu, 2015). Extensive prior research attests to the widespread adoption of this platform and its effectiveness in bolstering student performance (Costa C *et al.*, 2012; Keržič *et al.*, 2017; Novo-Corti *et al.*, 2013).

During the lockdown that affected the 2nd semester of AY 2019-20 and the 1st semester of AY 2020-

21, the lessons for the integrated engineering courses were delivered remotely through the Moodle platform. They were presented as pre-recorded video lectures, by means of the Kaltura application, and PowerPoint presentations in .ppsx format with audio commentary on the slides. Supplementary educational materials were provided to complement the lessons. All video and audio lectures were uploaded to the portal to enable students to follow the remote lessons on the scheduled days, as per the calendar, and access the relevant educational materials.

The following list details the special measures undertaken:

- a. at the conclusion of each lecture cycle, the professors conducted interactive sessions with the students through Webex video conferencing. These sessions provided an occasion for students to make questions, seek elucidation on lesson content, and engage in discussions regarding potential exam scenarios. These meetings were recorded, with the participants' consent and in compliance with privacy regulations, and made available for student reference;
- b. the Scientific Coordinator of the engineering integrated courses provided clear instructions to all professors on the format for conducting lessons and preparing educational materials, including headings, recording methods, privacy, copyright, etc., in compliance with the guidelines outlined in Rectoral Decree No. 870, dated 04/03/2020;
- c. a fully automated system was implemented to monitor students' attendance – for solely informational purposes – that tracked down access to the course materials on the platform within the scheduled dates. This approach ensured the ongoing participation of

students in the educational programme, a decision seen as reassuring for students and in line with the broader guidelines for educational delivery, as outlined in D.L. February 23, 2020 n. 6, and DPCM March 4, 2020;

- d. the final examinations for the integrated courses were conducted remotely via the Moodle platform, in accordance with Rectoral Decrees prot. 142212 dated 12/06/2020, No. 1355 dated 10/04/2020, and No. 1097 dated 20/03/2020. A thorough system test was conducted to ensure the smooth administration of the exams, and the procedures were communicated to the students in advance of the examination sessions. Each exam consisted of two parts: the first part involved the completion of several multiple-choice quizzes, covering the arguments discussed in each module of the integrated course. The second part, accessible only to the students who had obtained at least a pass in all modules in the first part – in line with the meaning of an integrated course – consisted of one in-depth question, assigned using a random selection mechanism to ensure coverage of all topics dealt with during the integrated course. The final exam grade was determined by a combination of the weighted average of the scores for the quizzes in the first part and the score for the in-depth question in the second part. Efforts were made to establish a suitable system for students with specific learning disabilities.

els were available, we conducted a literature review based on subsequently published works; in addition, we developed a structured questionnaire to systematically collect the opinions and suggestions of the students. Following the emergence of the pandemic, a substantial surge occurred in scientific research and publications related to education during these unprecedented times (Fauzi, 2022). In pursuit of continuous improvement and the establishment of parameters for tailored questionnaires, we conducted

a comprehensive bibliographic search (Fig. 2).

This search aimed to gather general insights into the subject matter and identify scenarios and studies that could offer valuable perspectives.

We used the following search query on the Google Scholar database: (“*covid 19*” OR “*pandemic*”) AND (“*university*” OR “*higher education*”) AND (“*learning*” OR “*e-learning*” OR “*distance learning*” OR “*online learning*”) AND (“*resilient systems*” OR “*adaptive organization*”).

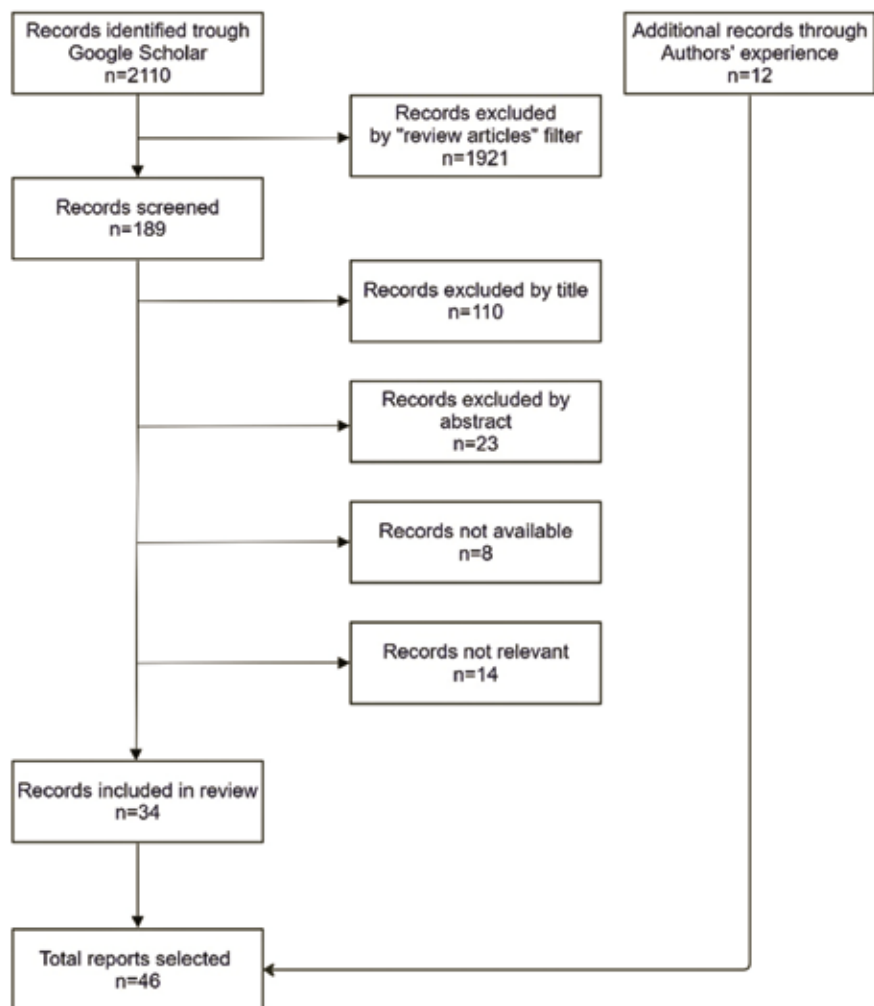


Fig. 2. Flowchart of bibliographic research. Total reports selected comprehend all references cited in the text (including papers, materials from the personal experience of the authors, and normative sources) and additional documents that have contributed to the research objective (Abdulkareem and Eidan, 2020; Alam et al., 2022; Alharbi et al., 2020; Ariesta et al., 2021; Dhawan et al., 2022; Dubey and Pandey, 2020; Emblemståg, 2021; Kapasia et al., 2020; Kedraka and Kaltsidis, 2020; Ionescu et al., 2020; Lassoued et al., 2020; Leo et al., 2021; Pawilen, 2021; Naciri et al., 2021; Ngoatle et al., 2022; Nomfundo, 2022; Pinto et al., 2021; Sahu, 2020; Simamora et al., 2020; Turnbull et al., 2021; Wagardinata et al., 2020).

2. Methods

To validate and refine the approach outlined in section 1.3, immediately implemented during a period when no reference mod-

Drawing from existing literature models (Almaayah *et al.*, 2020), we established parameters that represented performance assessment criteria to create dedicated questionnaires for TPALL students actively engaged in educational activities on engineering topics during and immediately following the pandemic period, the primary goal being to evaluate the effectiveness of the approach employed in the integrated engineering courses.

The questionnaires were used as an informal sub-investigation within Edumeter, the official tool for the assessment of teaching quality, and were designed to be anonymous and optional, offering a direct channel for the Scientific Coordinator of the engineering integrated courses to gather feedback on the re-shaped system management. The survey consisted of 18 sections with a total of 48 questions with closed-ended response options, including a final section to collect additional suggestions.

The questionnaire was administered to TPALL students during the pandemic period and the subsequent AY. As this was an optional survey, responses were received from 62% of students in AY 2020-21 and 47% in AY 2021-22.

3. Results

In the wake of the COVID-19 pandemic, an extensive body of literature has emerged (Amaechi *et al.*, 2022), encompassing a wide array of topics, with occasionally contradictory findings, including:

- a. techniques, tools, and methods for distance learning, the provision of educational facilities at various levels, the teachers' skills in effectively using them, and the students' ability to access and use such resources;
- b. psychological and sociological

dimensions (e.g., changes in teacher-student dynamics compared to traditional teaching, adaptation challenges, and anxieties regarding the future);

- c. organizational challenges, along with discussions about the pros and cons of the temporal gap between the availability of educational materials and their use by students.

The COVID-19 crisis forced universities to use digital tools to enhance their quality of teaching and learning. This transformation required the acquisition of dedicated systems and devices, as well as the recruitment of skilled personnel capable of effectively managing the use of appropriately selected new technologies. These changes were incorporated into a completely updated organizational structure, bringing in new ideas about adaptability and ongoing enhancements, as confirmed from the findings shown in Figure 2.

In this context, the European Commission has recently enacted the Digital Education Action Plan (2021-2027), outlining its vision for high-quality, inclusive, and accessible digital education across Europe (European Commission, 2020).

The results arising from the delivery of integrated engineering courses within the TPALL degree program were analysed alongside the questionnaire findings. As the following academic year approached, efforts were made to maintain the positive assets achieved during the emergency period. This was done in the pursuit of validation along with new ideas for improvement, drawing from the literature and students feedback on the new strategies implemented. The approach aimed to further enhance a resilient and effective environment in dynamic contexts, and encompassed the following actions:

- a. the lessons of the modules in-

cluded in the integrated engineering courses were conducted face-to-face, following the upload of educational material on the Moodle platform, downloadable the day before each lesson. A dedicated page was created on the platform, organized into distinct sections for each module in every integrated course. On students' request, access to the uploaded materials, even from previous academic years, remained available. The Scientific Coordinator of the engineering integrated courses provided guidance on how to access the additional materials on the platform and outlined the examination procedures during the introductory lesson of each integrated course;

- b. considering the proven effectiveness of the examination method, it was deemed appropriate to retain its basic criteria even with the resumption of face-to-face teaching, the only variation being the management of both the test phases in the classroom rather than online. This improved the interaction with the candidates, and any technical issues were more easily overcome. Occasional connectivity problems were solved by reconnecting to the platform and administering different prepared questions. This was possible due to an extensive collection of exam questions that had been ongoing for over a decade and was partially included in the educational materials at the end of each chapter, to provide students with self-assessment tools (Maxia, 2021).

4. Discussion

The study summarizes the 20 years history of the three-year TPALL Bachelor's Degree program at Uni-

To, with special reference to the integrated engineering courses which since its beginning have yielded a recognized and organic additional value, and presents an analysis aimed an unbiased evaluation of the effectiveness and quality of education provided in the engineering courses following the discussed approach. The research was developed through a comprehensive review of the available literature, which provided insights for designing the assessment criteria.

All endeavours aimed at enhancing the quality of the university education process fit into a broader context where resilience in teaching to unforeseen changes becomes essential. The analysis confirmed the effectiveness of the system adopted and implemented in less than a month, allowing the academic calendar to proceed without disruptions. This success was possible due to the presence of appropriate resources at UniTo and the pre-existing rigorous criteria for the engineering courses organization and delivery. The adopted approach provided tangible evidence of continuity and temporal stability, ensuring students that the planned teaching and tutoring remained on track, even in dramatically challenging circumstances. The introduction of self-assessment opportunities also encouraged students to independently delve into the covered topics, even during periods of distance learning. Moreover, all of this facilitated further improvements to the system after the emergency phase, which included the preservation of face-to-face examination methods with computer support, resulting in a further reduction in the time delay for publishing the exams results.

Finally, as part of our ongoing commitment to continuous improvement, we have assigned new responsibilities to the Scientific Coordinator of the engineering-in-

tegrated courses. These tasks have emerged in response to insights gained during the ongoing program revision, aiming to prevent gaps and redundancies. As a result of these changes, several actions are currently in progress:

1. conducting a feasibility analysis for the implementation of short remedial courses for 1st year students. The data collected in 2021-22 has confirmed the advisability of this initiative. Once the roles and functions of the various professors and collaborators are re-established, content and schedules will be defined in consultation with students;
2. formalising scheduled meetings with student representatives;
3. substantially revising the approach to face-to-face teaching support activities to optimise the system's synergy;
4. updating the content of some teaching modules of the 3rd year Risk management integrated course, to copy with the substantial evolution of rules and recommendations, as well as the evolving Culture of Safety. This is consistent with the increasing adoption of innovative techniques and technologies, along with modern approaches to Hazard Identification, Risk Assessment and Risk Management (ISO 31000:2018; ISO IEC 31010:2019).

5. Conclusion

The study summarizes the 20-years history of the three-year TPALL Bachelor's Degree program at UniTo, with special reference to the integrated engineering courses, which since the TPALL Degree program beginning have provided a recognized additional value, and presents an analysis carried out to evaluate the effectiveness and

quality of the education provided in the integrated engineering courses as adapted to cope with the Covid 19 crisis.

The pandemic had a sudden and dramatic impact on university teaching. The organization of the courses with engineering content made possible to maintain good efficiency from the very first phase of the emergency, thanks to:

- a. the pre-existing internal organization (the engineering content Courses are managed within a quality-focused framework in collaboration with the International Training Centre (ITC) of the International Labour Organization (ILO));
- b. the resources already available in the University of Turin (UniTo), promptly implemented to professors and students.

In the Authors' opinion, the endeavours undertaken thus far represent a significant contribution to the advancement of robust and effective university teaching systems, well-equipped to meet the demands of high-quality education and adapt to unforeseen challenges.

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Declaration of interest

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