Designing a Pedagogical Framework for Transnational Training

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***Abstract*—This paper presents the pedagogical framework designed to be implemented in an engineering transnational pilot training composed of eight training courses, taught in five different higher educational institutions across four European countries. The major unifying role played by the pedagogical framework between the various courses' leaders, imposing the necessary discipline to integrate and align all the different training courses into the same transnational training project, is described.**

Keywords—pedagogical framework, transnational training, engineering education

I. Introduction

Higher educational institutions must adapt their formative offer to the constant changing needs of employers and society. One of these current needs is the decarbonization of buildings [1], within the challenge of the European Union for 2050 to decarbonize the economy. Nowadays, the concept of sustainability in construction has been extended to health and well-being, as the need to create healthy built environments is becoming increasingly present [2]. However, Construction 2050 is considered to have other challenges, like the use of circular economy, in addition to minimizing the consumption of resources [3]. To achieve this goal, it is necessary to develop technologies in an integrated way and in a holistic approach, properly adapted to climatic, cultural and natural resource conditions, through circular economy methodologies [4]. This is an enormous challenge for all authors, technicians, scientists, policy makers and the population of all member states. Future professionals in these areas, who interconnect different areas of knowledge, will have different employment opportunities. In addition to creating professionals for decarbonization in construction, which implies sustainability criteria, the health of construction and the regeneration or restitution of construction are increasingly necessary and complementary challenges.

The need to provide suitable and adequate training for these future professionals is a big challenge for higher educational institutions [5]. In fact, this induces more flexibility on the study cycles since the current models of continuous training in different areas of knowledge, in general, take too long and lead to a difficulty in deepening knowledge, a recurrence of similar contents and an ensuing excessive workload. Thus, shorter, and more complementary study cycles may allow greater flexibility in the acquisition of knowledge, creating specialized training offers in addition to the existing ones. So, it is necessary to develop new training courses based on innovative training methods [6] with interdisciplinary content, with a European scope, allowing an effective continuous updating training.

This paper presents the pedagogical framework designed to be implemented in the European project Training for Sustainable and Healthy Building for 2050 (BUILD2050), coordinated by Polytechnic Institute of Setúbal from Portugal and promoted by the Erasmus+ Programme KA220 – Cooperation partnerships in higher education since February 2022. This project is an integrated and transnational [7] pilot training composed of eight training courses, taught in five different higher educational institutions across four European countries, that are designed to respond to the emerging challenges at European level in the different areas of construction: renovation, healthy and sustainable buildings.

II. Context of Application

BUILD2050 is a three-year pilot training project, from February 2022 to January 2025, in which 8 training courses are developed, using the blended learning approach [8], by Polytechnic Institute of Setúbal (IPS) from Portugal, University of Bologna (UNIBO) from Italy, Warsaw University of Life Sciences (SGGW) from Poland, National and Kapodistrian University of Athens (NKUA) from Greece and Polytechnic University of Milan (POLIMI), also from Italy, as shown in Fig. 1.

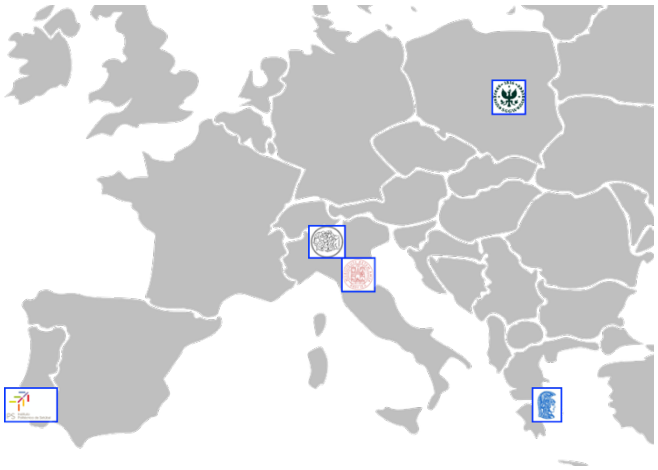

Fig. 1. BUILD2050 higher educational institutions leaders

Each one of these training courses are led by as follows: Course 1 - Innovative and transnational teaching methodologies applied to BUILD2050, led by IPS; Course 2 - Zero energy and positive energy buildings towards the full decarbonization, led by NKUA; Course 3 - Circular water management in buildings, led by IPS; Course 4 - Innovative construction materials, led by UNIBO; Course 5 - Digitization of buildings, led by POLIMI; Course 6 - Sustainable, healthy and regenerative construction, led by UNIBO; Course 7 - Circular economy and LCA methodology applied to construction, led by SGGW; Course 8 - Innovative business

models based on circular economy in construction, led by NKUA.

These training courses are taught sequentially, with a logical contents' sequence and 25 attendance hours each (5 hours per week). The students attending these courses will be graduates or professionals of architecture, physics, environmental engineering, civil engineering, mechanical engineering or power engineering from the countries of the higher educational institutions above-mentioned.

This project is developed in three phases, each lasting approximately one year. In the first phase, dedicated to the contents' preparation of the 8 training courses, associated partners offering relevant contributions to the preparation and evaluation of contents for each one of the courses are added to the BUILD2050 network. Also, one of the challenges within the scope of the project is the development and implementation of a common innovative pedagogical methodology for teachers, of all the academic institutions involved, to transmit the courses' contents and for students to perform active learning activities based on proactive research, collaborative working group, challenge-based learning, project-based learning and simulation. This demands the standardization of innovative forms of knowledge transmission to promote and guarantee the complementarity of contents between courses. In addition, the choice of appropriate contents in each training course to ensure that no contents' overlap or duplication exists between them has to be properly addressed.

So, at the first phase of project BUILD2050 a pedagogical framework has to be designed to support and monitor the courses' standardization, articulation and smooth integration.

III. Pedagogical Challenges

In general, designing innovative training courses starting from scratch requires careful planning and a suitable pedagogical framework to be implemented. In addition, the eight training courses of project BUILD2050 have some specific characteristics which present themselves as real pedagogical challenges.

A. Different Educational Institutions

The training courses of BUILD2050 are developed and taught by five different higher educational institutions across four countries (Portugal, Italy, Greece and Poland). This means that different time zones, native languages and school calendars have to be taken into account. Also, different pedagogical cultures have to be combined to generate a unique pedagogical strategy supported by blended learning, since in each training course there will be students attending face-to-face (the ones from the academic institution leading the training) and, simultaneously, students attending remotely (the ones from other academic institutions).

B. Transnational Teachers

Each training course of BUILD2050 will be taught by diverse engineering teachers from different academic institutions. This means that teachers with different pedagogical background and mindset, who probably have never worked together, have to collaborate to find a mutual teaching path to guide students in achieving the learning objectives of the training course.

C. Transnational Students

Each training course of BUILD2050 will be attended by students from different academic institutions and areas of knowledge, graduates or professionals of architecture, physics, environmental engineering, civil engineering, mechanical engineering or power engineering. This means students with different background knowledge and experience, transversal skills and technical language carrying out the same learning activities in order to achieve the learning objectives of the training course.

D. Synchronous and Asynchronous Classes

Each training course of BUILD2050 will have the total duration of 25 hours, distributed over 5 weeks for 5 hours per week: a 3-hour class in synchronous mode (with face-to-face students and students attending the course remotely) and a 2-hour class in asynchronous mode (with all students attending the course remotely). This means that the courses' teaching and learning activities, and all the didactic resources, must take into account these two learning modes.

IV. Pedagogical Framework

The pedagogical framework of a course training consists of establishing all the necessary elements in the pedagogical activity of a teacher at different levels of its performance and interaction with the students, considering the available timeframe. Some of these elements are the learning objectives, the contents, the teaching techniques, the learning activities, the didactic resources and the assessment method to be implemented. In the context of a transnational training, it is also fundamental the support of IT tools to help the course teachers to establish the development phases of the training structure.

The pedagogical framework of project BUILD2050 was developed over 7 months, from July 2022 to January 2023, taking into account in the teaching-learning process of the training courses all the pedagogical challenges previously addressed, and the references given by the European Working Group on Learning and Teaching [9]. In this context, the student-centered approach [10] was the teaching method chosen to support the design of this pedagogical framework, in which students are responsible for their own learning, fostering a proactive attitude in the engagement of their knowledge and acquisition of new knowledge to achieve the intended learning objectives of each training course. Also, the flexible profile of this method allows teachers to correct learning pathways, adapt pedagogical techniques and improve the learning activities, fostering the link between the contents, the learning objectives, the students' training needs and the learning techniques to be applied [11, 12]. In particular, in project BUILD2050 the pedagogical framework was designed based on the expansion of the pedagogical alignment [13], an upgrading of the constructive alignment [11].

The application of the expansion of the pedagogical alignment was motivated by the fact that constructive alignment only considers the learning outcomes (statements describing the knowledge or skills students should acquire by the end of the course training), the learning activities (activities developed by the teacher designed to bring about, or create, the conditions for students learning) and assessment (evaluation process used to measure what the students know or have learned), the three pillars of Bigg's constructive alignment that sustains the teaching-learning process, as

shown in Fig. 2 on, not taking into account several other pedagogical elements that are used in teaching-learning activities, such as contents, teaching resources, teaching and learning techniques, types of assessment, duration for each learning objective, among others. All these pedagogical elements may vary depending on the characteristics of the type of training, the motivation, the investment in terms of time in planning, the support resources used, the knowledge that the teacher has about the target students and the syllabus' topics and pedagogical practices that are intended to be implemented.

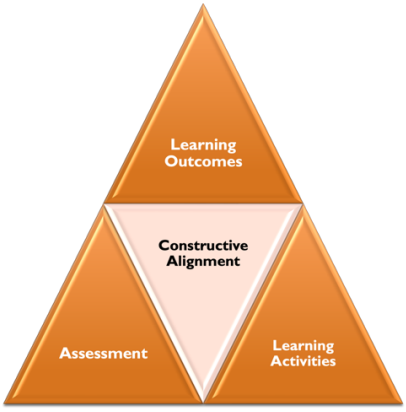

Fig. 2. Biggs' constructive alignment

In the expansion of the pedagogical alignment each one of the three pillars of Bigg's constructive alignment is extended for more two pedagogical items, as shown in Fig. 3. In particular, the learning outcomes are supported by Bloom's taxonomy [14], a set of six hierarchical models used to classify educational learning objectives into levels of complexity and specificity, and by the contents, which outline the subjects to be covered by the learning outcomes.

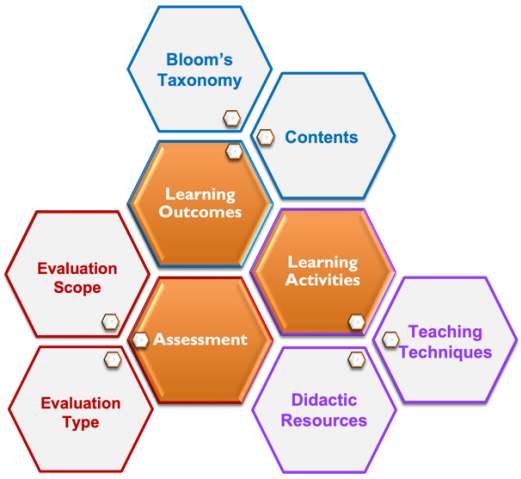

Fig. 3. Expansion of the pedagogical alignment

Also, the learning activities are supported by the teaching techniques (a set of procedures chosen by the teacher to engage students in the learning process) and by didactic resources (any pedagogical tool that helps the teacher to teach and the student to learn). In addition, the evaluation method is supported by evaluation scope (what is monitored or evaluated) and evaluation type (how the evaluation is carried out).

So, the expansion of the pedagogical alignment is an instrument that allows to set up the pedagogical framework of a training course, tailored to its requirements and aiming at technical-scientific and behavioural skills simultaneously. This development can be conducted in the context of outside and inside the classroom, in both synchronous and asynchronous modes, through intentionally designed and projected learning activities that use active learning techniques, fostering the exercise of the desired competences.

V. Setting Up the Pedagogical Framework

The pedagogical framework of project BUILD2050 was designed based on the expansion of the pedagogical alignment previously presented, supporting the teaching and assessment activities, the knowledge level of depth and the setting and duration of the learning activities, all aligned with the course's learning objectives. To this end, the 8 training course leaders, with the support of their teams, firstly had to set the learning objectives of each training course, considering the available timeframe and the level of knowledge intended. Learning objectives connect what students must be able to do, how will they get there and when will they be evaluated about. Afterwards, the contents supporting the learning objectives and the assessment elements for each learning objective were chosen. The next stage was to establish the teaching and learning activities, along with the active learning techniques to be applied. Finally, the development of the didactic resources to be applied was carried out. Since the 8 training courses of project BUILD2050 are to be taken in an integrated and transnational context, with face-to-face students and students attending classes remotely, in both synchronous and asynchronous modes, all the courses' didactic resources need to be digital, with the support of IT tools. So, the communication platform chosen for synchronous activities was MS-Teams and the learning platform chosen for asynchronous activities was Moodle. For setting up this pedagogical framework, the aforementioned hands-on pedagogical activities were carried out simultaneously by all course leaders within a timeframe of 7 months as shown in Fig. 4.

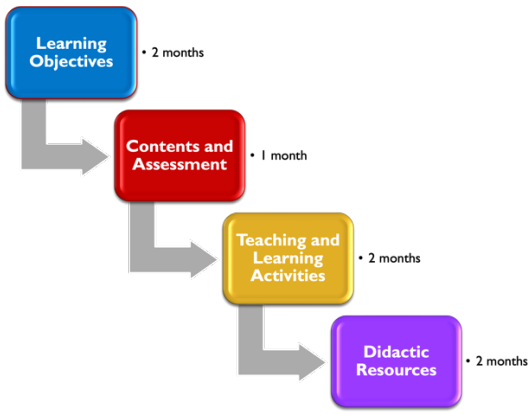

Fig. 4. Hands-on pedagogical activities performed by course leaders

In this context, the active learning techniques planned by the course leaders to be applied over the 8 training courses, designed according to the courses' learning objectives, were around ten: challenge-based learning, problem-based learning, interviews, role playing, video presentation, cooperative group, group evaluation, reflection about content focus, round-table discussion, think-pair-share and self-assessment. Within these active learning techniques, the challenge-based learning is the most complex of all, since

students are engaged with big ideas related to the subject, investigate proposed solutions and act considering practical issues [15,16]. The application of these active learning techniques, allowing the development of a set of soft skills needed for the job market, as shown in Fig. 6 on the top 10 skills of 2025 highlighted by the Word Economic Forum [17], in addition of the technical-scientific skills, emerges as an innovative pedagogical strategy in engineering trainings.

Fig. 5. Top 10 skills of 2025

VI. Final Remarks

The pressure that the needs of employers and society put on the higher education system fosters the constant urgency in updating the students' skills addressed at its training courses. These needs lead to profound changes that strongly demand new didactic and pedagogical paradigms in engineering education and so the future of engineering learning will require the conceptualization and implementation of a new learning model [18].

In engineering transnational training courses with reduced face-to-face classes, taught by teachers from different educational institutions across several countries, having different pedagogical backgrounds and mindsets, and attended by students from different academic institutions and areas of knowledge, the challenge of designing a suitable and adequate pedagogical framework is even bigger. In fact, in this context, the pedagogical framework plays a major unifying role between the various courses' leaders, imposing the necessary discipline to integrate and align all the different training courses into the same transnational training project. In particular, in project BUILD2050, the pedagogical articulation and integration of all its training courses into the same pedagogical framework before classes begin, using collaborative working group between course leaders, presents itself as a key to innovate pedagogically, in the sense that this pedagogical framework may act as a training guideline for teachers to focus on their activities during classes and for students to successfully achieve the courses' learning objectives.

The design of the pedagogical framework of project BUILD2050 is now concluded. In the second phase of project BUILD2050, from March 2023 to April 2024, the application of this pedagogical framework on the 8 training courses, which will be sequentially taught, will be followed up to evaluate its pedagogical efficiency.

Acknowledgment

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