INTERNACIONAL CONFERENCE
ON EDUCATIONAL INNOVATION
IN BUILDING

9° CONGRESO INTERNACIONAL INNOVACION EDUCATIVA EDIFICACION

DEPARTAMENTO DE TECNOLOGÍA DE LA EDIFICACIÓN
Escuela Técnica Superior de Edificación de Madrid
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CINIE 2026

18, 19 & 20 MARZO

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IX Congreso Internacional de Innovación Educativa en Edificación

IX International Conference on Educational Innovation in Building

ESCUELA TÉCNICA SUPERIOR DE EDIFICACIÓN

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GREETINGS

IX INTERNATIONAL CONGRESS ON EDUCATIONAL INNOVATION IN BUILDING (CINIE2026)

18th to 20th March 2026

The **International Congress on Educational Innovation in Building (CINIE)** has thus become an international forum for sharing knowledge, experiences, and innovations in educational innovation applied to the building sector. In a context marked by deep transformations in technology, society, and professionalism, the innovation of teaching and learning processes has become a fundamental requirement for the development of higher education institutions capable of addressing the current challenges of the construction sector.

The **ninth edition** of the congress takes place on the **18th, 19th, and 20th of March 2026** at the **Escuela Técnica Superior de Edificación of the Universidad Politécnica de Madrid (UPM)**, with the objective of bringing together researchers, teachers, and professionals and students interested in sharing innovative teaching practices, research findings, and new ideas for the improvement of higher education in the building sector.

The scientific programme of the congress will include **oral presentations and poster sessions** with some of the most relevant contemporary challenges for technical education, with special attention paid to the development of **three-dimensional technologies in education, active teaching in building education, educational innovation in technical training, and the new challenges and trends in the development of higher education in the built environment.**

The contributions included in this **Book of Abstracts** demonstrate the academic community's commitment to improving teaching and learning processes and to integrating new pedagogical approaches that align students' technical knowledge and skills with technological innovation and the new challenges of the professional sector.

On behalf of the Organising Committee, we would like to thank all the authors, reviewers, and participants for their contributions.

The Organising Committee

CINIE 2026 PROGRAM
ORAL COMMUNICATIONS

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IX Congreso Internacional de Innovación Educativa en Edificación CINIE 2026

Miércoles 18

9:30-14:00	Registro/Recepción de documentación Lugar: Vestíbulo ETSEM (planta 0)
10:15-11:00	**OPENING SESSION** Lugar: Sala de Juntas AMPARO VERDÚ VÁZQUEZ *Directora del Departamento de Tecnología de la Edificación* ENRIQUE GÓMEZ DE LA PEÑA *Responsable de prescripción zona centro, Grupo Saint-Gobain* *Profesor Asociado, Universidad Alcalá de Henares*
11:00-12:15	COFFEE BREAK & POSTER SESSION Lugar: Vestíbulo ETSEM (planta 0)

Lugar: Sala de Grados (planta -1), Modera: Israel Olmedo Zazo
Educational Innovation in Technical Education

12:20-12:40	**123899. Service-Learning Between Technical Training And Social Engagement**
	Miguel A. Ajuriaguerra-Escudero; Ana Sanz Fernández; Ana Zazo Moratalla
12:40-13:00	**123922. Thinking, Drawing and Building; Pedagogy of a Beautiful House**
	Alejandro Cervilla García
13:00-13:20	**125059. Optimising Energy Consumption For Space Heating In The Álava Campus: Engineering School Of Vitoria-Gasteiz, Faculty Of Pharmacy, And Las Nieves Lecture Hall**
	Juan María Hidalgo-Betanzos; Estibaliz Apiñaniz-Fernández de Larrinoa; Eduardo Ogando; Iñaki López-Ferreño; José Miguel Gil-García Leiva; Isidro Calvo-Gordillo; Ángel García-Adeva; Amaia Mesanza-Moraza, César Escudero-Revilla
13:20-13:40	**Emerging Challenges In Topography Education For Building Degrees: Immersive Virtual Reality And Flipped Learning**
	Paula Andrés-Anaya; Miguel Ángel Maté-González; David Fernández Fernández; Fernando Peral Fernández; Benjamín Aria-Pérez

Jueves 19

Lugar: Sala de Grados (planta -1), Modera: Julio José Caparrós Mancera

Active Teaching Methodologies in Building Education

9:40-10:00	PONENCIA ARPADA Ponente: Celia Esteban Herranz
10:00-10:20	125043. Service-Learning Applied To The Subject "Challenges In Building" María Isabel Prieto Barrio; Fernando Israel Olmedo Zazo; Alberto Leal Matilla; Tomás Gómez Prieto; Alfonso Cobo Escamilla
10:20-10:40	123946. Interactive Digital Exploration For Planetary Gear Train Labs Ángel Mariano Rodríguez Pérez; Julio Jose Caparros Mancera; César Antonio Rodríguez González; Antonio García Chica
10:40-11:00	123955. Self-Assessment As A Learning Strategy In The Design Of Steel Structures In Architecture Arianna Guardiola-Víllora; Davinia Ros-Bonanad; Jésica Moreno-Puchalt; Ana Almerich-Chulia
11:00-12:15	COFFEE BREAK & POSTER SESSION Lugar: Vestíbulo ETSEM (planta 0)

Lugar: Sala de Grados (planta -1)

12:20-12:35	PONENCIA ISCAR software Ponente: Juan Ibargüen
12:35-14:00	**CATA DE VINO** (organiza ISCAR software)
14:00-15:30	COMIDA CÓCTEL Lugar: Vestíbulo ETSEM (planta 0)

Lugar: Sala B (planta 1), Modera: Alicia Zaragoza Benzal

3D Technologies in Education

15:30-15:50	122578. Podcast Interviews For Teaching Structural Engineering Paula Villanueva Llauradó; María Rodríguez Marcos; Andrea Vázquez Greciano
15:50-16:10	123887. Bridging Theory And Practice: Project-Based Learning In Solar Geometry And Shades And Shadow Theory Marta Torres González; Margarita Infante Pere; Roberto Narváez Rodríguez

New Challenges and Trends in Higher Education

16:10-16:30	127466. Automation In Structural Design Angelo Ernesto Estivariz Olmos; Anna Baranova

Jueves 19

18:00-20:00	**Visita guiada al Madrid de los Austrias** Lugar de encuentro: Plaza de la Villa
20:30	**CENA DE GALA** **Hotel Mayorazgo**

Viernes 20

Lugar: Sala de Grados (planta -1), Modera: Ángel Mariano Rodríguez Pérez

New Challenges and Trends in Higher Education

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	Julio José Caparros Mancera; Ángel Mariano Rodríguez Pérez; César Antonio Rodríguez González; Antonio García Chica
10:00-10:20	123970. Modernizing mechanisms labs from legacy software to interactive tools
	Julio José Caparrós Mancera; Ángel Mariano Rodríguez Pérez; César Antonio Rodríguez González; Antonio García Chica
10:20-10:40	123936. Smart Glass Technologies As A Catalyst For Educational Innovation In School Buildings
	Mehrnoush Kenarkouhi, Ana M. Martín Castillejos, Mercedes Valiente López
10:40-11:00	123904. Lecturers' Opinions On Entrepreneurship Poster Exhibitions In The First Year Of Building Engineering At UPV
	Elena Navarro-Astor; M. Luisa Nolé-Fajardo
11:00-12:15	COFFEE BREAK & POSTER SESSION Lugar: Sala de profesores ETSEM (planta -1)
12:30-12:45	**RESUMEN DEL EVENTO Y CIERRE** Lugar: Sala de Juntas (planta -1) AMPARO VERDÚ VÁZQUEZ *Directora del Departamento de Tecnología de la Edificación*

ABSTRACTS INDEX

Opening Conference

Strategies for reducing GWP emissions on a macro scale in buildings. Industrial transformation of mineral wool production.

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Keywords: *Stone Wool, Electric, Furnace, Carbon footprint. GWP.*

Abstract

Buildings account for 35% of global energy use and 38% of CO2 emissions [1]. Due to this situation, together with climate change, the European Union has established climate neutrality for buildings by 2050, with the consequent establishment of intermediate milestones by member countries [2,3]. This study establishes the influence of low-carbon Mineral Stone Wool on GWP (Global Warming Potential) emissions in the PNIEC (Plan Nacional Integrado de Energía y Clima) [3] to see the potential of this solutions to reduce the embedded carbon footprint of buildings. To this end, two similar materials manufactured for use with ETICS (External Thermal Insulation Construction System) have been compared, based on a comparable solution manufactured using current furnaces operated with coke as the main fuel and a future material manufactured using electric furnace supplied with electricity from renewable sources. The properties of both materials, obtained from the EPD of Mineral Stone Wool [4] and the extrapolation based on the LCA of Electric Mineral Stone Wool, can be seen in Table 1. The verified EPD for the material produced in the electric furnace will be published once the facility is operational, scheduled for 2027.

TABLE I

FUNCTIONAL UNITS OF MINERAL WOOL INSULATION UNDER STUDY

Functional Unity	Units	Mineral Wool	Electric Mineral Wool
Mineral wool type		Stone Wool	Stone Wool
Density	Kg/m³	100,00	100,00
Thermal Resistance	m²K/W	1,00	1,00
Conductivity	W / mK	0,034	0,034
Size	m²	1,00	1,00
Thickness	mm	34,00	34,00
Climate change	KgCO2 eel	4,89	-52%

Table 2 shows the characteristics of the insulation panels established for the study of the carbon footprint impact obtained from the average extrapolation of the thicknesses established in the supporting document for compliance with DB-HE [5], adopting a thickness of 80 mm as it is the commercial thickness closest to the average values established with the conductivity of the material studied.

TABLE II

CHARACTERISTICS OF THE INSULATION PANELS STUDIED

Climate change of panels	**Units**	**Mineral Wool**	**Electric Mineral Wool**
Thickness of insulation	mm	80,00	80,00
Climate change / mm	KgCO2 eq / mm	0,14	0,07
Insulation panel Climate change	KgCO2 eq	11,51	-52%

Table 3 shows the embedded carbon footprint corresponding to the insulation panels studied, applied as an ETICS insulation solution for the renovation of the total number of homes established in the PNIEC objective.

TABLE III

EMBEDDED CARBON FROM THE TARGET OF HOUSING TO BE RENOVATED USING THE INSULATION PANELS STUDIED

Climate change of panels	**Units**	**Stone Wool**	**Electric Stone Wool**	**Reduction**
Embodied Carbon of rehabilitation	KTnCO2 eq	1660,41	797,00	863,41

Table 4 shows the GWP values emitted by residential buildings in Spain in 2024 [5] and the emissions target for these buildings in 2030 [6,7], and establishes the reduction in GWP emissions if the low-carbon solution studied had been used for the renovation of all homes. To this end, the emissions target has been established as the sum of operational carbon emissions plus the embedded carbon emissions from the materials used for such refurbishment, equating it with the current solution of stone wool insulation manufactured in a coke furnace. The façade area was established as the average area obtained by dividing the number of single-family dwellings by the number of dwellings in multi-family buildings [8] using an area of 200 m² for a single-family dwellings and 60 m² for a dwellings in multi-family buildings.

TABLE IV

REDUCTION OF EMBEDDED CARBON IN THE HOUSING RENOVATION TARGET SET OUT IN THE PNIEC	**Units**	**GWP**	**Electric stone wool**
Residence Buildings Spain 2024	KTnCO2 eq	23300	23300
2030 Spain Target Residence Buildings	KTnCO2 eq	14100	13236
Target number of rehabilitated homes	Units	1377000	-
Facade surface	m2	104,80	-
Reduction	KTnCO2 eq	9200	10063
Total	**%**		**-6,12**

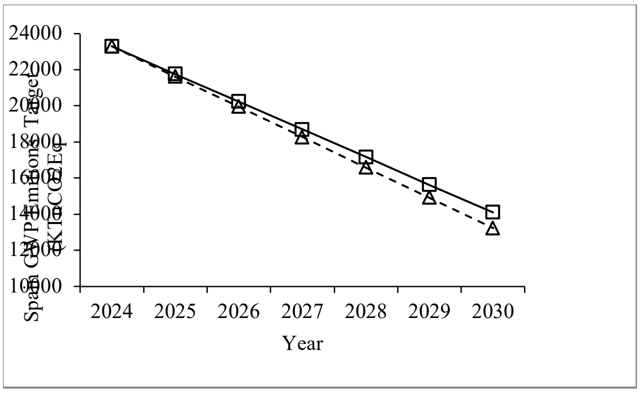

Fig. 1. Comparation of Spain GWP emissions target per year renovating buildings with standard Stone Wool and Electric Low Carbon Stone wool.

Meeting decarbonization objectives will require the deployment of solutions that can be implemented at industrial scale, such as the one studied. Stone wool produced in an electric furnace powered by renewable electricity helps to reduce the embedded carbon footprint, cutting emissions by more than 10,000 kTnCO2 eq in the case studied, achieving improvements in greenhouse gas reduction targets.

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Educational Innovation in Technical Education

SERVICE-LEARNING BETWEEN TECHNICAL TRAINING AND SOCIAL ENGAGEMENT

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Keywords: *Service-Learning, Educational innovation, Urban planning education, Transversal competences, Sustainability*

Abstract

Educational innovation in technical disciplines requires adapting curricula to dynamic methodologies that consolidate knowledge and strengthen students' transversal competences. In the course Urban Infrastructure and Facilities, part of the Bachelor's Degree in Fundamentals of Architecture, various teaching strategies have been tested over the last five academic years to improve the assimilation of technical content. In the past two years, the Service-Learning (SL) model has been adopted as the central methodology through an agreement with the City Council of Getafe (Madrid), its Municipal Housing and Land Company (EMSV), and several local neighborhood associations. This approach has integrated both the acquisition of professional skills and the response to real social demands within the participatory processes of urban planning [1].

The implementation of the Service-Learning methodology connects curricular content with urban regeneration projects developed in contexts characterized by obsolete or non-existent infrastructures [2]. Students actively participate in real processes of diagnosis, design, execution, and maintenance, while incorporating the sustainability principles set out in Royal Decree 822/2021, which regulates the organization and quality of official university education in Spain (Bachelor's, Master's, and Doctorate degrees). At the same time, the projects respond to the specific needs identified by neighborhood associations and local administrations. In this way, students experience an initial approach to professional practice and real urban challenges.

The Service-Learning methodological approach has fostered an integrated understanding of the technical and social aspects of professional practice, strengthening students' sense of responsibility and decision-making in urban design [3]. The results show a clear positive impact, with a significant reduction in the course's historical dropout rate from 41% in 2020 to 9% in the most recent academic year, along with improved academic performance and greater student engagement, both in the course and in their professional development. Altogether, these outcomes confirm the value of Service-Learning as a powerful tool for educational innovation in technical university training.

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THINKING, DRAWING AND BUILDING. PEDAGOGY OF A BEAUTIFUL HOUSE

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Keywords: *estructura; belleza; construcción esencial*

Abstract

I would like to present at this International Congress on Educational Innovation in Building a pedagogical proposal carried out in the course Construction Systems I, within the Degree in Fundamentals of Architecture at Rey Juan Carlos University. The common thread running through the course was a simple house designed by a Spanish master of contemporary architecture: Casa García Marcos, built in Valdemoro in 1991. Its architect, Alberto Campo Baeza, winner of the National Architecture Award, is known for his search for essential architecture, in which structure, space, and light are taken to their most poetic expression. By combining these two factors, simplicity and beauty, we find a very clear example that is easy for second-year students to understand and which, at the same time, encapsulates the fundamental problems of construction.

First, we asked the students to think about and draw its structure by hand. Then, based on what they had learned, they designed a new structure and built it in wood on a scale of 1:30. The structure establishes the shape of the architecture. The structure establishes the order of space. It is one of the essential ideas of architecture. It is no coincidence that the German philosopher Arthur Schopenhauer, in his Lessons on the Metaphysics of Beauty, states that "the truly aesthetic theme of beautiful architecture is the struggle between weight and rigidity," and further, "in fact, this is the only aesthetic theme that characterizes it exclusively" [1]. The Spanish master architect Alejandro de la Sota also used to challenge his students with this impossible question: "Can you imagine if, when a child is born, its mother exclaimed, 'They've forgotten the skeleton! Would we have to cut the child open to insert the skeletal frame?" [2]. In this way, he made them understand that structure must be present from the beginning in the project idea. That is also our aim with our students. To teach them the importance of structure in architecture. To teach them how to understand structure [3].

Finally, we asked them to produce a complete construction detail section of the house, also by hand, on a scale of 1:10. This was a plan over a meter and a half long in which, on the drawn structure, the space was configured by with the walls, roof, floors, ceilings, and partitions.

The result was not only beautiful models and drawings, but also a way of learning construction that combines manual work, an understanding of structure as essential to architecture, and the work of a master.

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SIMULATION-AUGMENTED LABS FOR FIXED-AXIS GEAR TRAINS IN A MANUAL GEARBOX

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Keywords: *mechanical engineering; fixed-axis gear trains; modeling; gear ratio analysis;*

Abstract

Fixed-axis gear trains are a cornerstone of machine elements education because they link kinematic ratio, torque transmission, direction of rotation, packaging constraints, and selection logic within a single system [1]. In laboratory settings, combining physical manipulation with interactive simulation has been shown to improve conceptual understanding and reduce common misconceptions in mechanism and transmission topics, while enabling safe, repeatable exploration of "what-if" scenarios. [2]

This contribution describes a teaching innovation for the Fundamentals of Machines and Mechanisms laboratory focused on fixed-axis gear trains through a manual gearbox mock-up. The proposed methodology integrates two digital tools, Gear Generator and GeoGebra, together with the real laboratory model. The aim is not to replace hands-on work, but to build a structured bridge between theoretical analysis and the physical assembly, increasing student autonomy and making the reasoning behind gear selection explicit.

Using Gear Generator, students quickly generate and visualize meshing gear pairs and trains by defining tooth counts and basic geometric parameters. This supports rapid iteration to study feasible combinations, rotation sense, and the effect of changing tooth numbers on transmission ratio and speed–torque trade-offs. The simulation environment also helps students identify practical constraints that are hard to grasp from static drawings, such as gear compatibility, alignment logic, and the consequences of selecting extreme ratios. In parallel, a GeoGebra-based worksheet is used to formalize calculations and document results: students build a parametric representation of the gearbox layout, compute ratios for each gear stage, and create a clear "ratio map" across the available gears, including the overall transmission ratio between input and output shafts. The GeoGebra component is designed to make assumptions explicit and to

support sensitivity analysis by adjusting tooth counts and observing how the gearbox's stepped ratios change.

The digital exploration is complementary to students work with the physical mock-up to validate the predicted behaviour by observing shaft rotation direction, verifying the engaged gear pairs, and relating the selected path through the gearbox to the computed ratio. This sequence reduces trial-and-error time on the hardware and shifts the lab focus towards interpretation, verification, and engineering communication. The activity is assessed through short conceptual checks, a structured lab report template, and comparison between predicted and observed outcomes.

Although implemented in Mechanical Engineering, the approach is directly transferable to Building Education contexts where fixed-axis transmissions appear in construction machinery and building-service equipment (elevators, hoists, mixers, and maintenance systems), and where institutions face similar constraints regarding specialized hardware, wear, and limited lab time. The paper details the practice workflow and the digital resources developed. Figure 1 presents the developed simulation resources (Gear Generator and GeoGebra materials) together with the manual-gearbox laboratory mock-up used for hands-on validation.

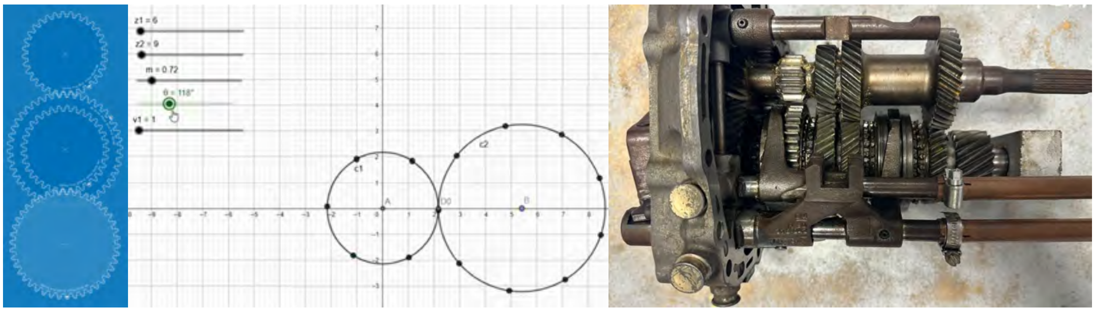

Figure 1: *Simulation resources and manual-gearbox mock-up for fixed-axis gear-train labs (Source: Original)*

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GEOGEBRA AND A PLOTTING RIG FOR CAM KINEMATICS LABS

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Keywords: *mechanical engineering; augmented reality; sand casting; laboratory safety;*

Abstract

Cam mechanisms are a core topic in mechanical engineering education since they connect motion laws, geometric synthesis, and real kinematic behavior in a compact and highly visual way [1]. In laboratory teaching, students benefit from both the analytical design perspective and the experimental observation of the motion produced by a real cam. However, traditional hands-on resources based on dedicated cam-plotting rigs can be costly, require periodic maintenance, and rely on consumables for plotting displacement diagrams, which may reduce repetition opportunities and limit scalability.

This contribution presents an educational innovation that combines a parametric GeoGebra tool with a physical cam-plotting machine as complementary resources within the same practice program. GeoGebra has been increasingly adopted in engineering education as an accessible dynamic-geometry environment that supports parametric modeling, interactive visualization, and rapid iteration in kinematics and mechanism design [2]. The methodology is designed to support understanding from two perspectives that are conceptually different but pedagogically synergistic. The digital component allows students to build the cam geometry from a mathematical motion law and immediately visualize the resulting cam profile. The applet is parameterized so that key design variables, particularly the primitive radius and the lift, can be adjusted interactively to explore their influence on feasibility, curvature trends, and expected follower motion. The physical component, in contrast, focuses on obtaining the displacement diagram from an existing cam, reinforcing measurement, setup procedures, and the interpretation of non-ideal effects that are often hidden in purely virtual environments.

Rather than positioning GeoGebra as a substitute for the laboratory rig, the approach treats it as a structured complement that increases visual clarity, reduces dependency on consumables for iterative exploration, and prepares students before hands-on work.

During the session, students compare the digitally synthesized results with the experimentally obtained profiles, discuss discrepancies, and justify them using kinematic reasoning.

Figure 1 shows the GeoGebra interface used for parametric cam synthesis alongside the cam-plotting rig and examples of the physical displacement profiles obtained in the laboratory.

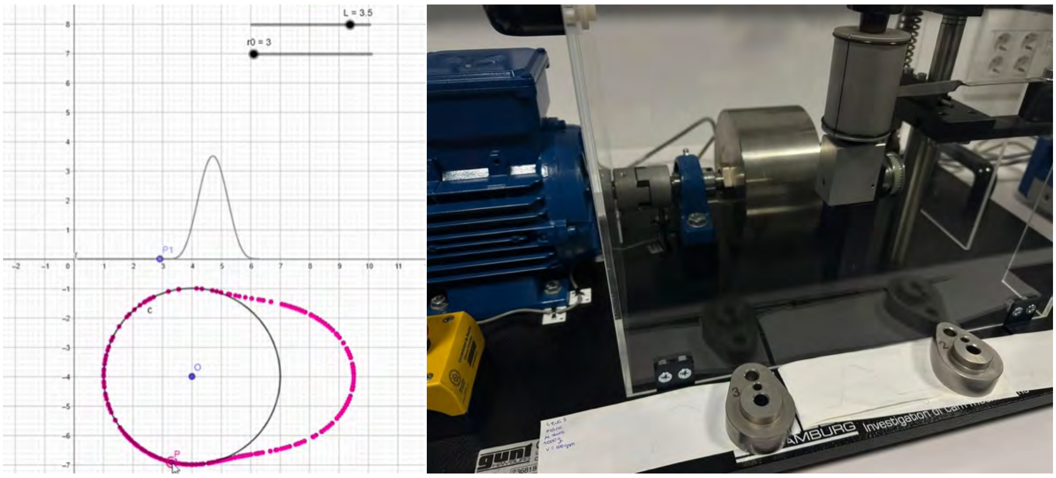

Figure 1: *Geogebra tool and cam-plotting rig for cam kinematics labs (Source: Original)*

Implemented in the "Fundamentals of Machines and Mechanisms" laboratory of the Mechanical Engineering degree at the University of Huelva, the proposal uses the contrast between an ideal parametric digital synthesis and a constrained physical plotting process to drive discussion on design intent versus real outcomes and on why discrepancies appear (setup, contact effects, measurement errors, and tolerances); the paper details the practice workflow and assessment strategy and argues its transferability to Building Education labs where construction equipment and building-service mechanisms require the same kinematic reasoning and systematic verification.

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AUGMENTED REALITY FOR SAND-CASTING LABS IN MECHANICAL TECHNOLOGY

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Keywords: *mechanical engineering; augmented reality; sand casting; laboratory safety;*

Abstract

Laboratory-based learning is essential in Mechanical Engineering, particularly in Manufacturing and Mechanical Technology courses where students must connect theoretical concepts with real processes, tools, and safety constraints. However, workshop sessions often face recurring limitations: heterogeneous prior knowledge, reduced effective practice time due to repeated explanations, difficulty in maintaining consistent safety behaviour, and uneven quality in reporting and engineering documentation. These challenges are especially relevant in hands-on practices such as metal sand casting, where the procedure is sequential, error-sensitive, and includes multiple verification points that students must internalize to avoid defects and unsafe actions [1]. This study presents an educational innovation implemented in the Mechanical Engineering Bachelor's degree at the University of Huelva. A mobile Augmented Reality (AR) application has been designed to guide and scaffold the complete sand-casting laboratory practice, based on mould making with sand. The tool is accessed directly in the lab through a smartphone, enabling students to consult contextual information while interacting with the workbench and equipment. AR allows better results in these contexts [2-3]. Figure 1 shows real in-lab use of the AR application via smartphone, illustrating its suitability for authentic workshop settings.

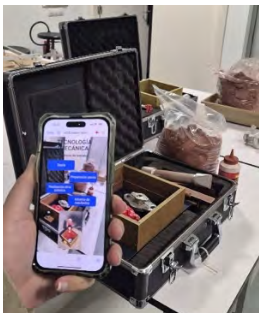

Figure 1: *Use of AR app in metal casting laboratory (Source: Original)*

The proposed AR-based support is structured into four aligned modules that mirror the learning workflow and the practical session timeline, Figure 2. First, the theory module provides concise, practice-focused content covering the concepts required to understand and execute the session (process fundamentals, mould components, gating/feeding rationale, typical casting defects and their causes, and critical parameters influencing quality). Second, the pre-lab preparation module consolidates operational readiness and safety: required tools and materials, workstation organization, personal protective equipment, risk prevention reminders, and checks prior to starting the task. Third, the execution module offers a step-by-step sequence with verification checkpoints, prompting students to confirm key conditions before moving forward (e.g., sand condition, correct pattern placement, ramming quality, parting line integrity, sprue/runner formation, venting, and final inspection). This design aims to promote self-regulation, reduce avoidable errors, and standardize the minimum safe and correct procedure across student groups. Finally, the results report module specifies deliverables and reporting criteria (structure, required evidence, formatting, and submission deadlines), reinforcing engineering communication and helping students connect observed outcomes with process decisions. Beyond its impact on Mechanical Engineering, this AR scaffolding model is transferable to Building Education workshops with similar safety, stepwise procedures, quality checks, and reporting needs, such as concrete testing, formwork, masonry, materials characterization, equipment operation, and inspection.

Figure 2: *Designed AR interface (Source: Original)*

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INTERACTIVE DIGITAL EXPLORATION FOR PLANETARY GEAR TRAIN LABS

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Keywords: *mechanical engineering; epicyclic gear trains; planetary gears; transmission kinematics; parametric modeling*

Abstract

Epicyclic (planetary) gear trains are a fundamental topic in mechanical engineering because they concentrate high power density, multiple operating modes, and non-intuitive kinematic relationships within a compact architecture [1]. Their analysis is often challenging for students due to the coexistence of several rotating members and reference frames, and because small configuration changes can lead to substantially different speed ratios and torque paths. For these reasons, interactive visualization and structured practice activities are commonly recommended to strengthen understanding and reduce persistent misconceptions in gear-train kinematics. [2,3]

This study presents a teaching innovation centred on epicyclic gear trains within the Fundamentals of Machines and Mechanisms practice program. The laboratory includes a physical mock-up that allow students to identify members (sun, planet, ring, carrier), observe relative motion, and relate locking conditions to distinct transmission modes. To extend these hands-on experiences, the innovation incorporates Gear Generator 2 Beta as the main digital resource, enabling students to explore planetary configurations and kinematic outcomes in a rapid, repeatable, and consumable-free way.

The proposed workflow is structured in three stages. First, students use the physical model to recognize the architecture and to operationally define the roles of each member, including which element is driven, which is the output, and which is held fixed for each mode. Second, they reproduce the same configuration in Gear Generator 2 Beta, setting tooth counts and defining constraints (locked member, input, output) to obtain the corresponding motion relationships and transmission ratio. This step supports immediate verification of the analytical reasoning and allows controlled parameter variation, such as changing tooth numbers, swapping the held member, or reversing the direction of rotation, to observe how the ratio and motion distribution change. Third, students consolidate the results through a structured comparative report

that requires a clear statement of assumptions, identification of the operating mode, computed ratios, and interpretation of differences between configurations.

Pedagogically, the approach uses the contrast between a tangible mechanism and a manipulable digital environment to make abstract concepts visible: relative motion, carrier reference, and the logic behind mode-dependent ratios. The digital tool does not replace the mock-up; rather, it expands the number of configurations that can be explored within the same session time, reduces trial-and-error on the hardware, and supports deeper discussion through testing. This is especially valuable for epicyclic trains, where understanding is strengthened by comparing multiple cases under consistent reporting criteria.

Although implemented in Mechanical Engineering, the methodology is framed as scalable to Building Education contexts where planetary transmissions are present in compact drives, lifting systems, powered tools, and construction equipment, and where similar constraints exist regarding access to specialized training hardware. The paper describes the instructional design and the set of guided activities. Figure 1 presents the developed simulation resources (Gear Generator 2 Beta) along with the laboratory mock-up.

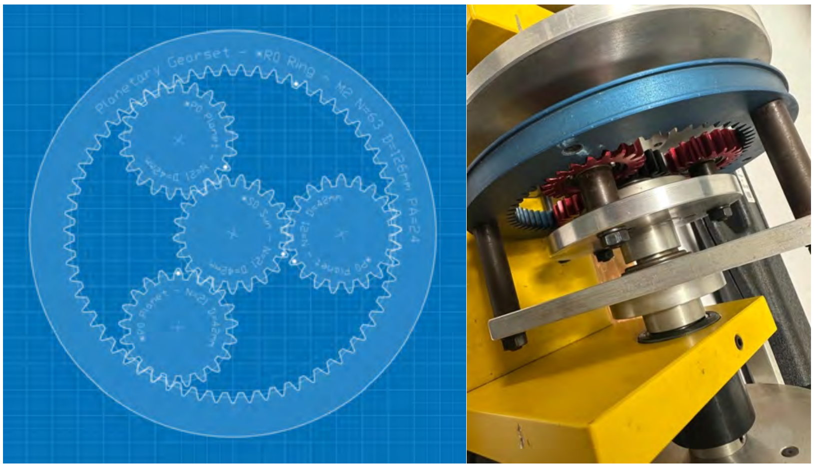

Figure 1: *Simulation resources and planetary-gear mock-up (Source: Original)*

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MECHANISM IDENTIFICATION THROUGH INDUSTRIAL HERITAGE USING THE FARGA ROSSELL IRONWORKS

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Keywords: *mechanical engineering; mechanism identification; industrial building; farga rosell*

Abstract

Identifying basic mechanisms and kinematic pairs in real artefacts is a decisive step for students moving from schematic kinematics to engineering interpretation, and industrial-heritage settings provide a full-scale context that helps consolidate this transition [1]. This paper presents a guided mechanism-identification methodology based on the Farga Rossell ironworks (Andorra), using the site as a readable machine-in-place where hydraulic power is captured, transmitted, and converted into periodic forging work [2].

Students carry out an ordered decomposition and modelling task. They first map the system-level energy and function chain and then extract, name, and represent the mechanisms through simplified kinematic diagrams and explicit kinematic-pair assignment. The mechanism analysis is organised in four blocks. (1) Water-power capture and control: the water route, channel elements, and sluice regulation are identified as operational control components and linked to operating states and safe procedure. (2) Prime mover and shafting: the water wheel, main shaft, and bearing supports are modelled through revolute pairs and constraints, so students can define reference frames and identify input variables. (3) Transmission: a wooden spur-gear stage is identified and used to discuss rotation sense and the relationship between tooth numbers and speed/torque trade-offs; students compute the overall ratio for the camshaft and contrast it with qualitative expectations. (4) Motion conversion and actuation: a camshaft with lobes is modelled as a higher-pair cam–follower mechanism that lifts the forging hammer; the hammer guide is treated as a prismatic pair with gravity return, allowing students to reason about cycle frequency as a function of camshaft speed and number of lobes. When present in the observed layout, auxiliary air supply is discussed as a second rotary-to-reciprocating conversion mechanism for bellows actuation.

Pedagogically, the methodology prioritises evidence-based identification over historical narration. It includes a short pre-lab briefing on mechanism taxonomy and diagram conventions, a worksheet with checkpoints (subsystem boundaries, pair selection, assumed constraints, and observable variables), and a post-lab report requiring a clean kinematic diagram, a table of pairs and degrees of freedom, simple derived quantities (ratios and cycle reasoning), and a concise reflection on non-idealities such as friction, compliance, clearances, and misalignment. The same exercise can be extrapolated as a system embedded in a built environment: channels, supports, foundations, access routes, and maintainability become part of the analysis, mirroring tasks in construction heritage rehabilitation, building plant-room inspection, and the study of construction machinery installed on site. The accompanying figure combines a photograph of the Farga Rossell installation with a simplified model of the same mechanism as a reference representation for student diagramming [3].

Figure 1: *Farga rossell installation and simplified model used for guided mechanism identification (Source: Original)*

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THERMOGRAPHY APPLIED TO FAULT LEARNING IN ROTATING SHAFTS

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Keywords: *mechanical engineering; infrared thermography; shaft failures; predictive maintenance; experiential learning.*

Abstract

Infrared thermography (IRT) is widely recognized as a non-contact technique for machinery condition monitoring because many mechanical faults increase frictional losses and generate localized heat patterns that can be captured as thermal “signatures” [1, 2]. In mechanical engineering education, however, students often struggle to connect abstract failure mechanisms (e.g., misalignment, looseness, fatigue cracking, and increased friction) with observable phenomena in operating machines. To address this gap, this work presents an active, experiential learning activity implemented in the course Construction Calculation and Machine Testing. Students operated a belt-driven shaft test bench under controlled conditions and compared thermal responses across different fault scenarios, fostering conceptual understanding through direct experimentation and evidence-based interpretation. The instructional goal was to help students interpret how shaft defects and assembly conditions influence heating as rotational speed increases, emulating practices used in industrial diagnostics and predictive maintenance [3].

The learning design combined short theoretical briefings (fault typologies and heat-generation mechanisms), hands-on operation of the rig, and guided analysis of thermal images. Student teams were asked to formulate hypotheses about where heat would concentrate, justify expected trends with speed, and then validate their reasoning using IRT measurements. Temperature data were collected with an infrared camera at representative points (belt and fasteners) under an ambient temperature of 19.9 °C. Measurements were taken at three operating states (initial, 1000 rpm and 2000 rpm) for: (i) a healthy shaft with belt tension, (ii) a cracked shaft clamped with two fasteners, (iii) a cracked shaft clamped with four fasteners, and (iv) motor no-load. This comparative structure enabled students to isolate the thermal contribution of the transmission and joint conditions from the baseline motor heating.

Figure 1: *Measurement on the test bench (Source: Original)*

Results show a consistent rise in belt temperature with speed, reaching approximately 35–36 °C at 2000 rpm (maximum 35.8 °C), illustrating the effect of speed-dependent losses. Fastener temperatures were more sensitive to fault configuration: the cracked shaft with four fasteners reached 27.2 °C (Δ≈7.3 °C above ambient), suggesting increased dissipation at constrained interfaces, while the motor no-load condition remained comparatively stable (~25–27 °C). Beyond the numerical outcomes, the thermal maps provided an immediate visual narrative that supported discussion of friction, contact pressure, and energy conversion pathways. Finally, the activity is consistent with evidence that active learning improves student achievement in STEM and enhances engagement through authentic problem solving [4].

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EDUCATIONAL INNOVATION IN BUILDING ENGINEERING THROUGH EXPERIENTIAL LEARNING OF FLUID THERMODYNAMICS

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Keywords: *energy efficiency, experiential learning, open educational resources (OER), sustainable building, thermodynamic engineering.*

Abstract

One of the greatest challenges facing contemporary society is climate change and its associated consequences, such as the increase in extreme weather events, the advancement of desertification, and the rise in diseases related to air quality. These issues are closely linked to greenhouse gas emissions, which has driven the development of policies and strategies aimed at both mitigation and adaptation across different productive sectors. In this context, the Sustainable Development Goals of the 2030 Agenda constitute a key reference framework for promoting more sustainable development models.

The building sector plays a particularly significant role in this challenge, as it is responsible for approximately 36 % of CO_2 emissions and 40 % of primary energy consumption in the European Union. This situation highlights the need to improve building design, management, and energy efficiency, both in terms of the thermal envelope and active systems for heating, cooling, and energy production.

Within this scenario, higher education emerges as a fundamental tool for advancing towards a more sustainable building sector. It is essential that future Building Engineers, Architects, and Industrial Engineers acquire a solid background in sustainability principles, energy efficiency, and the thermal behavior of systems, with particular emphasis on understanding the thermodynamic properties of the fluids used in building services.

In this framework, this work presents the contribution developed by the Teaching Innovation Group of the University of Burgos on Active Learning and e-Learning in Engineering, materialized in an experimental open educational resource for learning the thermal equation of state of fluids. The resource, published in book format [1] and available in Spanish, English, and French, proposes an active learning methodology based on experimentation using laboratory equipment to obtain pressure-volume-temperature (PVT) relationships. Through this approach, students analyze fluid behavior in different thermodynamic regions, such as superheated vapor, liquid–vapor

equilibrium, saturated liquid, and compressed liquid, as well as the identification of saturation lines and the critical point.

This teaching material is used in engineering-related degree programs at both Spanish and Moroccan universities, within the framework of an international cooperation project aimed at the creation of open educational resources. The experience shows that the use of experimental and multilingual methodologies enhances the understanding of fundamental thermodynamic concepts and their subsequent application to the analysis and improvement of the energy performance of thermal systems in residential, tertiary, and industrial buildings.

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SERVICE-LEARNING FOCUSED ON SDG 11: "SUSTAINABLE CITIES AND COMMUNITIES" IN AN ADULT EDUCATION CENTER

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Keywords: *Service Learning, Sustainable Cities and Communities, Adult Education Center (CEPA), 2030 Agenda.*

Abstract

Service-learning (SL) is an educational methodology that integrates academic learning and community service in equal measure [1]. This innovative teaching strategy is increasingly integrated into university contexts and supported by institutions and governments. Through this strategy, students apply the knowledge and skills acquired in the classroom to address real social needs, promoting critical thinking and teamwork [2]. This is particularly relevant in university settings, where students' scientific and technical training can be highly useful in solving everyday problems and contributing to community improvement. It also allows students to develop cross-cutting and soft skills in high demand in today's job market, including leadership, environmental commitment, social responsibility, and emotional management in conflict resolution [3].

Education for Sustainable Development (ESD) is UNESCO's response to the urgent challenges facing our planet [4]. In this context, it is essential to integrate training on the 2030 Agenda across academic levels, promoting the knowledge, skills, values, attitudes, and behaviors needed to live in respectful interaction with the environment, the economy, and society. This led to the emergence of the Service-Learning project, now well established at the UPM: "Promoting Energy Efficiency and Sustainability in the Salamanca District through Adult Education." For several years, students from the E.T.S. de Edificación (School of Building Engineering) have contributed ideas to improve the facilities of an Adult Education Center (CEPA) in the Community of Madrid, while also serving as mentors to the center's students and generating synergies to work on content related to sustainability in building [5].

In this latest edition, a plan has been launched to work on SDG 11: "Sustainable Cities and Communities," focusing on designing more efficient buildings and less-polluting transportation. To this end, professors and students from the Polytechnic University of Madrid have held a series of seminars to raise awareness among adult students in the

Salamanca District. These results have spread beyond national borders and have benefited from collaboration with other CEPA centers in France and Italy, leading to joint sessions and innovative content for the construction sector. This has helped spark scientific vocations among students receiving the service, while also contributing to their education. For their part, teachers and university students have worked to present their results in a non-expert forum, improving their communication skills and gaining firsthand knowledge of the social problems in their environment.

Figure 1: *Image of the sessions held at CEPA Joaquín Sorolla. (Source: Own work).*

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REVALORIZATION OF END-OF-LIFE TIRES: A SERVICE TO LEARN HOW TO INTEGRATE SUSTAINABILITY INTO BUILDING

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Keywords: *Service Learning, Sustainability, Active Methodologies, Critical Thinking.*

Abstract

Service learning (SL) is important in higher education because it connects academic training with society's real needs, promoting deeper, more meaningful, and more engaged learning [1]. Through SL, students not only acquire theoretical knowledge and technical skills but also develop key cross-cutting skills such as critical thinking, teamwork, communication, social responsibility, and professional ethics. In addition, SL helps students understand the social impact of each discipline and reinforces civic engagement, which is especially relevant in a global context marked by complex social, environmental, and economic challenges [2]. In recent decades, service learning has been progressively integrated into university education, driven by the European Higher Education Area and a competency-based educational approach [3]. At the Polytechnic University of Madrid, through the creation of the Office of Learning and Service, interdisciplinary projects are promoted each year, and there is a commitment to integrating this active methodology into compulsory and optional subjects, as well as into final degree projects, having been recognized as a strategic tool for improving the quality of teaching.

On the other hand, one of the major challenges facing modern cities is the management and recovery of end-of-life tires (ELTs) [4]. This waste can be recycled to produce high-value by-products for the construction sector, such as rubber, textile fiber, and recycled steel fiber. For more than three years, professors at the Polytechnic University of Madrid, in collaboration with the organization SIGNUS Ecovalor S.L., have been carrying out an APS project to find efficient solutions for managing these ELTs. University students are involved in a real-world experience where they apply the technical knowledge and critical thinking skills they have developed during their studies.

***Figure 1**: APS training provided during the last academic year through the company SIGNUS. (Source: Own work).*

This paper outlines the guidelines used to develop this LS project and explains how it has remained relevant over recent years. It describes how this project has been integrated into the syllabi of subjects such as Strategic Management and Production Management, as well as the timing and activities carried out throughout an academic semester. In this way, it provides a practical guide for implementing this methodology in the classroom and reflects how it increases student satisfaction and provides a useful service to the community. This creates a useful framework for future teachers interested in applying the APS methodology in university contexts.

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SERVICE-LEARNING TO AWAKEN STEAM VOCATIONS: DESIGNING THE "HACKEANDO EL AIRE" EXPERIENCE

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Keywords: *Service-learning, Learning Landscape, higher education, STEAM vocations.*

Abstract

The Service-Learning (SL) methodology has become highly relevant in Spanish universities because it integrates academic training with social actions that add value to the community [1]. Through this approach, students not only acquire curricular content but also develop cross-cutting skills and values such as social responsibility, solidarity, and professional ethics, which are increasingly in demand in today's society [2].

This is the context for the Hackeando el Aire (Hacking the Air) experience, developed by teachers at the Polytechnic University of Madrid, which aims to strengthen key skills in university students, such as critical thinking, teamwork, effective communication, and the ability to solve complex problems in real-world contexts. At the same time, the service helps awaken STEAM vocations among students in Basic Vocational Education and Training (FPB) at an educational center in the Community of Madrid by connecting technology, sustainability, and improving the school environment through the monitoring and analysis of classroom air quality.

An IM x Bloom matrix is used for the didactic design of the experience, combining Gardner's Multiple Intelligences (MI) with the different levels of Bloom's Taxonomy, resulting in a structured, progressive, and competency-based learning landscape [3]. This matrix enables the planning of activities ranging from a basic understanding of concepts related to comfort and health in buildings to more complex tasks such as programming and implementing sensors, analyzing data, and proposing solutions for environmental improvement.

The IM × Bloom matrix helps focus on the diversity of student profiles, promotes active learning, and encourages the transfer of knowledge to real-world contexts. It also reinforces the role of university students as mentors and places FPB students at the forefront of a technological process that directly affects their environment.

Beyond describing the educational experience, the paper emphasizes the model's transferability by presenting a practical framework for implementing the project,

outlining the phases, activities, participant roles, and products in a structured manner. This outline provides insight into how Service-Learning is applied in real contexts, facilitating its adaptation to other educational environments where there is a desire to work on sustainability, STEAM vocations, or improving the built environment through collaborative projects.

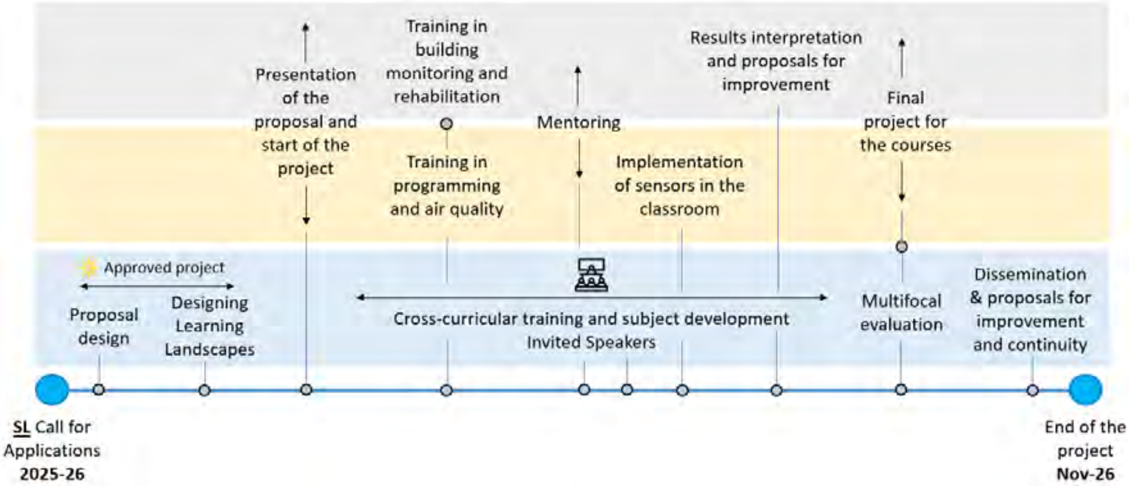

Figure 1: *Simplified temporary work line from the "Hackeando el Aire" experience. (Source: Own work).*

This experience demonstrates the potential of SL, supported by pedagogical design tools such as the IM x Bloom matrix, to articulate educational innovation, sustainability, and social commitment. The aim is to serve as a basis and practical reference for teachers interested in Service-Learning and its application in the classroom, particularly in the fields of construction, sustainability, and educational innovation.

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TEACHING INNOVATION METHOD APPLIED TO LEARNING CONSTRUCTION PROCEDURES

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Keywords: *Learning innovation, Teaching innovation, Educational motivation,*

Abstract

In the field of construction engineering, mastery of construction procedures is an essential cross-disciplinary skill for future professional performance. However, the transfer of technical and theoretical knowledge in the conventional classroom environment presents significant challenges due to the complexity of variables on site and the abstraction of processes. This study presents an innovative teaching methodology that integrates graphic and cinematographic projection with assessment systems based on binary response tests (true/false). The results indicate a positive correlation between the use of these resources and an increase in academic performance, optimizing the learning curve and fostering intrinsic motivation among students. The results obtained allow us to conclude that the systematic integration of visual resources and binary assessment methods is a highly effective pedagogical tool in the teaching of construction engineering. It has been found that exposure to graphic and video projections significantly reduces the gap between classroom theory and the technical complexity of the work, facilitating a holistic understanding of the processes. Likewise, the use of true/false tests has proven to be a superior diagnostic tool for the identification and immediate correction of conceptual errors, resulting in a measurable increase in academic success and technical decision-making ability among students. Specifically, this methodology has been applied for six years, resulting in an annual pass rate of 80%.

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IMMERSIVE UAV TRAINING THROUGH SIMULATED ENVIRONMENTS AS A CROSS-DISCIPLINARY EDUCATIONAL METHODOLOGY FOR ARCHITECTURE AND ENGINEERING EDUCATION

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Keywords: *UAV-based education; Immersive learning; Flight simulation; Architecture and building engineering; Photogrammetry*

Abstract

The rapid incorporation of Unmanned Aerial Vehicles (UAVs) into professional practice has transformed workflows in architecture, building engineering, construction management, heritage documentation, territorial planning, and infrastructure monitoring [1]. Despite this growing relevance, UAV training in higher education is still predominantly based on theoretical instruction and limited real-flight practice, often constrained by safety regulations, weather conditions, logistical complexity, and equipment availability. This paper presents a novel, immersive, and transferable educational methodology based on simulated UAV training environments, designed to enhance practical learning across engineering and architecture-related disciplines [2-4].

The proposed methodology is grounded in the use of professional flight simulators combined with physical controllers, enabling students to acquire technical, operational, and decision-making skills within a safe, controlled, and repeatable environment prior to real-field UAV operations. Unlike discipline-specific approaches, the methodology is conceived as a global framework adaptable to multiple educational contexts, including geomatics, building engineering, architecture, safety, and construction management. The core pedagogical strategy integrates active learning, challenge-based missions, and competency-oriented assessment within immersive simulation scenarios that replicate real professional situations [5,6].

From an architectural and building perspective, the methodology facilitates the acquisition of essential skills for architectural inspection and data capture using unmanned aerial vehicles (UAVs). Furthermore, it enables the application of complementary techniques, such as photogrammetry and thermal analysis using infrared cameras, to generate high-resolution orthophotos and thermal maps of building façades, historical structures, and surrounding landscapes [7]. These products provide valuable information for architectural analysis, energy performance assessment, heritage documentation, conservation studies, and urban or landscape

planning [8,9]. In addition, data products derived from UAV platforms can be applied to construction supervision, progress assessment, and the inspection of complex or hazardous areas [10]. Through simulated environments, students can practice flight planning, mission execution, and error management before operating on real buildings or construction sites, significantly reducing risks and improving operational efficiency.

The proposed framework is structured into progressive phases: (i) preparation of the methodology and analysis of commercial tools for flight simulation (e.g., DJI Flight Simulator Launcher); (ii) definition and application of evaluation rubrics, including an initial and a final assessment; (iii) analysis of learning outcomes; (iv) transition to real UAV field practices when feasible (assessment rubric if this activity is carried out); and (v) overall project evaluation and formulation of methodological improvement proposals. The learning process emphasizes not only technical proficiency, but also transversal competencies such as teamwork, problem-solving, and decision-making in complex operational environments.

This methodological proposal will be implemented and validated during the 2025–2026 academic year through the teaching innovation project “Immersive Training in Simulated Environments for Professional UAV Piloting” (ID2025/235), funded by the University of Salamanca. Although empirical results are not yet available, this contribution focuses on the conceptual design, pedagogical foundations, and transferability of the methodology, offering a scalable and replicable model for innovation in higher education.

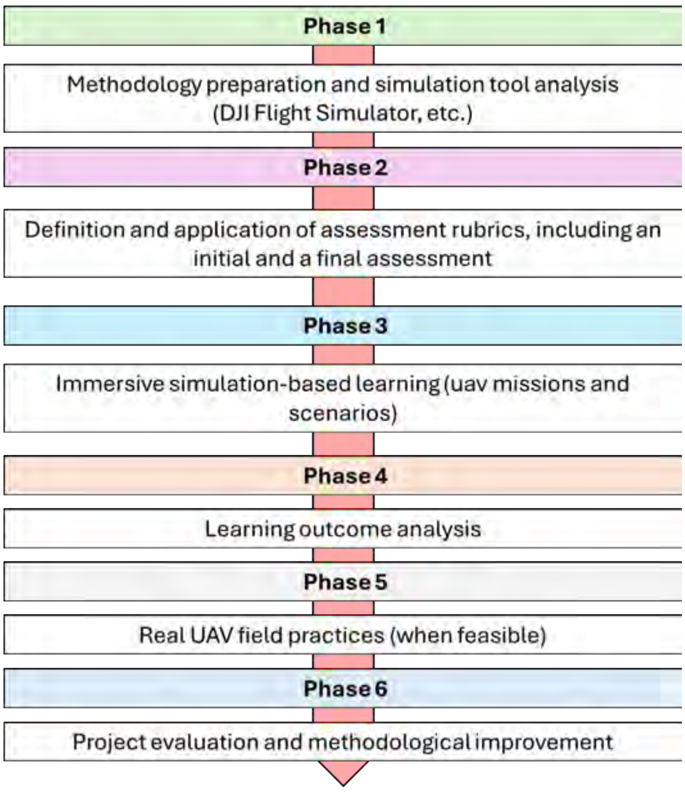

Figure 1: *Progressive methodological framework for immersive UAV training, integrating simulation-based learning, competency assessment, real-field practices, and continuous methodological improvement.*

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ARCHEOLOGIES OF DISRUPTIVE PEDAGOGIES: JAVIER SEGUÍ

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Keywords: *Seguí, ideation, uncertainty, hope, drawing*

Abstract

Designing in architecture means operating in time to anticipate futures; it involves making decisions—sometimes without complete data—and learning to wait, managing the anxiety of working within uncertainty while turning indeterminacy into working material. In any creative context, it is crucial to instill in students from the outset a kind of "cosmic confidence" that can accompany them throughout their lives. This paper offers a critical archaeology of disruptive pedagogies through the figure of Javier Seguí de la Riva (1975–2021), Professor of Graphic Ideation, who introduced the term "ideation" in place of "expression" to rename a department that had originally dealt with little more than drawing skills and representational systems and languages governed by codes established in the past. As the driving force behind the first educational innovation group at the School of Architecture of the UPM, Seguí conceived the learning space as a laboratory in which drawing becomes a way of knowing, configuring, and communicating multiple overlapping realities. He shifted the focus—decisively and early—toward an open form of drawing capable of activating imagination and complex thinking.

"Degree zero," understood as a gesture of methodological unlearning, operates as a teaching device within a pedagogical pact between teachers and students: the former accompany a tentative, exploratory making that avoids reproducing their own trajectories and fosters an understanding—and a feeling—of error as a motor of action that exceeds the studio itself. All of us who inhabit planet Earth are in a continuous process of becoming something else [1]. The university is an institution specifically designed to orient us in these moments of transformation, and architecture is situated within such processes of becoming. It is precisely this drive toward transformation that draws us to epistemologies of change, where essentialist ontologies are no longer valid.

Seguí's radicality lies in a disruptive didactic strategy that frames learning from uncertainty through specific tactics that unlock design processes. This ethic legitimizes the unfinished, the imperfect, and the strange; it protects personal exploration and empowers each body-in-action, building trust and horizontality in the classroom; it fosters serendipity by urging students to pay attention to every matter that constructs the present—however small—within an environment of estrangement where nothing is beyond question. In continuous action without certainties, making mistakes is part of learning rather than a punishable deviation; and waiting, as a productive temporality of

work-in-suspension, allows the project to mature without the discomfort of an imposed deadline.

In dialogue with theoretical frameworks on imagination, perception, and creative learning (Bachelard, Merleau-Ponty, Arendt, among many others) and with contemporary debates on critical and affective pedagogies (Haraway, Amann, Nieto), this paper reclaims Seguí's practice as a timely contribution amid the crisis of representation and a global reactionary return to instrumental graphics without thought.

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THE IMPLEMENTATION OF VIRTUAL LEARNING ENVIRONMENTS IN SUSTAINABLE BUILDING EDUCATION

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Keywords: *Virtual Learning Environments, Sustainable Building Education, Construction Education, Building Information Modeling, Virtual Reality*

Abstract

Virtual Learning Environments (VLEs) have emerged as pedagogically relevant tools within the teaching and learning process in sustainable building education, since they enable the integrated, multi-disciplinary, and experimental type of learning required to address complex sustainability challenges in construction [1]. Therefore, this approach is also aligned with competence-based teaching and learning in Higher Education, where the development of specific skills through hands-on practice is a major requirement [2]. VLEs offer scalable platforms that integrate performance simulation, collaborative design and immersive experiences, thus supporting capabilities that are difficult to replicate in traditional classroom settings [3]. With the assistance of interactive technologies such as Building Information Modeling (BIM), virtual reality (VR) and digital twins, learners can test design decisions, visualize energy and lifecycle performance, and engage with complex or unsafe construction practices in safe, accessible and user-friendly environments [4]. This enhanced engagement has been shown to improve a series of crucial competencies related to sustainability, design thinking, and pro-environmental behaviors among learners [2,3].

This paper presents a comprehensive literature review examining the current state-of-the-art in the implementation of VLEs in the area of sustainable building education. The review shows a convergence towards immersive VR platforms, BIM-integrated workflows, virtual design studios, and massive open online courses (MOOCs) as mainstream approaches for delivering sustainability education. A focus of the literature review is on the analysis of documented cases of good practice, which seems to demonstrate the effectiveness of various VLE implementation formats. BIM-coupled project-based learning courses, for instance, have improved learners' understanding of green building practices and integrated performance thinking [4]; VR-aided project courses combining lectures, virtual site visits, and practicum projects have effectively covered lifecycle sustainability knowledge [3]; and online laboratories have produced significant, sustained gains in students' knowledge, skills, and pro-environmental behaviours [2]. However, the reviewed literature also identifies widespread challenges including technical resource requirements, variable simulation literacy among learners [6], as well as limitations in interaction quality within fully virtual platforms.

These findings provide a foundation upon which the paper elaborates a pedagogical proposal for integrating VLEs into sustainable building curricula. The proposed framework combines different VLE modalities, such as VR for experiential site access, BIM for quantitative performance analysis, and collaborative platforms for design discussion, within a project-based learning structure that emphasizes authentic assessment and iterative design [1,3]. The proposal incorporates strategies to address identified issues, including scaffolded simulation training, hybrid pedagogical approaches that balance synchronous and asynchronous interaction, and integration of sustainability rating systems to align educational practice with industry standards [5]. This pedagogical framework aims to optimize the documented benefits of VLEs while diminishing implementation drawbacks, thus improving the quality and accessibility of sustainable building education in the current context of urgent climate action.

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PROMOTING PROGRAMMING AS A TRANSVERSAL COMPETENCE IN THE BACHELOR'S DEGREE IN AGRO-ENVIRONMENTAL ENGINEERING

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Keywords: *competencia transversal, ingeniería, programación, Python*

Abstract

Computationally based transversal competencies have been implemented unevenly across engineering degrees [1]. Although students take courses with a strong technical and quantitative component, they do always not perceive programming as a useful and powerful tool for their future professional practice, which puts them at a disadvantage compared to graduates from programmes with stronger training in computing and data analysis. This situation is compounded by the fact that the use of programming tools by teaching staff is neither homogeneous nor widespread. This is the case, for example, in the Bachelor's Degree in Agro-Environmental Engineering of the School of Agricultural, Food and Biosystems Engineering.

In order to address this identified shortcoming and to maximise the development of computational competencies, an Educational Innovation Project is being carried out on the coordinated integration of Python programming across several courses of the degree. The proposal covers different disciplinary contexts and promotes the development of transversal skills related to computing, data analysis and numerical modelling [2].

The project will be implemented in the following courses:

First year: *Differential and Integral Calculus*, *Climatology*.

Second year: *Ecology*.

Third year: *Crop Science: Fundamentals and Techniques of Plant Production*, *Mechanisation for Sustainable Agriculture*, *Hydraulics and Environmental Hydrology*, *Geographic Information Systems*.

Fourth year: *Water Resources Management*, *Agro-environmental Remote Sensing*.

In each course, at least one representative numerical example will be selected and reformulated as a Python programming script, so that the traditional solution approach is complemented by the new method proposed in this project.

The project aims students to begin their experience by working with an advanced programming construct—classes, within the framework of Object-Oriented Programming—so that they can directly perceive the usefulness and power of the technique. Basic elements such as variables, functions and loops will be introduced through intermediate challenges posed to the students.

The objective of the problems presented to students will not simply be to obtain a solution using Python, but to create a class that allows the underlying problem to be addressed with sufficient versatility to enable future developments, adaptations and the generation of different scenarios for the same problem.

The methodology will be based on challenge-based learning (CBL), structuring the experience into progressively more complex levels. Intermediate challenges will be proposed to ensure that students acquire the basic competencies required to program effectively:

- defining and initialising variables,
- creating and using methods and functions,
- establishing loops and conditional statements,
- debugging errors and validating results.

These challenges will serve as formative bridges towards the final objective of each module or applied example, ensuring that students feel supported throughout the learning process and gain confidence in their ability to program.

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OPTIMISING ENERGY CONSUMPTION FOR SPACE HEATING IN THE ÁLAVA CAMPUS: ENGINEERING SCHOOL OF VITORIA-GASTEIZ, FACULTY OF PHARMACY, AND LAS NIEVES LECTURE HALL

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Keywords: *Smart building control, Experiential learning, Sustainable development goals (SDG), Energy efficiency, Thermal Comfort*

Abstract

Energy efficiency in university buildings is a key challenge in the transition towards sustainable campuses. This paper presents the results of the Campus Bizia Lab (CBL) project, an institutional programme at the University of the Basque Country (UPV/EHU) aimed at fostering innovation, learning, and the resolution of real campus needs to promote a more sustainable university [1]. These projects are based on collaboration among different stakeholders, including students, academic staff, and administrative and technical personnel.

The objectives of the CBL project presented in this study are twofold: on the one hand, to optimise energy consumption for space heating while improving thermal comfort; on the other, to raise awareness within the university community about responsible energy use, promote environmental sustainability, generate economic savings, and develop energy-efficiency related competences. Recent literature shows the potential of these measures to contribute to campus management and indoor quality improvement [1][2].

During the 2024-2025 academic year, monitoring campaigns were conducted in several classrooms, and the indoor temperatures were studied and correlated with occupancy patterns and heating system operation. Sensor networks and monitoring tools were used to identify inefficiencies and to propose adjustments to the space-heating service operation and schedules. In parallel, heat losses through façades and windows were analysed using an infrared thermal camera, allowing a partial quantification of the thermal improvements after local interventions such as window replacement and confirming significant gains in classroom efficiency.

The project follows an innovative educational approach in which students play an active role in research and solution development. Undergraduate final projects focused on energy optimisation and HVAC automation were promoted, while students from the Industrial Informatics course designed wireless sensors and devices to automate space-heating activation and motorise window control. These activities foster skills in IoT, programming, and industrial control, linking theory and practice in a real-world context and raising awareness of the Sustainable Development Goals (SDGs).

In addition, master's students implemented a commercial Home Assistant platform to adjust heating operation based on classroom occupancy data from WebUntis, weather forecasts, and real-time indoor conditions.

The results show that the combination of intelligent control strategies and improvements to the thermal envelope leads to a significant reduction in energy consumption and enhanced thermal comfort. This approach not only improves campus building efficiency but also strengthens practical training in emerging technologies and sustainability, while increasing awareness of the SDGs. Future work includes the integration of AI-based predictive algorithms and the extension of the model to other university buildings.

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PEDAGOGICAL EXPERIENCES IN EARTH ARCHITECTURE AND CONSTRUCTION IN NON-FORMAL EDUCATION

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Keywords: *training, professional, skills, building, experimental*

Abstract

Earthen architecture and construction, historically and currently, are in high demand in Spain and Europe from various professional sectors, both for new construction and for the restoration and rehabilitation of buildings. The use of earth as a building material allows for the creation of countless low-environmental-impact construction solutions that represent advantageous resources for safeguarding natural ecosystems. The Taph Taph Professional Association for Bioconstruction, Architecture, and Holistic Landscape was founded in 2016 and is based in Seville, Andalusia. Over its nine years of existence, the association's work has been primarily focused on promoting earthen architecture and construction. Through its divulgation, educational and scientific research activities, it has collaborated with numerous public and private entities, promoting earth as a building material and disseminating knowledge for its use in architecture and construction.

The educational activities have primarily targeted professionals and university students, as well as secondary and primary school students and the general public. More than 20 theoretical and practical workshops have been conducted on earth-based building materials, such as adobe masonry, rammed earth, Nubian and Mexican adobe vaults, paints, plaster mortars, lightweight earth, wattle and daub, etc. These workshops have taken place at various locations, including the association's headquarters, facilities at the University of Seville, protohistoric archaeological sites, and other sites scattered throughout the region.

Of particular importance has been the HELPS project (2018-2021), an Erasmus+ project on education and employment, which linked the association with other European entities connected to earthen architecture and construction. This project also developed various tools and publications of special interest for promoting earth as a building material and for the conservation of built heritage. It fostered the development of professional skills and pilot practical experiences and training in real-world construction projects for the assisted, socially and technically supported self-rehabilitation of earthen dwellings whose inhabitants were living in precarious situations. Furthermore, the more recent completion of another Erasmus+ project, BREATH, on education for the ecological transition, has enabled the association, along with other professionals, to create a framework of cross-cutting knowledge, skills, and competencies for non-formal education at the Vocational Education and Training, and Higher Education levels. This framework, divided into four modules, focuses on the fundamentals of earthen construction. Based on this competency framework, a short-term training program has been created. The main objective of this training is to equip professionals with the fundamentals of earthen construction to enhance their knowledge, skills, and professional competencies. The course, totaling sixty-four hours of instruction, is structured into four thematic blocks: Earthen construction cultures; soil characterization. manufacturing and Installation of earth-based construction materials; Key aspects for the design and analysis of contemporary and historical earthen buildings; experimentation, technical visits, and the work market. This half on line and half face to face learning course offers transversal and comprehensive training based on both lectures and hands-on practical exercises, technical visits, and professional exchanges. Therefore, it is aimed at construction professionals and university and vocational students in fields such as architecture, architectural engineering, engineering, archaeology, restoration, conservation, and related areas.

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Active Teaching Methodologies in Building Education

EXPLORING ROOF GEOMETRY THROUGH MULTIMODAL TOOLS AND 3D MODELLING: AN INNOVATIVE TEACHING EXPERIENCE IN ARCHITECTURAL GRAPHIC EXPRESSION

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Keywords: *Descriptive Geometry, Graded Line System, Pitched roofs, Higher Education, Problem-Based Learning (PBL)*

Abstract

The teaching of Descriptive Geometry in the *Degree in Building Engineering* is essential for developing, among other basic competencies, spatial visualisation skills and the ability to deduce metric properties in architectural elements. These competencies are fundamental for the correct interpretation, representation and resolution of geometric and constructive problems inherent to building design and construction. At the University of Seville, this training is structured through two courses that cover the dihedral system, the system of levelled planes, axonometric projection and conical perspective.

Over the last decade, teaching innovation in these courses has focused primarily on the application of parametric design and digital fabrication. Precedents such as the *Caterpillar Gallery* [1] and the *Bubble Pavilion* [2] have sought to connect surface analysis with professional practice and technological advances in construction, incorporating active learning methodologies aimed at promoting meaningful student learning. In this context, the present paper introduces a teaching experience centred on the system of levelled planes, specifically applied to the resolution of pitched roofs, a topic traditionally perceived as complex by students in the early years of the degree. The innovation lies in the creation and application of multimodal teaching materials (video tutorials, digital models and 3D-printed elements), conceived as support for autonomous learning, as well as in the implementation of a methodology structured around a flexible 2D–3D–2D learning sequence.

In an initial analytical phase, students address the technical resolution in two dimensions, supported by three-dimensional and audiovisual resources that facilitate the understanding of the underlying spatial geometry. Subsequently, during the materialisation phase, students are required to construct a 3D model based on the graphic solution, with the aim of reinforcing spatial perception, identifying inconsistencies and verifying the geometric validity of the solution. The experience also

allows for alternative workflows in which students start from given solutions to produce a 3D model and subsequently generate the corresponding two-dimensional projections. This approach fosters the reading and interpretation of technical graphic documentation, the assessment of geometric and constructive feasibility, and the critical comparison of results.

The approach combines Problem-Based Learning (PBL) with constructive and design-oriented analysis, coherently integrating physical and digital models as cognitive support tools to enhance spatial understanding and perception. The results show a significant improvement in academic performance and an increase in student motivation. The value of the proposal lies in moving beyond the purely instrumental use of technology, consolidating these resources as an essential form of cognitive scaffolding that enables students to move confidently between the abstraction of the drawing and the reality of volume, thereby optimising their preparation for the technical and constructive challenges inherent in building engineering.

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Beyond Image and Regulation: A Comprehensive Pedagogical Framework for the Refoundation of Architectural Education

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Keywords: *Educational Innovation, Architectural Design, Life Cycle Assessment (LCA), Tectonic Culture, Regenerative Design.*

Abstract

University architectural education in Spain increasingly oscillates between two reductionisms. First, a predominance of visual production (or "retinal architecture", [1]), where digital imagery can displace tactile knowledge and material judgment. Second, a procedural understanding of design as administrative validation, where tectonic culture is subordinated to normative scenography [2]. In both cases, students may learn to deliver images and compliance, but struggle to articulate how form, construction, systems, cost, and environmental performance co-produce architectural quality. This pedagogical gap is consistent with Sennett's [3] warning that the relationship between making and thinking can be severed in contemporary practice.

To respond to this problem, we implemented a matrix-based design framework in an architectural studio context, structuring each proposal through four interdependent vectors: (A) Modeling (morphological definition and spatial logic), (B) Materialization (constructive reality, detailing, and feasibility), (C) Technification (integration of active systems and technical services), and (D) Regeneration (environmental impact framed as performance across the building's life cycle). The framework obliges students to make explicit cross-implications, each design decision is examined through regulatory constraints and budgetary consequences, and economic assessment moves beyond execution cost toward financial sustainability and performance over time (life cycle thinking aligned with regenerative design principles, [4]). In operational terms, the matrix becomes both a design driver and an audit device, making inconsistencies visible early (for example, morphological choices that undermine constructive logic, or technical strategies that exceed budgetary viability).

The learning sequence combined individual divergence with collective convergence. Students initially generated 25 parameterized proposals, then five were selected for team development. This transition was designed to shift negotiation away from aesthetic preference and toward explicit reasoning, supporting processes of reflection-in-action [5] grounded in shared criteria. Assessment relied on a rubric aligned with the four vectors and on documented decision trails (matrix iterations, regulatory checks, and cost and performance rationales), complemented by peer critique sessions structured around evidence rather than taste.

As an explicit output, final submissions incorporated performance graphs and a normalized index: 0% represents the baseline defined as minimum regulatory compliance, values above 0% represent performance gains relative to that baseline across the selected criteria. This device supported comparability among projects and enabled students to objectify the implications of design choices, translating qualitative intentions into traceable commitments.

The experience suggests that technical rigor and creativity are not opposing forces but mutually conditioning capacities, provided that technological tools remain subordinate to social and environmental objectives. By relocating design judgment from image-only narratives and compliance-only checklists to a transparent matrix of interdependencies, the approach strengthens students' ability to justify decisions, negotiate collaboratively, and connect architectural form to the material, technical, economic, and ecological realities of their time.

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Learning LCA through play. Design and evaluation of a teaching strategy on the functional unit in architecture

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Keywords: *Life Cycle Assessment; functional unit; game-based learning; sustainability.*

Abstract

In the course Architecture and Environment of the Bachelor's Degree in Architecture, Life Cycle Assessment of buildings is introduced as a quantitative tool to support design decisions[1]. In this context, the functional unit is one of the methodological pillars that allows results to be interpreted and compared, however, students tend to work with lists of impacts per kilogram of material without problematising the reference question, impact with respect to what, which is consistent with the difficulties described in the application of LCA to buildings [2]. This difficulty leads to a partial understanding of LCA and to design decisions that do not explicitly incorporate the link between the service provided and the environmental outcome.

The paper presents a teaching experience based on a software tool that is introduced as an impact ranking game, in line with other game based learning approaches aimed at fostering life cycle thinking [3]. The activity has three main objectives, first, that students become aware that every LCA result is associated with an explicit functional unit, second, that they understand how material impacts change depending on the denominator chosen, third, that they develop criteria to select functional units that are appropriate to the type of building and its use programme.

The teaching session has a total duration of four hours and is organised into two two hour blocks. In the first block, the methodological framework of LCA applied to buildings is presented, including reference system, system boundaries, reference flows and definition of the functional unit, as well as examples of functional units commonly used in professional practice, consistent with current building assessment and regulatory frameworks [2], [4]. This part combines short lectures with guided discussion based on real case studies.

The second block is devoted entirely to the practice with the game supported by theused in the course projects is presented and, in small groups, students draw up a ranking of those they consider having higher and lower energy consumption and global warming potential. In the second phase, the software is introduced, showing the actual impacts per kilogram for each material, so that students can contrast their hypotheses with the available information and discuss the origin of the discrepancies.

In a third phase, the tool rescales these same results to different functional units, first at whole building level and then per user, per apartment or per bed depending on the type of building analysed, in line with whole life cycle assessment approaches for buildings [4]. Students observe how the rankings change when the quantities used are considered and when the denominator approaches the service provided.

The evaluation is based on the comparison between initial and intermediate rankings, on written justifications of the functional unit selected for each scenario, and on a short questionnaire on the perceived usefulness of the tool. The paper discusses preliminary results and the potential of the software as a support that can be replicated in other courses where LCA is applied to architectural design.

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LECTURERS' OPINIONS ON ENTREPRENEURSHIP POSTER EXHIBITIONS IN THE FIRST YEAR OF BUILDING ENGINEERING AT UPV.

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Keywords: *active learning, building engineering, entrepreneurship education, lecturers, poster exhibition*

Abstract

The percentage of Building Engineering graduates who work as self-employed professionals is high. In fact, some reports show that compared to an average of 8.7% among all university graduates, 19% of building engineers are independent professionals, either employing others or working alone [1]. In addition, the proportion of self-employed professionals is significantly higher in Building Engineering than in the wider engineering and architecture sector [2]. Therefore, aspects related to entrepreneurship should play a fundamental role during the bachelor degree [3].

This research describes a poster exhibition on entrepreneurship organised by the first-year Economics course [4, 5], and explores the opinions of some lecturers and members of the school management team. The title of the exhibition was "Shall we become entrepreneurs? We're already working on it in the first year of Building Engineering" and it was held in two editions in the school's main hall, with a total of 29 posters being shown and 125 students participating in teams. Both exhibitions were positively evaluated by the teachers involved, who believed they were useful for the students, as they were able to see and analyse tangible examples of the final result. In addition, the course was on display in the school for a month and a half each academic year, giving all students, teachers and academic staff an insight into some of the entrepreneurship topics covered in the classroom. Opinions from a sample of students about this learning activity were positive and published elsewhere. However, we still needed to know the opinions of other peer groups, such as lecturers of other first-year courses and members of the school management team. What are their opinions on this initiative, how do they asses it?

Following a qualitative methodology, semi-structured interviews were carried out face to face with a sample of nine participants with diverse academic background (five male and four female). Six of them were lecturers from 4 different departments (Applied Mathematics, Applied Physics, Graphic Expression in Architecture, Architectural Constructions) teaching the following first year courses: Descriptive Geometry, Mathematics I, Physics, Architectural Drawing I, Construction Technology I and Construction Materials I. One participant belongs to Technical, Management,

Administrative and Service Staff (PTGAS) and had been working at UPV's Entrepreneurship Area for many years, while two were School Vice-Directors (Entrepreneurship and Student Affairs and Quality). They were asked about the strong points of the initiative, the improvements to suggest, its practical benefits, and an overall rating from 1 to 10. These interviews were recorded and transcribed verbatim, generating a text file of 16.000 words that will be analyzed in detail with the aim of extracting findings and draw conclusions. A preliminary superficial analysis shows a very positive assessment, an average score of 9,4, and several ideas for improvement that will be taken into account for future editions of the entrepreneurship exhibition.

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SELF-ASSESSMENT AS A LEARNING STRATEGY IN THE DESIGN OF STEEL STRUCTURES IN ARCHITECTURE

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Keywords: *self-assessment, steel structures, buckling effective length, architectural structures*

Abstract

This paper presents a self-assessment-based learning strategy aimed at students of the compulsory subject Steel Structures (St3), taught in the first semester of the fifth year of the Bachelor's degree in Fundamentals of Architecture at the School of Architecture of the Universitat Politècnica de València.

The course, with a workload of 4.5 ECTS credits, is the last compulsory subject related to structures in the degree programme. The ultimate objective of the course is that, by the end of the academic year, students will be able to design and calculate a steel architectural structure: design of bars, joints, bracing systems and connections to concrete foundations, according to the Spanish code [1]. The approach of this course is eminently practical, aiming to replicate the professional practice of architects. With this objective in mind, the assessment of the practical part of the subject consists of an open book exam, allowing students to consult the standards in force, hand books, solved exercises and past papers.

This approach implies that students must be able to understand the behaviour of the proposed structure and the modelling of its members. The main points that present the greatest difficulty for students are, on the one hand, the calculation of internal forces and, on the other hand, the determination of the buckling effective length of supports and compressed chords in trusses. Both points are fundamental in order to confidently tackle the design and calculation of members subjected to compression or combined compression and bending.

With the aim of improving learning outcomes in this subject, and considering that the correct modelling is essential for solving problems successfully, a series of self-assessment exercises are proposed, focused on the calculation of buckling coefficients (β_y and β_z) and the corresponding buckling lengths (Lk_y and Lk_z).

Traditionally, assessment was more focused on results, but now its formative function is considered [2]. One of the main advantages of the presented self-assessment approach is that it allows students to receive immediate feedback.

This initiative, which is entirely voluntary, has been carried out using the 'exams' digital tool integrated into PoliformaT, the e-learning platform where professors share information with students [3]. The tool allows students to complete the proposed exercises as many times as they wish, storing the best result achieved. These results have been compared with those obtained in the first midterm exam of the course in order to draw conclusions about the usefulness of the proposal.

On the other hand, it has been possible to identify the situations that, in the self-assessment tests, have shown greater difficulty among the students that have participated in the activity, with the aim of reinforcing the approach strategies for these cases the next academic year.

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ADDRESSING THE DESIGN OF JOINTS IN STEEL STRUCTURES IN ARCHITECTURE

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Keywords: *spatial visualisation skills, joints, connections, steel structures, architectural structures*

Abstract

A fundamental part of the Steel Structures course (Structures 3) in the Bachelor's Degree in Fundamentals of Architecture focuses on the design and calculation of joints, a key aspect for the accurate definition and execution of steel structures. To successfully approach these problems, it is necessary, not only to know the calculation procedures included in the Spanish code [1], but also to have spatial visualisation skills to understand the three-dimensional arrangement of the structural elements to be connected, as well as their geometric and constructive relationships.

In this process, technical drawing plays an essential role, not only as the final result, but also as a tool for understanding, verifying and checking the constructability of the proposed detail.

Within the context of university architecture education, drawing is an essential means of expression [2]. However, despite students having previously completed 36 ECTS credits in courses related to graphic expression and architectural drawing [3],[4],[5],[6], a progressive decline has been observed in recent years in their ability to mentally visualize three-dimensional configurations and accurately represent complex structural connections. This deficiency becomes particularly evident in tasks involving the design of bolted and welded connections or columns base plates, resulting in low academic performance, even in open-book assessment contexts, where students have access to extensive supporting material.

After identifying that the main difficulty lies in limited spatial visualization skills and insufficient ability to produce detailed technical drawings, a set of teaching actions has been implemented during the first term of the 2025–26 academic year with the aim of strengthening these competencies. The initiatives combined flipped classroom methodologies, audio-visual resources, freehand drawing exercises, direct observation of real connections in the built environment, and hands-on experimentation with physical models. The goal was to enable students to develop a coherent mental image

of the connections to be designed and to communicate it through clear, proportionate, and technically accurate drawings.

Overall, the application of these teaching actions highlights the need to specifically recover and systematically train spatial visualization and technical drawing skills in structural courses. Based on this experience, the results indicate that drawing remains an essential language in architecture and that its use as an active thinking tool is indispensable for successfully addressing the design of steel profile connections. These actions represent a valid and coherent line of work aligned with the course objectives, and will be reinforced in future academic years.

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HERITAGE VALUATION FROM THE RECOMMENDATION ON THE HISTORIC URBAN LANDSCAPE: TEACHING EXPERIENCES BASED ON THE DYNAMIC NATURE OF HERITAGE

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Keywords: *Historic Urban Landscape; Cultural heritage education; Urban landscape dynamics; Threats; Interdisciplinary teaching methods*

Abstract

This paper presents a teaching innovation experience developed within the field of cultural heritage education, based on the critical application of UNESCO's Recommendation on the Historic Urban Landscape (HUL). The proposal builds on the work carried out by students of the course History, Theory and Architectural Composition 3 during the 2024–2025 academic year at the Higher Technical School of Architecture of Seville, focusing on a sector of Seville's historic city centre. The use of the HUL approach as a methodological framework seeks to move beyond object-based and static conceptions of heritage, advancing instead towards an understanding of heritage as a social construct that is dynamic and subject to continual transformation [1].

The teaching exercise was structured according to the phases proposed by the Recommendation: information gathering and heritage readings, diagnosis of values and attributes, and the formulation of criteria and lines of action. Unlike traditional approaches centred on isolated assets, students worked using a layered logic, incorporating historical, urban, social, economic, perceptual and ecological dimensions of the urban landscape. This methodology made it possible to identify not only tangible and intangible heritage values, but also vulnerabilities, conflicts and processes of change that directly affect their cultural significance.

One of the central axes of the experience was the consideration of heritage in terms of its dynamic character. The analysis was oriented towards recognising continuously evolving threats such as gentrification [2], touristification [3] [4], the loss of traditional uses, and the banalisation of the landscape, understanding heritage valuation as an active and participatory process. In this regard, the work incorporated tools such as SWOT analysis, the identification of heritage communities, and the formulation of intervention measures that were not only physical, but also conceptual and social.

From a teaching perspective, the experience demonstrated the potential of the HUL approach to foster critical thinking, interdisciplinarity and a strong connection between theory and reality. Students moved away from a traditional conception of heritage as an isolated object to understand it as a complex system, shaped by the impact of multiple threats. The paper concludes that the Recommendation on the Historic Urban Landscape constitutes a particularly effective tool for heritage education in contemporary contexts, as it enables the training of professionals capable of valuing, protecting and managing cultural heritage from an integrated and dynamic perspective.

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REFERENCE AND REPLICA: NEW METHODOLOGIES FOR THE DETECTION AND PROTECTION OF HERITAGE ELEMENTS AGAINST THE THREATS AND IMPACTS OF OVERTOURISM

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Keywords: *Heritage; Historic city centres; Participatory learning; Tourist monoculture; Touristification*

Abstract

The contemporary expansion of urban tourism has led to the saturation of historic centres, generating anthropic pressure that compromises the integrity of the urban fabric and built heritage. This phenomenon, widely documented in scientific literature as "overtourism", necessitates innovative pedagogical approaches that bring the complexity of the problem into the technical classroom—particularly regarding its architectural, urban, and heritage dimensions. These factors generate negative impacts on the city, as previously investigated by the authors [1-4]. This paper presents an active teaching methodology designed to identify, analyse, and protect against the effects of tourist monocultures on architectural heritage and its immediate surroundings. The method is applied within the "Architectural History, Theory, and Composition 3 (Heritage)" course of the Degree in Fundamentals of Architecture at the University of Seville, utilising the city's historic centre—specifically its north-eastern quadrant—as an analytical laboratory.

The proposal is based on a participatory, practice-led learning model where the didactic core lies in the comparative analysis of two case studies: a "reference building" and a "replica building". The former corresponds to a property already transformed by tertiary-tourist use, while the latter exhibits similar typological characteristics but remains vulnerable to imminent touristification processes. The methodology is structured into five operational phases:

1. Teaching Planning and Research Updating: Review and direct transfer of previous research findings to the classroom.
2. Theoretical Framework: Student-led construction of the state of the art.

3. Heritage Actions: Fieldwork and technical diagnosis. For the reference building, students evaluate the impact of tourist-led rehabilitation against protection planning and original records. For the replica building, an assessment of attributes is conducted to propose "dynamic protection"—conceived as an adaptive system capable of responding to emerging threats through monitoring and flexible methods.
4. Documentary Compendium: Drafting of a scientific report including critical analysis and bibliography.
5. Transversal Debate: Group presentations to foster collective knowledge construction.

The results of this method demonstrate that the application of such a methodology fosters profound heritage awareness and a technical understanding of how excessive tourism subverts architectural-heritage logic and urban spaces. Beyond improving research and public communication skills, the method enables students to assimilate complex social, constructive, and heritage realities. It is observed that, although overtourism is a growing subject of social debate, its physical impact on buildings is often omitted in traditional academic training.

In conclusion, this approach not only complies with the European Higher Education Area guidelines by immediately linking research and teaching but also stimulates self-directed learning and critical reflection. The student's progression—from initial uncertainty regarding a complex topic to the capacity to propose technical protection measures—reaffirms the validity of active methodologies in addressing contemporary challenges in the management of built heritage.

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RESEARCH: A PROPOSAL FOR WORKING ON SUSTAINABILITY IN AN EXPERIMENTAL WAY

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Keywords: *Research-Based Learning (RBL), Sustainability, Active Methodologies, Building Quality, Engineering Education.*

Abstract

University education in construction faces the challenge of preparing future professionals who can integrate technical and scientific knowledge, sustainability, innovation, and regulatory compliance in an increasingly complex and changing context. In recent years, there has also been a growing trend of demotivation and absenteeism in the final stages of undergraduate and graduate studies, associated with imminent entry into the labor market and the perception of a disconnect between theoretical content and its practical application. Within this framework, this paper presents a proposal derived from the educational innovation project InvestigAcción: experimentation as a driver of learning, developed at the School of Building Engineering, whose methodological focus is Research-Based Learning (RBL).

In general, the RBL methodology has a wide range of applications in university contexts because it places the student at the center of the teaching-learning process, making it an active methodology of great interest for science and experimental education [1]. By asking relevant questions, formulating hypotheses, designing analysis strategies, and critically interpreting results, students develop key skills in critical thinking, intellectual autonomy, and evidence-based decision-making [2]. This approach improves student motivation by confronting them with real problems related to their future professional activity, while also developing so-called "soft skills" and competencies of great interest to the labor market, such as teamwork, scientific communication, and conflict management [3].

This paper presents a proposal for undergraduate and master's students at the School of Building Engineering, engaging them in solving current problems in the sector and focusing on sustainability, the circular economy, and construction and demolition waste management. One of the main objectives of the project is to familiarize students with the new European Construction Products Regulation (EU) 2024/3110, integrating its technical, environmental, and traceability requirements into practical activities [4]. In this regard, students analyze the potential of waste as secondary raw materials, evaluate its technical feasibility through physical-mechanical tests, and assess its regulatory suitability, preparing technical reports, material data sheets, and proposals for on-site

applications. The project design promotes collaborative work in multidisciplinary teams, the development of cross-cutting skills—leadership, communication, time management and conflict resolution—and autonomy in learning, with teachers serving as guides and facilitators of the process. It also incorporates progressive and formative assessment based on tools such as laboratory logs, rubrics, oral presentations, pre- and post-tests, and learning perception surveys.

Figure 1: *Students working in the Construction Materials laboratory. (Source: Own work).*

All of this has led to the development of a proposal that aims to increase student motivation and participation, can be used in other university contexts, and facilitates the planning of its implementation. Overall, this experience demonstrates the potential of RBL as a tool for improving the quality of the teaching-learning process in building and for training critical, responsible, and innovative professionals prepared to face the current and future challenges of the construction sector.

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AI-powered virtual course assistants for building engineering education

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Keywords: *large language models; virtual course assistants; Innovation; building engineering; higher education.*

Abstract

The following study reports the development of a Virtual Course Assistant (VCA or AVA in Spanish), an educational tool based on large language models (LLMs), implemented as a customized "GPT" within ChatGPT and, in parallel, as a "Gem" in Gemini. The VCA was destined to support teaching in undergraduate and master's degree courses at the school of building engineering of the Technical University of Madrid, acting as an active, all-round and accessible complement to traditional instruction [1][2]. Its design focuses on providing contextualized support, guided problem solving, and conceptual reinforcement, adapting to the educational level and the specific content of each course. From a social and educational perspective, the VCA may contribute to reducing inequalities in access to academic support, fostering autonomous learning, and alleviating workload without replacing teacher–student interaction. During the upcoming academic year, this study will assess the integration of a VCA into teaching activities, analyzing its impact on student motivation, understanding of complex concepts, and the development of transversal competencies. Therefore, VCA's position themselves as a disruptive educational tool that introduces artificial intelligence in a critical, ethical, and pedagogically oriented manner [3][4].

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EMERGING CHALLENGES IN TOPOGRAPHY EDUCATION FOR BUILDING DEGREES: IMMERSIVE VIRTUAL REALITY AND FLIPPED LEARNING

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Keywords: *Educational Innovation, Immersive Virtual Reality, Flipped classroom, Topography, Building Engineering Education*

Abstract

This paper presents an innovative educational approach to address emerging challenges in topography education within building engineering degrees through the integration of Immersive Virtual Reality (IVR) and flipped learning methodologies. The proposal responds to common constraints in technical higher education, such as large class sizes, the high cost and limited availability of topographic instruments, restricted teaching time to cover complex procedures (e.g., topographic traverses), and the dependence on favourable weather conditions for fieldwork activities. Implemented over two consecutive academic years, the initiative focused on improving student learning outcomes in topographic procedures, including geometric levelling, intersection methods, and topographic itineraries. Immersive 360º virtual environments were developed to simulate real field scenarios, allowing students to familiarize themselves with instruments, workflows, and decision-making processes prior to on-site practice.

Figure 1: *Image from the virtual tour of the topographic levelling. (Source: Own work. https://iedu.usal.es/nivelacion/index.html)*

This virtual preparation was complemented by targeted real-world sessions, optimizing the use of available equipment and field time. Student performance was evaluated through rubrics, practical assessments, and perception surveys. The results indicate increased student engagement, improved understanding of complex topographic procedures, and enhanced academic performance. The proposed dual approach demonstrates its potential as a scalable and replicable strategy to optimize resources,

mitigate logistical constraints, and enhance practical skill acquisition in topography education for building degrees.

In this context, virtual reality applications in fields such as archaeology, engineering, and education have proven effective in simulating real-world tasks while reducing risks, costs, and resource constraints [1]. These outcomes reinforce the suitability of immersive virtual reality as a strategic tool for addressing current challenges in topography education.

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DIGITIZATION OF THE MATERIALS LIBRARY AS A TOOL TO TEACH MATERIALS FOR ARCHITECTURE

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Key words: *materials library, construction, digitization, database*

Abstract

Materials are the expressive tools of architecture, offering endless possibilities for exploring and conveying sensory experience. The senses enrich our perception of space and materiality. Moreover, materials give form to Architecture and constitute its primary resource. The teaching of construction materials is therefore a fundamental pillar in architectural education, as these materials are the main expressive and technical instruments of the architectural project [1], [2], [3]. In the Bachelor's Degree in Fundamentals of Architecture at the UPM, the course Construction Materials represents the students' first direct encounter with the material and technological dimension of architecture, following an initial year focused mainly on graphic content. In this context, the materials library— a physical space that brings together real material samples and enables their manipulation and sensory analysis— becomes a key pedagogical resource for linking theory and practice [4].

Over the past decades, materials libraries have gained relevance in schools of architecture, professional institutions, and industry, as they provide direct access to material innovations and sensory experiences that complement theoretical teaching. At ETSAM (Figure 1) the materials library and the testing laboratory allow students to experience properties such as texture, color, appearance, physical behavior, and construction applications— and even emotional responses— thereby enriching theoretical learning through experimentation [5], [6].

However, the large number of enrolled students— more than 400 per year— makes equitable access to the physical space difficult and limits active learning. To address this issue, a digital materials library has been developed to expand and facilitate access to these resources. This environment integrates videos, 360-degree photographs, and detailed technical sheets for each material, including mechanical, physical, and chemical properties, as well as examples of use in built works. The platform allows students to interact with each sample, examine it in detail, and connect it to a database linked to construction elements and work units documented through real photographs.

Digitization not only improves access to content but also encourages participation from ETSAM students and those from other universities, broadening the educational reach of the materials library. This hybrid resource— physical room and digital repository—

enhances educational quality, supports active methodologies based on exploration and autonomous learning, and strengthens a comprehensive understanding of materials as a foundation of the architectural process.

Overall, the digital materials library emerges as an educational innovation capable of transforming architectural training through the integration of technology, experimentation, and accessibility.

Figure 1: *Image 360 º of the materials library in laboratory "Luis de Villanueva" ETSAM (Source: Marina Hevia)*

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SERVICE-LEARNING APPLIED TO THE SUBJECT "CHALLENGES IN BUILDING"

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Keywords: *Service-Learning, ApS,* challenges*, plastic, mortar*

Abstract

The fight against climate change is a critical issue, as it is causing problems in the health, economy, and quality of life of people worldwide [1]. Furthermore, the incorporation of active learning methodologies helps students gain a deeper understanding and develop their critical thinking skills [2].

Based on the above premises, the objective of this work has been to combine challenge-based learning with a Service-Learning project that allows students in the "Challenges in Building" course at the Universidad Politécnica de Madrid (UPM) to investigate, integrate knowledge, and raise awareness about the importance of plastic recycling and its value in the building sector. In addition to technical knowledge, the social dimension has been addressed, as the solution to the challenge has been presented to students at lower educational levels, to show them the importance of their actions in recycling the waste they generate. A unique aspect of implementing the project in this subject was that all the students were Erasmus students who volunteered their time, enriching the experience with an international and multicultural perspective.

The project unfolded in several phases. The first phase presented the challenge: to find alternative recycling methods for commonly used plastics by incorporating them into mortars and concretes. The plastics the students worked with included expanded polystyrene, PET, recycled rubber, low-density polyethylene, and polypropylene. In the second phase, under the guidance of their professors, the students developed their projects until they achieved the learning objectives set for the course. In the third phase, the knowledge acquired by our students was adapted to the educational level of the students at Salesianos Estrecho school, culminating in a joint presentation, the cover of which can be seen in Figure 1.

Figure 1: *Presentation given at the Salesianos Estrecho schooL*

The final stage involved evaluating the activities carried out. First, the students' acquisition of academic skills at the UPM was assessed, followed by an evaluation of their personal and social skills. Finally, a survey was conducted among students from the School and the Salesianos Estrecho school to determine their level of satisfaction with the activities.

In conclusion, the work carried out has allowed us to work on new solutions to combat climate change as well as to raise awareness among students of different educational levels about the existing problem, with a high level of satisfaction from all those involved. Furthermore, the application of the Service-Learning project in this new subject confirms its potential for implementation in various technical subjects.

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FULL-SCALE GRAPHIC TEMPLATES AS COGNITIVE SCAFFOLDING IN BASIC VOCATIONAL TRAINING: AN ACTIVE LEARNING APPROACH

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Keywords: *Technical drawing, active learning, vocational education, cognitive scaffolding, challenging educational environments.*

Abstract

Currently, Basic Vocational Training (BVT), a lower secondary vocational pathway in Spain, particularly when delivered in challenging educational environments, faces significant social and academic challenges. These difficulties are frequently associated with underdeveloped cognitive processes that hinder the acquisition of technical competencies [1]. In the Fabrication and Assembly specialty, planimetric interpretation often represents a major obstacle. Students usually demonstrate strong manual skills but limited cognitive abstraction abilities, making it difficult for them to translate two-dimensional technical drawings into the physical assembly of an installation.

This study analyzes the educational impact of a multi-phase didactic transition from freehand sketches and conventional technical drawings of simple plumbing circuits toward the use of a full-scale "graphic template" as a visual enhancement and cognitive scaffolding tool. The research was conducted in a public vocational training center located in Pinos Puente (Granada, southern Spain). The main objective is to evaluate the influence of prior analysis of a 1:1 technical drawing as a preliminary step before the cutting and assembly of circuits, with the aim of improving technical competence while reducing student frustration in workshop-based learning [2].

The methodology employed is participatory action research, conducted over a one-month period within an authentic workshop-based learning environment. A sample of second-year BVT students was selected, characterized by a predominantly practical learning profile prior to the introduction of formal theoretical concepts. The pedagogical intervention was structured in three phases. First, recurring errors in the assembly of copper circuits drawn solely by hand were systematically documented. Second, the "Graphic Template Method" was implemented, requiring students to draw each circuit at full scale (1:1) and explicitly identify welding points, fittings, and real dimensions. Finally, the assembly process was carried out directly over the graphic template, which functioned as an immediate verification and guidance tool.

Quantitative results show a significant reduction in material waste, total execution time, and assembly errors. Qualitative findings indicate that technical drawing ceased to be perceived as a purely theoretical task and became an integral part of a meaningful

practical process. Full-scale graphic expression operated as cognitive scaffolding, enabling students to visualize workflows and anticipate procedural steps.

In conclusion, this study demonstrates that graphic expression is an essential pedagogical tool in challenging educational environments in technical and vocational education. Integrating prior technical drawing with mechanical action not only improves the quality of the final product but also enhances students' professional identity. The proposed approach shows strong potential for transferability to other vocational and technical training contexts.

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New Challenges / Trends in Higher Education

THE SUSTAINABILITY COURSE IN THE AGE OF ARTIFICIAL INTELLIGENCE

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Keywords: *Sustainability, Higher education policy, Artificial intelligence, Technical degree programs, Environmental awareness*

Abstract

Royal Decree 822/2021, which regulates the organization and quality of official university education in Spain (Bachelor's, Master's, and Doctorate degrees), explicitly incorporates sustainability into university teaching as a guiding principle for all official degree programs, and establishes it as a mandatory transversal competence in study plans [1]. This regulatory framework requires degree programs to incorporate democratic values and the Sustainable Development Goals and urges the integration of sustainability and climate change issues in line with Law 7/2021 on Climate Change [2]. Consequently, Bachelor's, Master's, and Doctorate programs have incorporated these competences either through new specific courses or via their transversal integration across various training itineraries.

This paper presents the experience and challenges of launching a new sustainability course in technical degree programs, coinciding with the emergence and widespread adoption of artificial intelligence (AI) tools in higher education [3]. It describes the teaching methodology employed and the formation of a multidisciplinary teaching team participating transversally in the course, along with its alignment with normative sustainability requirements and emerging trends in educational innovation.

The course addresses the challenge of delivering content that demands a high level of intellectual maturity from students to comprehend, relate to, and critically assess sources and data, aiming to foster the development of their own sustainability criteria [4]. This occurs in a context where dominant discourses may limit the expression of divergent ideas, and the extensive use of AI tools introduces additional challenges. On the one hand, these tools reveal concerning biases in access and handling among technical degree students; on the other hand, their massive deployment increases energy and natural resource consumption, indirectly accelerating the effects of climate change.

Key results from this initial experience include the democratization of AI tool access and use for information queries and document creation, as well as the design of activities and challenges to help students develop their own sustainable criteria and become critically aware of technology's environmental impact. However, the first edition also revealed partial failure in controlling AI overuse and achieving effective awareness of its

ecological footprint, particularly regarding energy and water consumption and ecosystem impacts. This tension between technological innovation, access equity, and sustainability emerges as one of the key new challenges in technical higher education.

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SMART GLASS TECHNOLOGIES AS A CATALYST FOR EDUCATIONAL INNOVATION IN SCHOOL BUILDINGS

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Keywords: *smart glass, educational innovation, school building, interactive learning environment, sustainable architecture*

Abstract

Educational innovation increasingly extends beyond teaching methods to encompass the physical and environmental qualities of learning spaces. School buildings, as active components of the educational system, directly influence learning experiences, cognitive performance, and student motivation [1]. However, existing research has largely overlooked the role of smart building technologies as tools for fostering educational innovation. In this context, smart glass technologies emerge as an innovative solution capable of enhancing learning environments through adaptive control of light, transparency, and visual comfort.

This paper adopts a qualitative and analytical approach to examine the role of smart glass as a catalyst for educational innovation in school buildings. The study is based on a structured review and qualitative content analysis of interdisciplinary literature published between 2010 and 2025, covering educational design, smart building technologies, environmental psychology, and sustainable architecture. Approximately 30 articles were systematically analyzed using inclusion criteria focusing on English-language studies addressing interior daylighting, privacy, and adaptive learning environments, while irrelevant studies were excluded.

Findings indicate that smart glass technologies—including electrochromic, SPD, and PDLC systems—go beyond energy efficiency benefits. By dynamically regulating daylight, reducing glare, and providing visual privacy, these systems create flexible, responsive, and student-centered learning environments [2,3,4]. These characteristics align with contemporary pedagogical approaches emphasizing interaction, focus, and active learning, highlighting the innovative contribution of this research in directly linking building technology to educational innovation [1].

The findings are particularly applicable to school spaces such as classrooms, libraries, laboratories, interior partitions, and flexible learning zones, where adaptive control of light and transparency can support glare reduction, visual privacy, and collaborative activities. The paper also proposes a conceptual framework illustrating the relationship between smart glass capabilities, environmental quality, and educational innovation outcomes. This framework demonstrates how adaptive building envelopes can mediate between physical space and pedagogical processes, transforming school buildings into responsive learning environments.

The study not only provides theoretical contributions to the existing literature on educational buildings and smart technologies but also offers practical insights for architects, educational planners, and policymakers. It further suggests directions for future research and the implementation of innovative technologies in schools, reinforcing the strategic potential of smart glass in aligning architectural innovation with educational objectives.

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GAMIFICATION IN VIRTUAL HIGHER EDUCATION: AN APPROACH TO ENHANCING STUDENT MOTIVATION AND LEARNING EXPERIENCE

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Keywords: *gamification, virtual education, student motivation, artificial intelligence*

Abstract

Online teaching in higher education has increased in recent years to overcome geographical barriers and facilitate access to higher education. However, this educational model presents significant pedagogical challenges, particularly regarding student motivation, perceptions of isolation, and the difficulty of fostering active learning in asynchronous environments. For this reason, the Teaching Innovation Group at the University of Extremadura GRAFIPRO has developed a teaching innovation project to evaluate the impact of gamification in virtual higher education. This project is grounded in principles of active learning and intrinsic motivation and integrates game-based dynamics as an educational strategy to enhance students' learning experiences. To this end, a gamified questionnaire was designed using the Genially platform, complemented by artificial intelligence technologies such as Gemini and ElevenLabs to increase personalisation and student interaction with the educational resource. This educational strategy was implemented in an asynchronous virtual master's degree program, and feedback was collected from 42 students. The results demonstrate a very high level of satisfaction and positive evaluation of the experience. 73% of the students reported being fully immersed in the game dynamics, highlighting the potential of gamification to foster student engagement and self-regulated learning. Additionally, 97.6% of the students indicated that the gamified questionnaire increased enjoyment and recommended its application in other courses, while 100% stated that the methodology contributed to improved retention of learning content. On a 5-point Likert scale, students rated their overall experience with a mean score of 4.78 and assigned a

level of motivation during the completion of the gamified questionnaire a value of 4.52. These findings underscore the effectiveness of gamification, supported by digital technologies and artificial intelligence, as a pedagogical strategy to humanise virtual higher education, reduce perceptions of loneliness, and enhance student motivation and engagement, ultimately providing more attractive and meaningful learning experiences in higher education.

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AN INNOVATIVE APPROACH TO TRAINING ENGINEERING PhD STUDENTS IN ENGINEERING IN GREEN SKILLS

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Keywords: *green skills, engineering PhD candidate, educational innovation, higher education*

Abstract

The European Commission aims to enhance sustainability across Europe through a range of initiatives [1]. Prominent among these is the development of GreenComp, which delineates a framework of environmentally sustainable skills that citizens should develop [2]. In this context, higher education institutions must adapt their curricula to effectively facilitate the acquisition of the green skills advocated by the European Commission [3]. Doctoral candidates, particularly those specialising in engineering, must be rigorously trained in sustainability, as they will be responsible for disseminating this knowledge and these competencies through their sustainable research endeavours and in educating future engineers [4]. Nevertheless, currently, no training programs specifically target the development of green skills among engineering doctoral students [5].

This training plan, formulated within the framework of the TECSKILL project—an Erasmus+ initiative funded by the European Union [6] —aims to adapt the green competencies outlined in the GreenComp framework to meet the educational requirements of future social engineering researchers. To achieve this, four universities from Spain, Sweden, Portugal, and Italy have collaboratively developed a transnational training program employing dynamic, problem-solving methodologies that emphasize teamwork. The implementation phase commenced with the identification of twelve green skills and the delineation of forty-eight knowledge indicators necessary for their mastery. Subsequently, four progressive levels were defined for each indicator, thereby facilitating systematic advancement in both knowledge and skill acquisition.

The training program was structured around a curriculum comprising 22 workshops aimed at fostering the development of the knowledge and skills delineated by the new

competency framework. These workshops were conducted over 15-day periods at four European universities. Upon evaluating the outcomes of each session, it was determined that they effectively support the attainment of a substantial level of knowledge, independent of participants' specific areas of specialization. Notably, students demonstrated proficiency in four of the twelve designated green skills.

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MODERNIZING MECHANISMS LABS FROM LEGACY SOFTWARE TO INTERACTIVE TOOLS

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Keywords: *mechanical engineering; mechanism kinematics; software; formative assessment*

Abstract

Computer-based practical sessions in mechanisms courses are intended to help students translate analytical kinematics into an engineering workflow, but when they depend on legacy software with limited visual feedback and high interface friction, classroom time can shift from reasoning to tool troubleshooting and "button-following". In this context, short step-by-step instructional videos can provide consistent procedural guidance and worked examples, supporting autonomy and reducing recurring operational mistakes during computer labs. [1]

This contribution presents an educational innovation implemented across the Informatics practicals in a Fundamentals of Machines and Mechanisms framework. The innovation is built on two coordinated changes: modernization of the digital ecosystem used in the sessions and a change in the way evidence of learning is produced and assessed. First, a legacy desktop program (WinMecC) is contrasted with more recent interactive resources (GeoGebra and Gear Generator) selected to emphasize immediate visual verification, transparent assumptions, and parameter exploration. GeoGebra supports parametric kinematic constructions in planar mechanisms, including guided activities on velocity and acceleration, where students can vary geometry and input motion and immediately check the coherence of results. This shifts the task from obtaining a single numerical output to understanding trends, constraints, and sensitivity to design variables. Gear Generator supports rapid assembly and inspection of gear pairs and trains, allowing students to test tooth-number combinations, observe rotation sense, and map transmission ratios efficiently. The tool also enables quick comparison between alternative layouts, which helps students link numerical ratios with physical interpretation in later sessions involving real mock-ups (e.g., gearbox-related practices).

Second, the practicals adopt in-class, time-bounded submission supported by a short checklist and rubric. Instead of finishing the core work at home, students complete and

deliver the essential outputs during the session, which promotes systematic verification (ratio consistency checks, clear labeling of figures, traceability of calculations, explicit statement of assumptions) and enables immediate formative feedback. This approach also helps instructors identify typical misconceptions and operational bottlenecks while they occur, rather than after delayed submissions. [2] The videos are integrated as a preparation and in-session support resource, reducing repetitive troubleshooting and freeing class time for interpretation, discussion, and targeted guidance.

Student perception data from the 2025 cohort (n=82, 0–10 scale) are used to summarize the impact of the innovation beyond a single satisfaction indicator. Figure 1 shows a paired comparison between the legacy session and the average perception across the sessions using the updated resources and workflow. Mean ratings increase in interest and motivation (6.20 to 8.06), perceived learning (6.72 to 8.02), resources (6.66 to 8.34), and overall rating (6.52 to 8.21). Difficulty/workload rises moderately (5.66 to 6.37), which is interpreted as a controlled increase in perceived demand associated with richer exploration and in-class verification, while maintaining clearer guidance and higher perceived learning value.

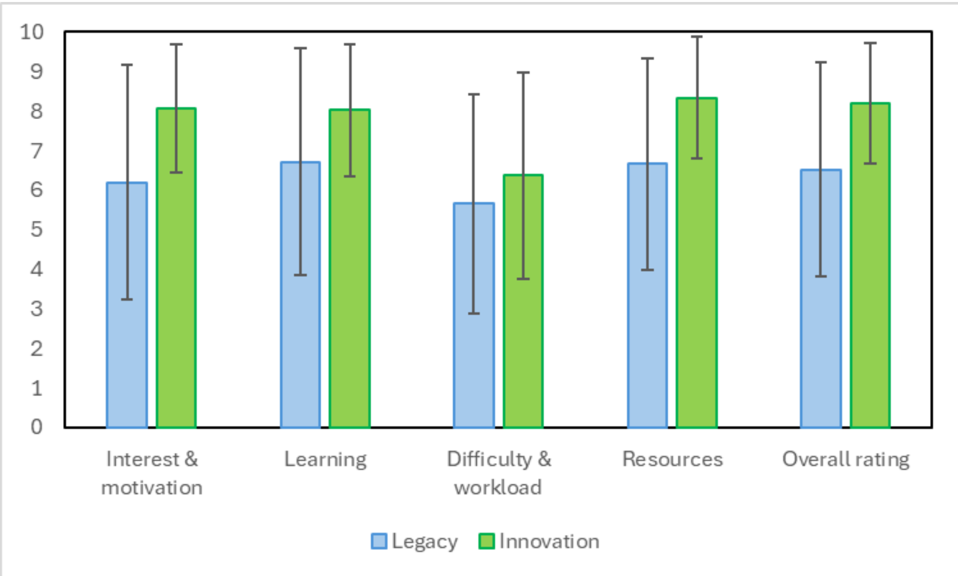

Figure 1: *Students perception on mechanisms computers practicals (Source: Original)*

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PROGRESSIVE VISUAL GUIDANCE FOR A CRACKED SHAFT DIAGNOSTICS

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Keywords: *mechanical engineering; mechanism kinematics; software; formative assessment*

Abstract

Rotating machinery reliability is a recurring engineering concern, and a cracked shaft is a representative fault because it connects structural damage with measurable changes in dynamic response and vibration signatures that students can observe and justify in a controlled setting. In procedural laboratories, applying multimedia design principles can reduce avoidable cognitive load by making the sequence of actions, safety constraints, and verification checkpoints explicit, so student effort is directed to interpretation rather than to navigation of instructions [1].

This contribution describes an educational innovation implemented in a cracked-shaft practical in Mechanical Engineering. Early-stage shaft cracking is a well-known reliability threat in rotating machinery, and vibration-based monitoring is widely used because a transverse crack modifies shaft stiffness and produces characteristic changes in the dynamic response [2]. Students work with a benchtop rotating rig and complete three tightly coupled tasks: (i) assemble and verify the setup under a safety and calibration checklist, (ii) acquire signals following a fixed measurement protocol, and (iii) produce an evidence-based fault statement supported by plots and concise technical reasoning. The innovation was deployed as progressive scaffolding across three consecutive implementations with the same learning objectives and assessment criteria. In the first implementation, guidance relied on a bulletin/manual. In the second, the manual was complemented with step-by-step photographs of the mounting and measurement procedure, aligned with explicit stop-and-check points (sensor placement, tightening, etc.). In the third, guidance was further condensed into a short vertical video in a smartphone-first format for on-bench viewing, with the same checkpoints and a concise common-errors section.

Across the three implementations, the student survey responses reflect a clear improvement in how the practical is experienced as the instructional support evolves from a bulletin and manual to step-by-step photographs and finally to an on-bench

video. The pattern suggests that progressively more visual and task-focused resources increase clarity at the points where mistakes most frequently occur, especially during mounting, alignment, sensor placement, and initial verification of the measurement setup. The photo-based guidance contributes by making the sequence explicit and by showing what the correct intermediate states should look like, which helps students confirm each step before moving forward and reduces uncertainty when problems appear. The vertical video strengthens this effect further because it adopts a format that matches students' everyday information habits in current social media platforms, making the guidance faster to consume, easier to revisit, and more practical to consult while working at the bench. As a consequence, students appear to spend less effort interpreting written instructions and more effort on the intended learning outcomes of the activity. Overall, the survey results are consistent with the idea that visual scaffolding enhances procedural reliability and supports deeper engagement with diagnostic reasoning, and they specifically support the value of short vertical videos as an effective, contemporary format for procedural guidance in hands-on engineering practicals. Figure 1 provides a visual overview of the multimedia resources created to support the cracked-shaft practical.

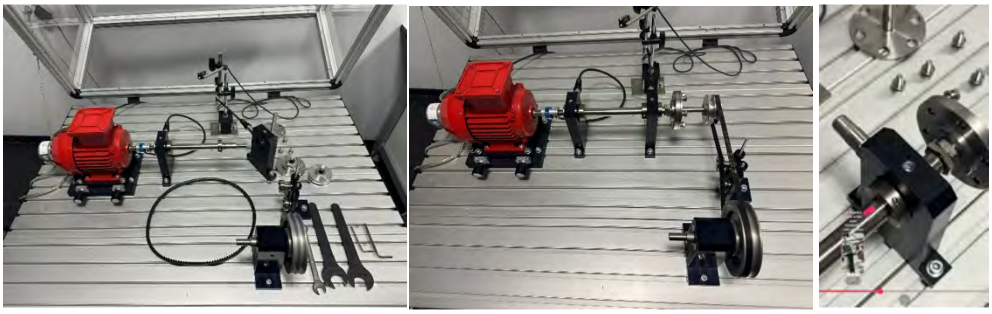

Figure 1: *step-by-step photos and vertical on-bench video for the cracked-shaft practical (Source: Original)*

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MULTIMEDIA SCAFFOLDING FOR BEARING DEFECT DIAGNOSTICS LABS

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Keywords: *mechanical engineering; rolling bearings; software; vibration analysis*

Abstract

Rolling bearings are ubiquitous in mechanical systems, and their defect modes offer a strong context to connect assembly quality, measurement reliability, and evidence-based interpretation within a single hands-on activity. In vibration-based condition monitoring, bearing damage typically appears through impulsive excitation and periodicity linked to rolling kinematics, but these patterns are only interpretable when the measurement chain is properly assembled and operating conditions are controlled. For students, the main difficulty is not only recognizing a spectrum feature, but understanding why certain signatures arise, what can mask them, and how to build a defensible diagnostic statement from experimental data. In procedural laboratories, applying multimedia design principles can reduce avoidable cognitive load by making the sequence of actions, safety constraints, and verification checkpoints explicit, so student effort is directed to interpretation rather than to navigation of instructions [1].

This contribution presents an educational innovation for a bearing-defect practical in Mechanical Engineering based on a progressive set of student-facing resources that combine a written guide, step-by-step photographs, and a short horizontal video for on-bench consultation. The activity is structured around a diagnosis-oriented workflow that explicitly links defect location, expected signal behavior, and verification of data quality. Students start by identifying the bearing elements and the fault locations most commonly addressed in introductory diagnostics: outer-race defects, inner-race defects, rolling-element defects, and cage-related anomalies. They then connect each defect family to a physical explanation that they must use in their report. Outer-race damage is discussed as a defect fixed in the housing reference, which tends to generate repeatable impacts as rolling elements pass through the loaded zone. Inner-race damage is treated as a rotating defect that can introduce modulation effects and time variability in the response. Rolling-element defects are analyzed through their intermittent contact nature and their sensitivity to load direction and slip. Cage-related issues are introduced as lower-frequency phenomena that may alter rolling-element

spacing and produce broadband vibration increases. Students compute characteristic defect frequencies derived from geometry and speed, and they use them as interpretation targets rather than as automatic answers, comparing expected frequencies with observed patterns and providing engineering explanations when mismatches appear [2].

The session is organized into four stages. First, students mount and align the assembly following basic safety requirements and a checklist focused on the items that most strongly affect signal integrity, including correct tightening, avoidance of mechanical looseness, and consistent sensor positioning. Second, they acquire signals under defined operating conditions, ensuring speed stabilization and repeatability across measurements. Third, they extract and visualize indicators using a guided template that combines time-domain inspection for impulsiveness, frequency-domain spectra for periodic components, and envelope analysis to enhance defect-related periodicity in the presence of structural resonances. Finally, students produce a concise diagnostic justification supported by labeled plots, stating the hypothesized defect location, referencing the observed indicators, and explaining why alternative causes such as misalignment, looseness, or sensor issues are less consistent with the evidence. Figure 1 summarizes the multimedia guidance used to support the bearing-defect practical.

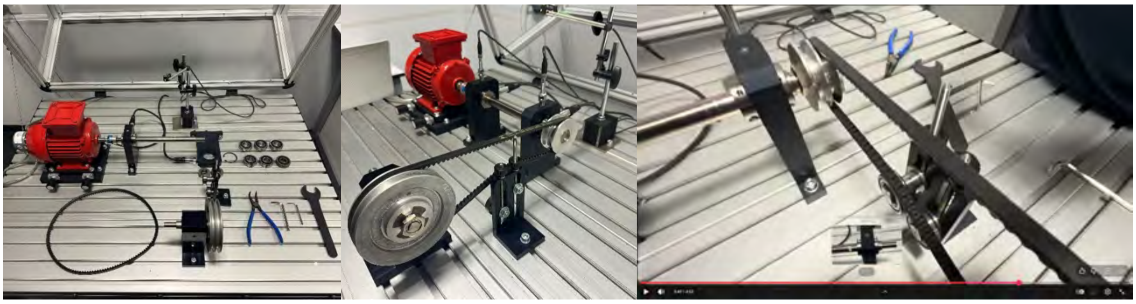

Figure 1: *Multimedia guidance for the bearing-defect practical (Source: Original)*

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USING ARTIFICIAL INTELLIGENCE TO DEVELOP TRUE/FALSE TESTS IN CONSTRUCTION ENGINEERING

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Keywords: *Learning innovation, Efficient assessment, Artificial intelligence*

Abstract

The teaching of construction procedures in architecture and civil engineering curricula lies at a critical intersection between theoretical abstraction and technical practice. Pedagogical literature recognizes that instruction in this area must cover not only regulations and material resistance, but also logical sequencing and constructive feasibility in real environments. One of the most complex epistemological challenges for faculty lies in the validity and reliability of assessment tools. Determining which type of exam, whether essay tests, short-answer questions, or multiple-choice items, most accurately captures a student's ability to transfer classroom knowledge to the infrastructure execution phase is a persistent question in the discipline. The assessment of learning in this area must be multidimensional. Students must demonstrate competence both in the project design phase (anticipating solutions) and in the execution phase (resolving contingencies on site). Traditional methods have intrinsic limitations: 1) Essay questions: These offer depth but suffer from a high degree of subjectivity in grading and inefficient response times. 2) Multiple-choice questions: These allow for objective grading, but their manual design is prone to bias and often does not cover the entire cognitive spectrum required. This article proposes a paradigm shift through the implementation of a validated method for generating exams using Artificial Intelligence (AI). This methodological approach is based on the processing of large volumes of technical and regulatory data to create assessment questions that meet scientific rigor criteria: a) Generation of Technical Discrimination Items. b) Customization and Adaptability. c) Reduction of Instructor Bias. The results indicate that students assessed under this system develop greater agility in identifying procedural errors, a vital skill for infrastructure supervision. In addition, the ability to generate multiple equivalent versions of the same exam ensures academic integrity and allows for more dynamic continuous assessment.

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THE SENSORY PAVILION: AN INTERDISCIPLINARY REFLECTION ON THE ACTIVE ROLE OF BUILDING AND ARCHITECTURE IN THE WELL-BEING OF NEURODIVERGENT CHILDREN IN CHILE.

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Keywords: *modular building, acoustic panel, sensory, infrastructure for neurodivergent individuals, fast fashion*

Abstract

The School of Architecture at the University of Talca, Chile, has approximately five hundred students in the city of Talca, located in central Chile. The research course has provided an opportunity to explore the potential of certain waste materials, identifying opportunities to develop pieces that are then incorporated into final degree projects.
This document presents the Sensory Pavilion, which connects the creation of a panel with acoustic and sensory properties, made from textile waste from the fast fashion industry, to the needs and shortcomings—specifically, the lack of spaces for sensory and emotional self-regulation within the Chilean educational system—and problematizes the limitations of the existing school infrastructure.

From the research:

As environmental awareness intensifies, the search for sustainable solutions to address this problem becomes a priority. In this context, the Atacama Desert emerges as yet another symbol of the excesses of the global fashion industry (1). This industry, still far from sustainable, faces a challenge whose solution is not in sight in the short term.

The growing, uncontrolled pollution of the Atacama Desert, caused by the massive accumulation of discarded clothing from the free trade zone in Iquique, is a clear example of how the lack of legal regulation or loopholes in developing countries are exploited in pursuit of economic gain without regard for the consequences for their inhabitants (2). While the need for change is widely acknowledged, a genuine transformation in the mindset of fast-fashion consumers, as well as politicians and business leaders, is required, moving towards a sustainable model.

Currently, numerous brands contribute to exacerbating this problem, and while recycling initiatives make sense, they have yet to have a significant impact on the fashion industry (3). Chile is one of the countries most affected by pollution

generated by discarded textiles; therefore, it is urgent to propose ideas that help address this challenge.

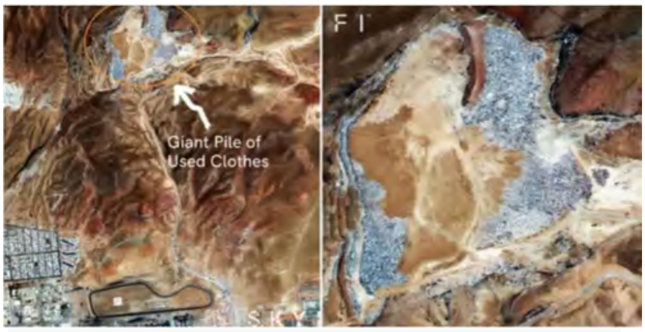
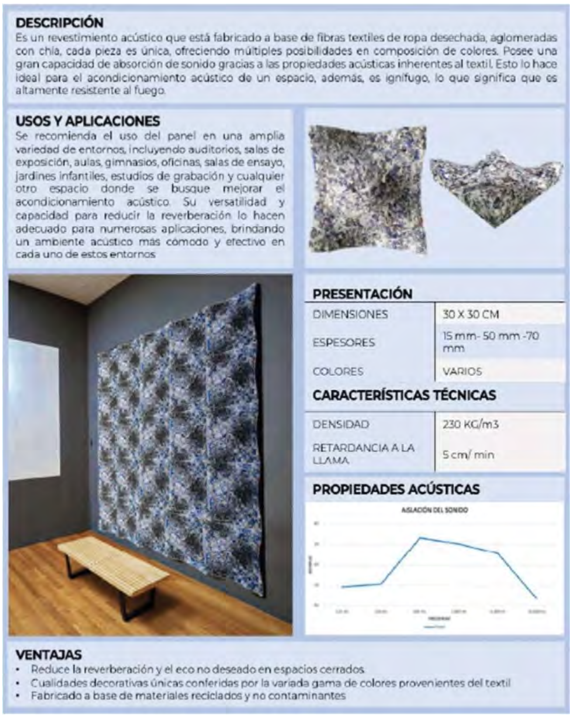


Figure 1*: Satellite image shows that the clothing dump in the Atacama Desert is visible from space.*

(Source: SkyFi)

The result of the research based on was the development of a series of prototypes until reaching a panel with acoustic properties.



DESCRIPCIÓN
Es un revestimiento acústico que está fabricado a base de fibras textiles de ropa desechada, aglomeradas con chía, cada pieza es única, ofreciendo múltiples posibilidades en composición de colores. Posee una gran capacidad de absorción de sonido gracias a las propiedades acústicas inherentes al textil. Esto lo hace ideal para el acondicionamiento acústico de un espacio, además, es ignífugo, lo que significa que es altamente resistente al fuego.

USOS Y APLICACIONES
Se recomienda el uso del panel en una amplia variedad de entornos, incluyendo auditorios, salas de exposición, aulas, gimnasios, oficinas, salas de ensayo, jardines infantiles, estudios de grabación y cualquier otro espacio donde se busque mejorar el acondicionamiento acústico. Su versatilidad y capacidad para reducir la reverberación lo hacen adecuado para numerosas aplicaciones, brindando un ambiente acústico más cómodo y efectivo en cada uno de estos entornos

PRESENTACIÓN

DIMENSIONES	30 X 30 CM
ESPESORES	15 mm- 50 mm -70 mm
COLORES	VARIOS

CARACTERÍSTICAS TÉCNICAS

DENSIDAD	230 KG/m3
RETARDANCIA A LA LLAMA	5 cm/ min

PROPIEDADES ACÚSTICAS

AISLACIÓN DEL SONIDO

VENTAJAS
- Reduce la reverberación y el eco no deseado en espacios cerrados
- Cualidades decorativas únicas conferidas por la variada gama de colores provenientes del textil
- Fabricado a base de materiales reciclados y no contaminantes

Figure 2*: Panel data sheet with acoustic properties made from recycled textiles (2023).*

Authors: Micaela Pino and Agustín Martínez. Advisor: Susana Sepúlveda. (Source: Research Repository, School of Architecture, University of Talca).

This result allowed for the design and implementation of a device that would facilitate tactile and visual stimulation activities, as well as emotional self-regulation, through a flexible, adaptive, and easily readable space, with the support of professionals in the field (4). In this way, the panel transitioned from a prototype to a finished work situated in a real-world context.

Regarding the graduation project and its connection to the environment:

The graduation project is the latest student milestone of the School of Architecture of the University of Talca – Chile, in this sense the Sensory Pavilion is the result of a research process, an architectural prototype that favors the sensory and emotional self- regulation of neurodivergent children in educational contexts that offers a sustainable, accessible and socially impactful solution.

The pavilion was developed in collaboration with the COANIL Foundation (Corporation for Aid to Children with Disabilities) and professionals in the therapeutic and educational fields. It is presented as a modular, flexible, replicable space, sensitive to needs that are often overlooked by conventional Chilean school infrastructure.

Through a design based on cognitive accessibility and material warmth, a safe and understandable environment is created, contributing not only to school inclusion but also to an interdisciplinary reflection on the active role of architecture in the well-being of neurodivergent children.

This thesis project stems from an interest in socially conscious architecture that transcends mere functionality, building upon collaboration, critical observation, and a commitment to reality. The Sensory Pavilion addresses the lack of spaces for sensory and emotional self-regulation within the Chilean education system, challenging the limitations of existing school infrastructure and confronting challenges largely ignored by the construction and architecture industries.

Figure 3*: Top: Process of making panels with recycled textiles (2025).*
Bottom: Users of the Sensory Pavilion
Authors: Micaela Pino and Agustín Martínez. Advisor: Susana Sepúlveda.
(Source: Thesis Repository, School of Architecture, University of Talca).

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ATHENS PROGRAMME COURSE 2025 ETSAM-UPM: INNOVATION IN MATERIALS FOR ARCHITECTURE

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Keywords: *Athens Programm, innovation materials, decarbonization, sustainable development*

Abstract

Within the **SOCRATES programme**, the European Union initiative aimed at improving educational quality and strengthening the European dimension of Education [1], an **ATHENS** course (Advanced Technology Higher Education Network/Socrates) was held from 17 to 21 November 2025 [2], [3]. The course, coordinated by **Mar Barbero** and taught by **Esther Moreno** and **Nuria González** (ETSAM-UPM), was supported by the **IETcc** and **CENIM**, institutes of the **CSIC**.

The one-week course, titled **"INNOVATION IN MATERIALS FOR ARCHITECTURE"**, brought together 15 students from leading European technological universities within the ATHENS network. The pedagogical design addressed the challenges of **decarbonization in the building sector** and the creation of **healthy environments**, emphasizing the role of material innovation [4], [5], [6].

The programme combined **active learning strategies**—theoretical lectures integrated with **hands-on laboratory research**, **biomaterials workshops**, and **project-based learning**—together with visits to cutting-edge research centres (IETcc and CENIM). This blended methodology fostered experiential learning and strengthened the connection between scientific research and architectural practice.

Evaluation through student surveys revealed **high satisfaction**, highlighting the development of research skills, critical analysis, and interdisciplinary collaboration. Additionally, participants reported significant gains in **international communication**, teamwork, and entrepreneurial thinking. The course ultimately provided a transformative educational experience, promoting innovation and fostering a multicultural learning environment aligned with current European educational priorities

Figura 1: *Students participating in the Athens course working in the ETSAM materials laboratory*

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3D Technologies in Education

PODCAST INTERVIEWS FOR TEACHING STRUCTURAL ENGINEERING

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Keywords: *Flipped-classroom; collaborative learning; structural design; case-studies*

Abstract

This text presents partial results, in form of interviews, of a project in learning innovation related to the area of building structures. The interviews were prepared, and recorded, to be used in the context flipped-classroom scenarios for students of Architecture or and building Engineering degrees. Flipped-classroom methodologies are fostered using different media for the content. In this sense, educational videos are the most widely used technique. Audio, and podcast, are less explored. However, authors such as Cabero and Gisbert highlight positive aspects of podcasts, including promotion of narrative continuity; humanisation; motivation and attraction of attention; allows process of identification and participation; reinforces interaction [1]. Also, the use of audio promotes synchronic thinking, thus fostering abstract thinking and engagement. In this case, engagement is reinforced by the flipped-classroom activity, in which students will be invited to share their own sketches in a collaborative whiteboard, responding to a challenge for flipped classroom [2]. At the same time, the activity in engaged with the methodology of case studies; this method allows the introduction of complex situations with different degrees of in-depth analysis, thus being adaptable to a wider variety of courses. The collaborative whiteboard allows the professor to share ideas and to guide the students, in the classroom, towards those sketches that better identify the key aspects of the structures considered. The idea is that students get acquainted with singular structures, and reflect on structural systems and typologies, rather than assessing the proper initial identification of structural systems and models. This supports the flexibility of the methodology for different levels of previous knowledge [3]. The use of flipped classroom in this context can be understood as a strategy to foster collective intelligence.

The design of the interviews was made according to the following steps: 1) selection of relevant case-studies, 2) selection of interviewees, 3) preparation of questions in collaboration with a student (a scholarship holder), 4) recording of the interviews, 5) audio-editing, 6) use in class groups. In this case, the audios were complemented with graphical elements (as proposed by the interviewees), to assist the comprehension of each structure.

The first chance to use the podcasts in class groups occurred in Autumn 2025, in a 4th year group of the bachelor's degree “Fundamentos de la Arquitectura.” The implementation of flipped-classroom strategies comprised two main aspects: the proposal of elective podcast episodes (up to two out of the 6 recorded ones, per student) to students to focus on, and the creation of a collaborative whiteboard. Then, in the context of a face-to-face class, the collaborative whiteboard of each episode is discussed with students and professor. The aim of these sessions is to encourage the active participation of students in the learning process.

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BRIDGING THEORY AND PRACTICE: PROJECT-BASED LEARNING IN SOLAR GEOMETRY AND SHADOW THEORY

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Keywords: *Solar geometry, shadow theory, Building Engineering Education, Project-Based Learning (PBL), Computer-Aided Design (CAD).*

Abstract

Within the framework of the course *Descriptive Geometry I* of the Degree in Building Engineering at the University of Seville, a teaching experience based on Project-Based Learning (PBL) has been developed, aimed at the acquisition of practical competencies in solar geometry and shadow theory [1]. These competencies are essential for environmental analysis, energy efficiency and sustainability in contemporary building design, as well as for informed decision-making throughout the architectural design process. Such knowledge has a direct impact on the layout of outdoor spaces, communal areas, car parks, solar protection elements and climate control strategies, exposing students to real professional challenges from the first year of the Degree in Building Engineering.

The methodological proposal is implemented entirely in a virtual environment through the use of CAD software (Rhinoceros) and is structured as a progressive sequence of activities that facilitate the understanding of solar behaviour at different scales [2]. The project begins with the volumetric modelling of a real fragment of urban area, to which the course competencies are applied in a practical manner. Subsequently, students carry out a detailed modelling of a façade. By allowing students to choose their own case studies, this approach encourages meaningful and personalised learning, in line with the principles of PBL and student-centred learning.

The learning strategy is organised into two complementary phases. In the first, analytical–manual phase, students position the solar ray in three-dimensional space using azimuth and elevation, enabling the reasoned calculation of light prisms and the determination of self-cast and cast shadows. This stage reinforces the conceptual understanding of solar geometry and prevents an uncritical dependence on digital tools. In the second, technical–applied phase, the software's solar simulation engine is used to perform automated analyses on key dates of the solar calendar (solstices and equinoxes), strengthening students' understanding of the geometric principles underlying the results generated by digital tools and enhancing their ability to interpret, compare and validate the outcomes obtained.

The project includes the production of structured graphic documentation and the exhibition of results through a technical presentation that simulates a professional practice context. This real-commission simulation constitutes a form of authentic assessment, requiring students to justify design decisions, communicate results clearly and respond to technical questions, thereby reproducing dynamics typical of professional practice.

The results demonstrate a significant improvement in students' understanding of solar behaviour and its impact on the built environment, as well as a notable increase in motivation, autonomy and engagement in their own learning process. The proposed methodology promotes autonomous learning, critical thinking and informed decision-making, while also reinforcing transversal competencies such as time management, spatial analysis skills, and graphic and oral communication. The PBL approach is thus consolidated as an effective strategy for bringing the teaching of descriptive geometry closer to the professional practice of future building engineers.

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AUTOMATION IN STRUCTURAL DESIGN

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Keywords: *structural design, BIM, automation*

Abstract

Structural design increasingly relies on complex digital environments in which geometry, analysis, and documentation coexist but rarely communicate seamlessly. Despite the widespread adoption of BIM and advanced calculation software, structural workflows remain fragmented, highly manual, and vulnerable to inconsistencies between models, calculations, and reports. Routine operations such as model rebuilding, data re-entry, load reassignment, and update tracking consume a disproportionate amount of engineering time while offering little added design value. This paper investigates automation as a systematic response to these challenges, proposing a data-centric approach to structural design that prioritizes continuity, traceability, and quality control.

Rather than treating automation as a set of isolated scripts or productivity shortcuts, the presented research frames it as an integrated design methodology. The core idea is to establish a fluid and rule-based data flow between BIM models and structural calculation environments, where each element carries not only geometry but also consistent identifiers, parameters, and engineering logic. In this context, BIM models function as structured databases capable of storing, updating, and validating structural information throughout the design process, rather than serving solely as sources of drawings.

The proposed approach was developed and tested through its application on real structural design projects, allowing the research to evaluate automation under practical conditions, including frequent design changes and evolving input data. Two applied examples are presented. The first demonstrates automated generation and updating analytical models derived from BIM data, ensuring consistency of geometry, materials, and element properties across design stages. The second example focuses on the automated creation of load and load combinations based on predefined engineering rules, enabling systematic alignment with calculation reports while introducing automatic checks for missing or inconsistent data.

The results show that this approach significantly reduces repetitive manual work while improving model consistency and transparency. Automation acts not only as a productivity mechanism but also as an additional layer of verification, capable of detecting discrepancies early and improving overall design reliability. The study concludes that rule-driven automation, guided by engineering judgment, can transform

structural design workflows into more resilient, auditable, and efficient systems, with clear implications for both professional practice and engineering education.

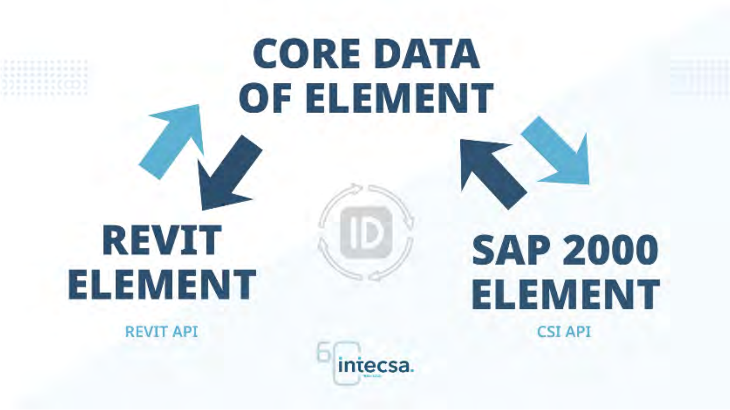

Figure 1: *Data exchange workflow.*

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GAMIFIED SIMULATION OF LEAN PROCESSES TO ENHANCE LEARNING OF THE LAST PLANNER SYSTEM

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Keywords: *Lean Construction, Last Planner System, Gamification, Collaborative Planning*

Abstract

In the context of the Planning and Scheduling II course of the Degree in Building Engineering at the Technical University of Madrid, a teaching innovation based on gamification was implemented during the 2025–2026 academic year to support the instruction of the Last Planner System (LPS) within the broader framework of Lean Construction. The main objective of this initiative is to bring students closer to the real dynamics of site coordination through the simulation of a pull session, thereby facilitating their understanding of collaborative planning principles, constraint management, and commitment-making among project participants [1,2].

The activity was structured as a role-playing game in which students represented different trades commonly involved in a building project: masonry, aluminum carpentry, wood carpentry, tiling and flooring, plumbing and sanitation, electrical works, HVAC, painting, drywall systems, and fire protection installations (Figure 1). Each team was required to analyze its prerequisites, identify constraints, sequence its tasks, and negotiate with the remaining “contractors” to develop a stable and reliable work plan. To increase motivation and active engagement, the exercise incorporated gamification elements such as time-bound rounds, activity cards, rewards for reliable commitments, and penalties for unmet agreements [3].

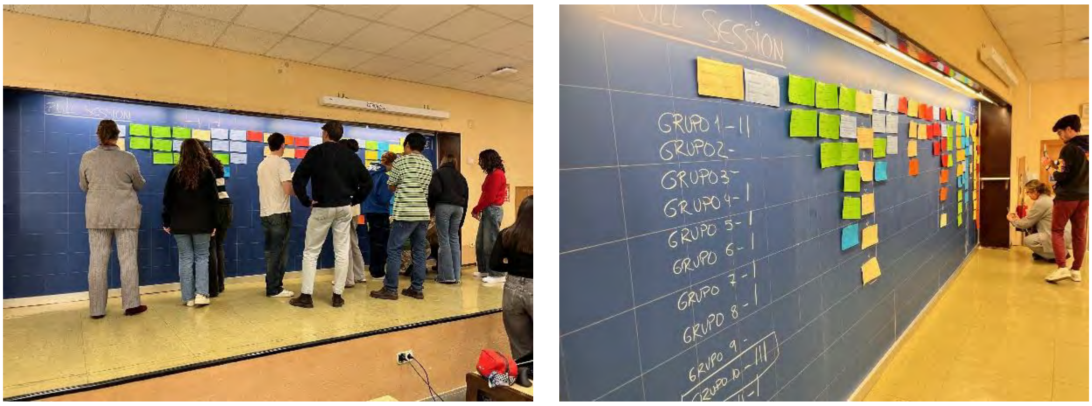

Figure 1: *Students participating in the gamified pull session simulation in the Planning and Scheduling II course.*

Preliminary results indicate a significant improvement in students' understanding of the LPS, particularly regarding the need to remove constraints before task execution and the importance of making realistic commitments to ensure reliable weekly plans. Moreover, the simulation strengthened key transversal competencies essential in professional practice, including multidisciplinary teamwork, effective communication among trades, and negotiation skills aimed at shared project goals. Students highlighted the value of experiencing a scenario closely aligned with real construction site dynamics, emphasizing that the participatory and playful nature of the activity enhanced their assimilation of theoretical concepts.

Overall, this teaching innovation demonstrates that gamifying real construction planning processes is an effective strategy to improve Lean Construction learning in university settings. The proposal not only provides students with a safe environment for decision-making practice but also fosters a deeper understanding of the complexity inherent to trade coordination, promoting meaningful and professionally oriented learning.

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