

## INTEGRATING LIVING LAB WEBINARS INTO UNIVERSITY TEACHING FOR DIGITAL AND SUSTAINABLE OPERATIONS

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### Abstract

This communication presents an innovative teaching experience based on the design and implementation of a webinar (online seminar) linked to a Living Lab research project focused on the digitalisation of greenhouse agriculture. The activity was mainly addressed to university students at the University of Almería (Spain). The live (synchronous) version of the webinar was held with students enrolled in the course Quality and Environmental Management, and Business Administration. The objective was to bring into the classroom a real-life case illustrating the application of digital technologies in production contexts and operations management. The session was recorded for later use (asynchronous) in other degree programmes, thereby increasing its dissemination, reaching around 120 views. The webinar was developed within the framework of the CODECS project (Horizon Europe) and provided an applied demonstration of how data interoperability, monitoring systems and decision-support tools contribute to improving operational efficiency and environmental sustainability in complex production systems. Through interaction with researchers, technicians and Living Lab professionals, students engaged with real operational challenges in intensive greenhouse agriculture and collaborative innovation processes. Unlike conventional webinars, the activity was fully embedded in the curriculum and combined real data, stakeholder interaction and structured academic reflection within an ongoing research project. The experience was designed to strengthen applied learning by connecting previously delivered theoretical content with a practical case of digital transformation. The Living Lab approach was introduced as an innovation and learning environment under real conditions, where technologies are tested and improved in collaboration with multiple stakeholders, including farmers, technicians, researchers and students, emphasising co-creation and real-world problem solving as core pedagogical elements. Specifically, the activity sought to complement traditional lecture-based teaching through applied research-based learning, enabling students to observe the practical relevance of concepts addressed in class. It aimed to facilitate students' understanding of the role of Operations Management in resource-intensive environments, emphasising efficiency, productivity and sustainability as key managerial competences. Furthermore, it introduced digitalisation and data interoperability as essential elements for the integrated management of operations, quality and environmental performance, reinforcing a systemic and information-based approach to decision-making. From an academic perspective, the webinar format encouraged active learning, critical thinking and analytical skills through direct contact with professionals and real data, fostering student engagement and development of transversal competencies. The data were collected through a structured Google Forms questionnaire completed by 119 participants and analysed using descriptive statistics, including Likert-scale items and basic comparisons between groups (live vs. recorded), complemented with questions related to the recorded session. The results revealed increased motivation and a better understanding of digital transformation and sustainability, supported by consistently high mean scores across all evaluated dimensions. The study analyses the potential of 'Living Lab' experiences delivered via webinars as innovative, transferable and replicable teaching strategies in higher education.

**Keywords:** *Learning, sustainability, digitalisation, agriculture, interoperability.*

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### 1. Introduction

The teaching experience described here is based on two major, interrelated factors: firstly, the development of the European CODECS project and its Agroecological Living Lab in Almería; and secondly, the content and skills previously covered in Quality and Environmental Management and

Business Administration modules, taught as part of the bachelor's degree in Labour Relations and Human Resources.

Firstly, CODECS (Maximising the CO-benefits of Agricultural Digitalisation through Conducive Digital Ecosystems) (CODECs Project, 2022) is a European research and innovation project funded by the Horizon Europe programme, running for four years (2022–2026). Its aim is to analyse and maximise the environmental, economic and social benefits of agricultural digitalisation, addressing both opportunities and barriers associated with the adoption of digital technologies. The project combines knowledge generation, demonstration and transfer, assessing the impact of efficiency, resource use, and sustainability in agricultural systems.

The literature on e-learning and online learning indicates that well-designed synchronous formats can be effective tools for supporting applied learning in higher education (Fernández-Cerero & Montenegro-Rueda, 2024; Meng et al., 2023). This perspective is complemented by Living Labs and digital ecosystems frameworks, which emphasise the integration of digitalisation into real-world contexts to improve sustainability, operational efficiency and value creation in line with their role as spaces for experimentation and co-creation with multiple stakeholders (Herth et al., 2025; Morales et al., 2024).

One of the central elements of the project is the development of a network of Living Labs across European agricultural contexts. Our Living Lab, focused on data interoperability in greenhouse horticulture, is located in a 1,900 m<sup>2</sup> experimental greenhouse at the IFAPA experimental station near the University of Almería, equipped with technologies that reproduce real commercial production conditions. It integrates climate control, irrigation and fertigation systems, energy monitoring, soil and climate sensors, renewable energy production and resource reuse.

The integration of these systems enables addressing a key challenge in agricultural digitalisation: the integration of data from multiple devices to support operational decision-making, (Timpanaro et al., 2024).

Secondly, the teaching experience is based on the content previously covered in the modules. In the Quality and Environmental Management, students had worked on quality management, ISO standards, total quality management models, environmental management, system integration, and quality and environmental auditing. This provides a theoretical basis for analysing how digitalisation and data interoperability support continuous improvement, operational efficiency and environmental performance, in higher education contexts (Van Wart et al., 2025).

In the Business Administration module, students had examined the organisation as a system, functional areas, Operations Management, planning and control, business strategy, innovation, social responsibility and sustainability.

The integration of the webinar into the curriculum allowed students to connect theoretical concepts from Quality and Environmental Management and Business Administration with a real-world case of digital transformation in greenhouse agriculture. This alignment between course content and the Living Lab experience supports applied learning and reinforces key Operations Management concepts, including efficiency, process control and sustainability.

## 2. Objectives

The overall aim of this paper is to present and analyse an example of teaching innovation based on the integration of a webinar (online seminar) linked to a Living Lab into university teaching of subjects related to operations management in various fields. The initiative has been designed to reinforce students' applied learning, linking the theoretical content previously taught in the classroom with a real-world case study of operations management, digitalisation and sustainability within a complex production environment such as intensive greenhouse agriculture.

The Living Lab approach is based on its role as an environment for innovation and learning under real-world conditions, widely used in higher education institutions to integrate sustainability, experiential learning and co-creation processes with external stakeholders, thereby fostering the connection between teaching, research and knowledge transfer. (Herth et al., 2025; Morales et al., 2024).

Specifically, the experience pursues the following teaching and training objectives:

- To complement traditional theoretical teaching through an activity based on an applied research project, enabling students to observe the practical utility of the concepts covered in class, in line with the principles of active and experiential learning, through engagement with real-world contexts (Rakha, 2025; Van Wart et al., 2025).
- To facilitate an understanding of the role of Operations Management in resource-intensive production environments, focusing on efficiency, productivity and sustainability, identified as key competencies in the contemporary training and management of such production systems (Van Wart et al., 2025).

- Bring the concept of the Living Lab into the classroom, demonstrating that it is a space for innovation under real-world conditions, where technology is tested and improved in collaboration with its users: farmers, technicians, researchers, students and businesses, highlighting its potential as a learning and co-creation environment with educational and social impact (Herth et al., 2025; Morales et al., 2024).
- Introduce digitalisation and data interoperability as key elements for the integrated management of operations, quality and the environment, reinforcing a systemic view of production processes and information-based decision-making (Herth et al., 2025).
- Foster active learning, critical thinking and analytical skills among students through direct contact with professionals, researchers and technicians in the sector, encouraging student engagement and the development of cross-disciplinary skills (Rakha, 2025; Sahito et al., 2025).
- Assess the potential of webinar and the Living Lab approach as innovative transferable and replicable teaching tools in Operations Management and Technology.

### 3. Methods

The methodology employed is based on the design, organisation and delivery of an online webinar, integrated as a complementary activity within the aforementioned modules. The webinar is conceived as a teaching tool that combines learning based on real-life cases, exposure to European research projects, and the involvement of professionals and technical experts from the sector.

This approach is consistent with recent studies highlighting the effectiveness of e-learning when pedagogical and technological aspects are properly integrated, and when active and contextualised student participation is encouraged (Fernández-Cerero & Montenegro-Rueda, 2024; Meng et al., 2023).

In an initial phase, the technological platform for the online session was selected and tested. Preliminary trials with Collaborate Ultra revealed limitations in image and audio quality, leading to improvements in audiovisual materials and the adoption of Zoom Pro, with fully revised session settings and recording system.

Care was also taken with the visual and communicative aspects of the activity, creating an initial PowerPoint presentation with a dynamic and attractive design, incorporating videos at the end and themed background images. The course's Virtual Classroom was used as a dissemination and access tool, hosting the information poster, the link to the session, a project questionnaire on Google Forms, an assessment activity designed specifically for this event, and a satisfaction survey.

The webinar took the form of a synchronous online session, open primarily to university students, though also to researchers, technicians and professionals interested in agricultural digitalisation. The methodological structure of the webinar was organised into several clearly distinct phases.

The live session was attended by students from the courses Quality and Environmental Management and Business Administration. In addition, the questionnaire responses included students from different degree programmes, with a predominance of agricultural-related studies (44.5%), followed by Quality and Environmental Management (21%), Economics and Business (13.4%) and Agri-food Business Management (11.8%). This diversity of academic backgrounds reinforces the applicability and the transferability of the experience across different educational contexts.

In the first phase, an introduction to the European CODECS project was given, explaining its context, objectives, duration, type of action and methodological approach. The role of digitalisation as a tool for improving the efficiency, sustainability and resilience of production systems was highlighted, linking these aspects to the theoretical content previously covered in class.

In a second phase, the concept of the Living Lab was presented as a space for innovation under real-world conditions, explaining the reasons for its location, the characteristics of the Almeria agricultural model, and the specific challenges associated with the intensive use of resources such as water and energy.

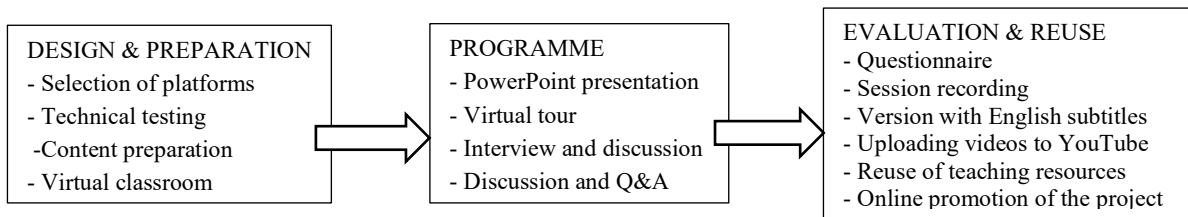
This was followed by a virtual tour of the Living Lab's experimental greenhouse, which used on-site videos to demonstrate, in an educational manner, the various digital technologies integrated into the farm. This allowed the students to visualise in a practical way the application of the concepts of Operations Management, process management and continuous improvement. Subsequently, an interview-debate was held with an expert in digitalisation and sustainable horticulture, moderated by the project's technical staff, encouraging interaction and critical analysis of the content presented.

Finally, time was set aside for questions and discussion, as well as for completing the project evaluation questionnaire and the webinar satisfaction form.

The session was recorded, and this video was subsequently uploaded to a YouTube channel, allowing it to be reused later as a teaching resource in other courses or subjects. In addition, another version with English subtitles was produced, suitable for publication on the European project's website.

For the use of the video in a recorded format for teaching purposes, an activity has been created featuring open-ended questions on the content to assess learning outcomes, in addition to using the Google satisfaction form.

Figure 1. Stages of the webinar methodology.



Source: by the authors

#### 4. Results and discussion

From a teaching and learning perspective, the webinar enabled students to observe how theoretical concepts are applied in a real production environment. The session covered key aspects such as climate control, efficient water management, renewable energy production, CO<sub>2</sub> recovery, monitoring of agronomic and energy variables, and the interoperability of data generated by different systems.

The online format, combined with the virtual visit and the participation of external professionals, enriched the learning experience and reinforced students' perception of the usefulness of the course content, while also enabling the recording and reuse of the session. This interaction facilitated a deeper understanding of the benefits, barriers, and challenges of digitalisation from a professional perspective, strengthening students' critical thinking.

The experience also introduced the Living Lab approach as an innovation and learning methodology, highlighting its potential as a complementary teaching tool to traditional instruction. Students were able to identify the importance of data interoperability, system integration, and information-based decision-making for operations, quality, and environmental management.

The recorded webinar, available as an online resource on platforms such as YouTube, facilitates its integration into different courses and learning contexts, while strengthening the connection and synergies between university, industry, and the productive sector, aligning with knowledge transfer and educational innovation objectives. Quantitative results support these findings.

Table 1. Main results of the analysis.

|                          | <b>WEBINAR<br/>SATISFACTION</b> | <b>DIGITISATION<br/>BENEFITS</b> | <b>LIVING LAB IN<br/>TRAINING</b> | <b>N</b> |
|--------------------------|---------------------------------|----------------------------------|-----------------------------------|----------|
| Live                     | <b>6</b>                        | 6                                | 5,88                              | 34       |
| Recorded                 | 5,72                            | 6,07                             | 5,84                              | 84       |
| Graduate                 | <b>5,91</b>                     | <b>6,15</b>                      | 5,93                              | 90       |
| Master                   | 5,46                            | 5,74                             | 5,62                              | 28       |
| Agricultural degree      | <b>5,85</b>                     | <b>6,19</b>                      | <b>5,98</b>                       | 66       |
| Non-agricultural degree  | 5,73                            | 5,87                             | 5,69                              | 52       |
| Reliability ( $\alpha$ ) | 0,93                            | 0,94                             | 0,92                              | 118      |

Source: by the authors

The analysis shows high internal consistency across all constructs (Cronbach's  $\alpha > 0.90$ ), confirming the reliability of the measurement instrument. Mean scores indicate a consistently positive evaluation of the webinar across satisfaction, digitalisation benefits, and Living Lab dimensions.

Differences between synchronous (live) and asynchronous (recorded) participation are minimal, suggesting that learning outcomes are not significantly affected by the delivery format. However, results vary according to student profile, with undergraduate and agriculture-related students reporting higher evaluations, highlighting the importance of contextual relevance and prior knowledge in shaping students' perceptions of experiential learning approaches.

An increase in student motivation and interest was observed, particularly due to the connection with a real European research project with clear practical applications. These findings are consistent with recent literature on e-learning in higher education, which highlights the value of reusable digital resources

in enhancing the reach and effectiveness of learning activities (Fernández-Cerero & Montenegro-Rueda, 2024).

## 5. Conclusions

The experience demonstrates the potential of a webinar based on a Living Lab approach as an innovative teaching tool in the fields of Operations Management, Quality Management, and Environmental Management. The integration of a European research project into university teaching promotes applied learning and strengthens the connection between theory and practice, enabling students to engage with real-world challenges related to operations and sustainability.

The findings confirm that this type of activity enhances student motivation, perceived usefulness of the content, and understanding of key concepts, particularly when learning is contextualised within real production environments. Quantitative results support these conclusions, showing high levels of satisfaction and consistent evaluations across different dimensions, regardless of the delivery format (live or recorded).

In addition, the experience highlights the value of reusable digital resources, as the availability of the webinar on YouTube extends its impact beyond the live session and facilitates its integration into different educational contexts. It also reinforces collaboration and knowledge transfer between academia, industry, and the productive sector.

Overall, the study confirms the relevance of incorporating knowledge transfer activities and European research projects into higher education, contributing to more contextualised, practice-oriented learning aligned with professional demands. It also supports existing evidence on the effectiveness of experiential learning and real-world project integration as mechanisms to strengthen the link between theory and practice (Herth et al., 2025; Morales et al., 2024; Salinas-Navarro et al., 2024).

Finally, although the results are positive, the experience is limited to a specific educational and disciplinary context. Future research could explore its applicability in other fields and analyse its long-term impact on student learning outcomes.

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