

# SEED Workshops: Designing a transnational learning strategy



# SEED

sustainable energy education

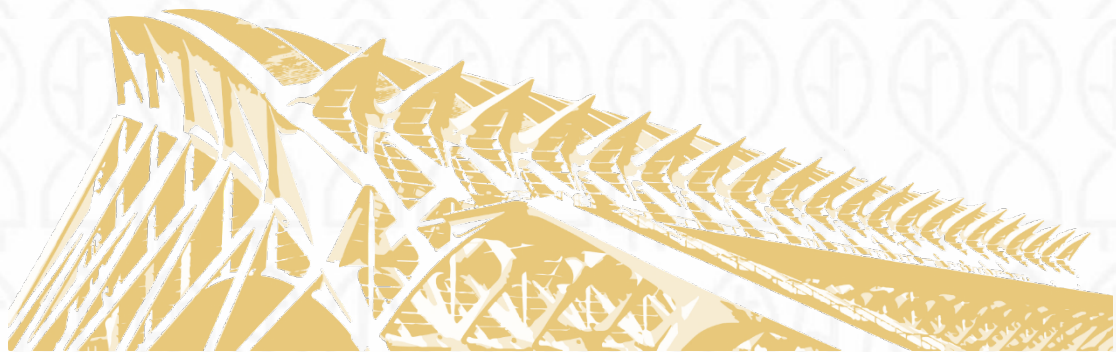


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# **SEED Workshops: Designing a transnational learning strategy**

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SEED Workshops: Designing a transnational learning strategy

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Elena de la Poza Plaza  
Amparo Blázquez-Soriano  
Ruijing Wang

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## Preface

This volume presents the main findings from the workshops held in CoVE SEED. The book comprises 13 chapters, authored by contributors from seven countries: The Netherlands, Greece, Switzerland, Ireland, Belgium, Italy, and Spain. These chapters show the collaborative efforts of institutions across sectors, including universities, vocational education and training (VET), Centres of Vocational Excellence (CoVE) within the Erasmus+ program, and industry partners in transnational and regional events.

The CoVE SEED project—Centre of Vocational Excellence for Sustainable Energy Education—aims to foster collaboration and build a global learning community around the shared vision of sustainable energy education. This project is dedicated to advancing high-quality and innovative education and training, aligning with Europe's strategic goal of phasing out fossil fuels and becoming a fossil-free energy continent. By bringing together experts from five European regions (Spain, Greece, The Netherlands, Finland and Germany), the SEED project seeks to create a model for excellence in sustainable energy education.

A central part of SEED's strategy for building this global learning community is the "transnational and regional learning strategy." The workshop is a key tool in these strategies—a structured and interactive setting designed to facilitate meaningful discussions, foster problem-solving, and generate actionable insights. These workshops engage participants through hands-on activities, group discussions, simulations, and collaborative exercises, allowing them to explore new ideas and develop practical solutions. Beyond the immediate outcomes of these workshops, the collaborative environment allows participants to apply what they have learned to real-world challenges, furthering their impact.

In July 2024, the SEED Conference was a key platform for exchanging ideas, experiences, and research in sustainable energy education. In addition to fostering regional cooperation, the event expanded transnational collaboration, with participants exchanging best practices and innovative approaches for impactful learning through oral presentations and posters. To ensure practical and tangible outcomes and after a global call for submissions the conference integrated 18 workshop sessions. Of those, 11 workshops' outputs were selected for inclusion in this volume, contributing to the discussion on the application and development of SEED's transnational learning strategy. Additionally, two chapters were created as a result of the SEED community analysis and reflection process.

The book's first three chapters focus on teaching skills and environmental and social sustainability. Chapter 1 covers teaching techniques and the development of a manifesto for sustainability, inclusivity, and aesthetics in higher education, focusing on the New European Bauhaus (NEB) and Nature-Based Solutions (NBS). Chapter 2 explores how integrating architectural design and technical knowledge aligns with the Sustainable Development Goals (SDGs) of the UN's 2030 Agenda, particularly in

architecture education. Chapter 3 shifts the focus to integrating sustainability into education through two frameworks: the SDG House, which provides tools for embedding SDGs into curricula, and the TEAMIT+ training program, which emphasizes entrepreneurial skills related to sustainability and innovation.

Chapters 4 to 7 delve into business game-based learning and entrepreneurship education. Chapter 4 offers recommendations for educators on developing business games that incorporate sustainability concepts. Chapter 5 discusses a workshop to foster digital entrepreneurship among secondary school students, while Chapter 6 details the development of a serious game on urban resilience and responsible entrepreneurship. Chapter 7 presents a variety of serious games focused on sustainability and renewable energy technologies developed under the Horizon Europe RES4CITY project.

Chapters 8, 9, and 10 address renewable energy skills training and education for the growing demand for skilled professionals in this sector. Chapter 8 emphasizes the interdisciplinary nature of modern energy projects, which require expertise in engineering, digital science, sustainability, and business management. Chapter 9 highlights the T-Shore project's innovative efforts to standardize wind turbine technician training across Europe. Chapter 10 explores the challenges faced by international students in renewable energy systems programs (master's degree), emphasizing the need for institutional support to help them overcome barriers related to differing academic backgrounds and social contexts.

The final three chapters (11, 12, and 13) focus on learning communities and co-creation. Chapter 11 presents a simulation game that guides participants through setting up a learning ecosystem for climate action education, building on common experience by implementing co-creation, facilitation, and co-design. Chapter 12 describes the design and implementation of a SEED project workshop for applying national learning strategies through the mission mapping technique. Finally, Chapter 13 reflects on how workshops have proven effective for implementing transnational learning strategies within international conferences.

**Elena de la Poza Plaza  
Amparo Blázquez Soriano  
Ruijing Wang**

**Scientific Editors**

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## Chapter 1

### **ESExNBS@NEB – Exploring Sustainable Education implementing the Nature-Based Solution in the New European Bauhaus perspective**

**Elena Mussinelli<sup>a</sup>, Andrea Tartaglia<sup>a</sup>, Giovanni Castaldo<sup>a</sup>, Annamaria Sereni<sup>a</sup>, Ioannis Fallas<sup>b</sup>, Nikolaos Ntavos<sup>b</sup>, Theodoros Gkiourkas<sup>b</sup>, Ellie Mavroudi<sup>b</sup>, Evidiki Mandela<sup>b</sup>, Valentina Plaka<sup>b</sup>, Sofia-Natalia Boemi<sup>b</sup>**

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#### **Abstract**

The New European Bauhaus (NEB) initiative aims to achieve carbon neutrality by 2050, as part of the European Green Deal, by integrating aesthetics with sustainability. Drawing inspiration from the Bauhaus movement, the initiative advocates for a multidisciplinary curriculum that emphasizes sustainability and innovation. Despite its potential, NBS still lacks an alternative to conventional grey solutions. The EU guidelines emphasize the importance of NBS in protecting, managing, and restoring ecosystems to address societal challenges and provide human well-being and biodiversity benefits. A workshop was organized to share teaching techniques and develop a manifesto encompassing sustainability, inclusivity, aesthetics, and social engagement in higher education.

The workshop has been structured using the World Café methodology, conducting two rounds of debate to focus on different topics. The two rounds of debate were guided by general questions designed to help direct the macro-topics to be addressed.

The workshop produced a tentative manifesto focusing on sustainability, inclusivity, aesthetics, and social engagement, outlining valuable skills for workforce upskilling and reskilling.

**Keywords:** New European Bauhaus (NEB); Nature Based Solutions (NBS); World Café; common language; communication skills.

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## **1. Introduction: objectives, topic and scope**

The initiative was promoted by the groups of the ENVI-Reg<sup>1</sup> group of Politecnico di Milano Cluster of Bioeconomy and Environment of Western Macedonia (CluBE)<sup>2</sup>.

The New European Bauhaus (NEB) initiative, aligned with the European Commission's ambition for carbon neutrality by 2050 under the European Green Deal, aims to integrate aesthetics with sustainability, drawing inspiration from the historic Bauhaus movement. This initiative is anticipated to revolutionize the educational landscape by advocating for a multidisciplinary curriculum that emphasizes sustainability, and innovation.

In the sustainability scenario, despite their potential, NBS still do not represent an alternative to conventional grey solutions. Their applications are even scarce, restricted to sectoral interventions, and benefits are rarely monitored. Nevertheless, the EU guidelines promoting climate and environmental-neutral transition (including decarbonization targets, 17 SDGs, and ESG and DNSH principles) assign a very central role to NBS “to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits” (WCC-2016-Res-06g resolution).

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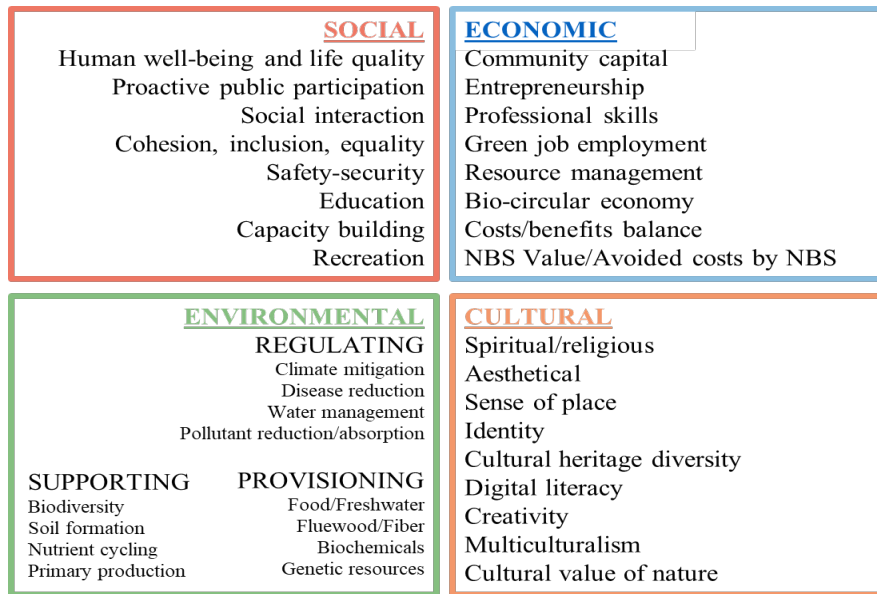
<sup>1</sup> ENVI-Reg Observatory is a research group operating at the ABC Department of Politecnico di Milano. We gathers expertise acquired over more than three decades of research and experiments devoted to urban and environmental regeneration: Strategic Plans, Feasibility Studies, Projects for Urban Transformation Societies, Cultural Districts, Territorial Marketing Plans, District Contracts, on behalf of a number of authorities and public administrations (projects commissioned by State Property Agency, Lombardy Region, Province of Mantua and Lodi, Municipality of Codogno, Desio, Milan, Mantua, Marsala, Mazara del Vallo, Naples, Novara, Piacenza, Olbia, Segrate, Authority of Bacino of the Liri-Garigliano and Volturno Rivers, Natural Park of the Ticino Valley, Mincio Park, Ca' Granda Development Foundation, and others).

ENVI-Reg Observatory aims to experiment innovative and integrated approaches to the regeneration of building and urban systems, public spaces and infrastructure, with a particular focus on the aspects of environmental quality and use of interventions.

<sup>2</sup>The Cluster of Bioeconomy and Environment of Western Macedonia (CluBE) is a non-profit company established among local actors and stakeholders of the Region of Western Macedonia in Greece. The mission of CluBE is to enhance collaboration and increase regional knowledge by promoting innovation and synergies between regional stakeholders in the fields of bioeconomy and environment. The "Eco-design and New European Bauhaus Initiatives" Department of CluBE is active in the development and implementation of European projects aimed at urban transformation through the promotion of a new design approach that integrates innovation and creativity, emphasizing sustainability and respect for the environment. The Department's projects are based on the three main pillars of the New European Bauhaus initiative, promoting the principles of aesthetics, sustainability, and inclusivity.

Our main goal is to promote co-design and social cohesion. Specifically, we focus on enhancing opportunities for participation and collaboration among all stakeholders, from citizens to design professionals, to shape solutions that represent the community's needs and values. Through co-design, our aim is also to create sustainable solutions that promote equality and accessibility at all levels of the urban landscape, laying strong foundations for a better and sustainable future for the cities and communities in the region.

Fig. 1 – Ecosystem Services benefits



Source: Authors elaboration

Sharing knowledge regarding best practices in teaching environmental design, along with providing methods and tools for their application in urban and territorial regeneration processes, is of paramount importance.

The aim of the workshop is therefore to think and share effective teaching techniques to bring the environmental component to the centre of education of the New European Bauhaus initiatives in the higher education, adopting the most appropriate didactic and communication strategies to raise students' awareness of climate change and the ecosystem quality of the built environment.

In parallel, the workshop seeks to explore the potential of NBS in contributing to sustainable, inclusive and resilient living spaces and communities, by means of the 3 NEB key values (beautiful, sustainable, together), transferring knowledge, skills and competencies, and also increasing the consciousness of the relevance of these issues in the project and in professional practice. Thus, the focus should not only be on transferring knowledge, skills, and competencies but also on enhancing awareness of the significance of these issues within project development and professional practice.

Furthermore, through the method of World Café, the workshop aims to identify essential skills and knowledge needed by professionals to implement the NEB's sustainability values via nature-based approaches. The expected comprehensive list of skills will generate new insights towards the competencies needed to be acquired to keep up with the future net-zero plans of the European Union, while simultaneously leveraging the current green and digital challenges. Consequently, the workshop intends to illuminate the impact of the New

European Bauhaus on sustainable education and professional practice, encouraging the cultivation of a nature-based and site-specific mindset, geared towards addressing environmental and societal challenges.

A tentative Manifesto covering namely sustainability, inclusivity, aesthetics and social engagement, and identify the most valuable skills that need to be cultivated to upskill and reskill the current workforce will be the outcome of the workshop, open to further development. The workshop has been an opportunity to exchange experiences, knowledge and best practices about the implementation of Nature Based Solutions techniques in the New European Bauhaus for education.

## **2. Methodology**

The participants were not required to be familiar with the New European Bauhaus initiative, however they were asked to be able to collaboratively explore and address questions related to sustainability, inclusivity and aesthetics. In order to nurture a multidisciplinary environment and foster knowledge exchange, people experienced in social engagement, awareness campaigns and co-design methodologies were also considered critical contributors to the workshop.

The workshop began with a short theoretical presentation on NEB and NBS topics, so that even less experienced participants would have a basis of knowledge on the topics that would be covered. Subsequently, the workshop was based on the 'World Café' technique. The World Café can be defined as a method of explorative data collection as part of a qualitative research approach, gathering experts in a workshop, which share their knowledge by rotating between several discussion tables, which each are focusing on a particular aspect of the overall topic. Since its introduction more than a decade ago (Brown & Isaacs, 2005), 200 plus papers relying on the world café have appeared in Scopus-listed journals, though often in specialized areas such as nursing, but also in general business research. Ritch and Brennan (2010) and While et al. (2006) argue that the World Café can be regarded as a special form of focus group research, more precisely a "circulating focus group".

This methodology was used to invite all participants to express their ideas, case studies and professional experiences in an intimate and cosy setting. The Word Café was structured around two different rounds of discussion. In both rounds, questions were provided as guidelines to help guide the discussion.

**Table 1 – Questions for the two rounds of World Café**

World Café / 1st round	World Café / 2nd round
<p>What specific skills and knowledge are essential for professionals to implement the NEB's value of sustainability in their work, mainly by means of a nature-based approach?</p> <p>What creative and design skills should professionals acquire to create NBS (and Green Blue Infrastructure-GBI) that are not only functional but also aesthetically pleasing?</p> <p>What should professionals in different fields do to develop and implement skills to ensure inclusivity?</p> <p>What are the key competencies and teaching methodologies that educators and trainers need to effectively convey the principles of the NEB by means of quality NBS (fostering multidisciplinary approaches and integrating the values of sustainability, aesthetics, and inclusivity in their training programs)?</p>	<p>How can NEB initiatives effectively engage local communities in co-design, co-implement, co-maintain/manage NBS, and in their monitoring too?</p> <p>What strategies can be implemented to foster collaboration between different sectors in the NEB initiatives and in the NBS co-design processes?</p> <p>What are effective methods to raise awareness and communicate the goals and benefits of NEB initiative to the broader public?</p> <p>How can we ensure that NEB projects remain aligned with social needs and adapt consistently?</p>

Source: Authors elaboration

Once the two Word Café rounds were over, the last part of the workshop was devoted to selecting the salient points that emerged during the discussion rounds in order to synthesise the emerging themes into a tentative manifesto.

### 3. Main findings

The majority of workshop participants were drawn from the academic research community, alongside with participants from a non-profit legal entity established among public actors and stakeholders. The main areas of experience dealt with fields of economics, engineering, management, environment and energy as well as bioenergy, in order to reinforce smart, bio, green and circular economy. Important themes were encapsulated for each round, to be summarised in the closing Manifesto attempt.

#### 3.1 World Café first round

Encouraging environmental sustainability education goes beyond teaching facts and figures, emphasizing the significance of the foundational skills. The primary areas of concentration for the first round were technical and general skills. It has been specifically mentioned that when it comes to general skills, a lack of communication skills might result in inadequate knowledge of environmental sustainability-related subjects as well as the absence or failure of participation procedures.

On the other hand, teaching technical skills forces curriculum revisions; nonetheless, the real difficulty is not determining what should be taught but rather how to teach it using the most efficient approaches.

During the discussion a faculty lack of sustainability knowledge emerged and the need for training in teaching competencies. Project-based learning is popular, but service-learning is successful due to faculty training deficiencies, making implementation challenging. Service-learning is a method of learning that connects theory with practice, allowing students to apply knowledge to community projects, allowing students to apply classroom knowledge to real-world problems. It enhances academic learning, critical analysis, and personal and social outcomes. This method can be particularly effective in engaging students with sustainability-related topics.

### **3.2 World Café second round**

Sustainability education in higher education has gained importance, with a focus on developing effective teaching and learning strategies. Project-based learning has become a prevalent approach, with university training focusing on composition topics. However, there is a deficit in teacher training for professional skills needed for sustainable development and social welfare. Service-learning, which bridges theory and practice, enables students to apply their knowledge to community projects and real-world issues, while this approach enhances learning, critical thinking, and personal and social growth. Educators are exploring innovative educational approaches in schools and community centres to promote inclusivity and collaboration.

There is limited evidence on effective public engagement strategies that address social and environmental challenges, such as social farming, neighbourhood associations, and citizen-led public gardens. This highlights the need for more initiatives and research in these areas. Architects and other professionals must listen to the public and engage in meaningful dialogue to understand societal needs and develop solutions that reflect the community's demands.

### **3.3 Manifesto**

The Manifesto, the outcome of the workshop, was organised according to four macro themes: aesthetics, sustainability, inclusion, social engagement. For each macro theme, key concepts and keywords were identified, concluding the main topics discussed during the previous rounds.

The **aesthetics** can be the answer to the need of a universal language and a way to communicate so that everyone can understand the benefits of sustainability. The language of aesthetics can guide individuals towards appreciating natural and sustainable elements,

promoting both aesthetic and environmental sustainability through a shared perception of beauty.

The broader theme of **sustainability** was read in a general key, as a cross-cutting approach to be adopted in any discipline and inseparable from current educational practices. The theme of sustainability is the underlying approach to a circular economy.

During the final discussion of the workshop, it was shared the importance of fostering knowledge to guarantee accessibility and **inclusion** for everyone. The importance of proposing experimentation laboratories within universities in order to combine the different disciplines involved in sustainable design, as well as to sustain traditional disciplines and repurpose them to meet current community needs, to foster collaborative and inclusive learning environments, was noted.

The three main problems related to **social engagement** that emerge were: educational programmes for students, educational processes of the public administrations and the education of citizens. Shared opinion was the need to use methodologies of co-creation and co-design to be able to engage all the different levels of stakeholders and figures involved. A starting point to move towards a solution, lied with the need to work not only in sectors and departments but to work in junction to solve broader problems, as well as favour real and effective communication against storytelling.

**Table 2 – Keywords of the Manifesto**

Macro themes	Keywords and concepts
Aesthetics	Create a common language for communication skills Sustainability to regenerate the aesthetics
Sustainability	Is an approach transversal to all disciplines that must be pervasive Circular economy
Inclusion	Building capacity for fostering knowledge Accessibility Repair – repurpose Laboratories of experimentation in universities
Social engagement	Proper communication Co-design Participatory process Capacity building

Source: Authors elaboration

#### 4. Future developments

Based on the outcomes of the workshop, future developments will focus on the creation of a detailed manifesto clearly outlining the shared objectives. This document will then be distributed through an integrated network of researchers, public administrations, and students, fostering interdisciplinary collaboration and stimulating discussions that can lead to innovative solutions. The aim is to build an active and engaged community capable of positively influencing current practices and policies.

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#### Conflicts of interest

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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## Chapter 2

### Teaching architecture in Architectural Design Studio for Built Environment Preservation and Transformation at Politecnico di Milano

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#### Abstract

This essay discusses the importance of integrating architectural design and technical knowledge in the teaching of Architecture, starting from the observation that the continuous technological development today also has a crucial impact on education and teaching methods. The reference is to the direct experiences carried out by the by the authors and their colleagues within an *Architectural Design Studio Built Environment Preservation and Transformation* at the *School of Architecture, Urban Planning and Construction Engineering of Politecnico di Milano*, within a Master's Degree in *Architecture/Building Architecture*, where for years an integrated methodology has been experimented, combining theoretical contributions and practical applications, exploring urban transformation and heritage conservation.

The different integrated disciplinary modules focus on a single project proposal that students must develop, aligned with the Sustainable Development Goals of the UN's 2030 Agenda, to demonstrate how it is possible to promote sustainable development and the enhancement of local cultural heritage through architecture.

**Keywords:** Architectural Teaching; AUIC School; Politecnico di Milano; Built Environment; UN's 2030 Agenda

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## 1. Notes for an idea of integrated teaching

“Although architecture is much discussed in all cultural and artistic environments, I believe that *the question of the substantial and formal relationships that connect architectural problems and construction technique is not sufficiently considered and explored. In other words, it seems to me that the role played by the development of static theories and construction methods resulting from the general scientific and technical progress of our era in the most intimate essence of the current architectural situation is not sufficiently highlighted. It is clear that technique alone cannot give spirit and life to true architectural expressions, and that these could not take shape without a construction technique, but, apart from this immediate dependence between ideation and realization – valid for all times and for all techniques aimed at giving sensible body to an abstract idea – it can be observed that in the architectural field something much more important has occurred and is only comparable to the transformation of music that followed the invention of written notation and the instruments that form the orchestra. [...] In a word, the Schools of Architecture should be directed towards training true creators of the architectural phenomenon, which takes shape through the harmonious fusion of all techniques, a result that cannot be achieved if the architect does not have a thorough knowledge of the methods, limits and possibilities of each branch of the technique and is not able to coordinate and guide the work of the specialists, each of whom must outdo in fertility of intuition and clarity of concepts.*” (Nervi, 2008)

With these words Pier Luigi Nervi offered his contribution towards the orientation of the teaching of architecture, in a precise historical moment in which the rapid and progressive affirmation of modernity, even in the field of construction, was able to offer increasingly cutting-edge technological solutions that nevertheless required direction to lead to the concrete definition of the architectural form.

## 2. Master’s Degree in *Architecture/Building Architecture* @AUIC School of *Politecnico di Milano*

In recent years, the School of Architecture, Urban Planning and Construction Engineering of Politecnico di Milano, in defining its educational offer in compliance with the ontological direction pursued by the University which, since its foundation, has intended to combine technical-scientific knowledge with humanistic knowledge. Our School has therefore

conceived the Architectural Design Studios in these same terms: a time and place for open comparison between different disciplines – architectural and urban composition and design; restoration; structural engineering; technological and environmental design – truly integrated into the architectural project and all operating with the positivist vision of those responsible for the transformation of the city and the landscape.

In particular, the Master's Degree in Architecture/Building Architecture – offered in Italian and English – intends to train highly qualified cultural profiles, capable of expressing the necessary ethical and scientific awareness as an expression of knowledge capable of relating the aspects of formal definition to a broad scope of content.

### **3. Architectural Design Studio Built Environment Preservation and Transformation**

Within this Master's Degree Course, our Architectural Design Studio Built Environment Preservation and Transformation – an integrate course with: Architectural and Urban Composition and Design (prof. Valerio Tolve, 8 CFU); Structural Design and Seismic Vulnerability (prof. Paolo Martino Calvi 4 CFU); Sustainable Technology (prof. Alberto Celani, 4 CFU); Built Heritage Preservation (prof. Sonia Pistidda, 4 CFU); Services Design for Sustainable Buildings (prof. Luca Alberto Piterà, 4 CFU); Materials for Sustainable Built Heritage (prof. Lucia Toniolo, 4 CFU) – aims to explore the relationships that underlie the logic of construction and modification of the city and landscape as facts of civilization and fields of study and interpretation: the teaching of the teachers is therefore always applied, in the different ways pertaining to their disciplines, towards the search for relationships of coherence and rationality between the context, architecture, structures and technology, against the arbitrariness of form and the randomness of settlement phenomena.

The entire teaching activity is supported by the idea that it is more interesting, useful and profitable to focus on the transmission of a working method oriented towards the practice of the project understood as research, convinced that "the teaching of a method of setting is more important than particular techniques." (Gropius, 1955).

Our ADS is therefore proposed as a moment of profound critical reflection on the real problems of working in architecture on a dual level of study, that is, in relation to the specific areas identified for the students' design applications and, more generally, within the overall dimension of 'building within the built', a theme that fully expresses the tension between old and new, between the continuity and resistance of forms, techniques and principles and the opposing need for renewal in relation to the different needs of living.

Even today, reflecting on the meaning of tradition and its values – reasoning backwards through the history and experience of architecture – means carrying out research on the

invariable constants of architecture, certainly not for imitative purposes, but rather to carry out a critical review in accordance with the need for rereading/rewriting on which the very concept of tradition is based – to draw – which is then the premise for its actualization with respect to the problems and issues of contemporary work.

In accordance with this idea, it is intended to structure the teaching activity of the teaching in two phases, closely correlated with each other. A cycle of theoretical lessons and study seminars – also with the support of external guests and speakers – through which it is intended to define the theoretical foundation of the various disciplines; a phase of continuous critical review of the project, carried out in parallel and in contradiction between teachers and students, to verify the depth of the proposals and their coherence with respect to the general themes of the ADS.

The location chosen for the students' design applications is the former Dominican convent of Sant'Eustorgio in the center of Milan, which was carefully restored in the Second World War and where, since the 1990s, the Museo Diocesano di Milano has been set up, designed by the architect Antonio Piva.

The theoretical and practical study is divided into disciplinary modules aimed at specific in-depth studies, all always oriented towards a deep knowledge of the subject and the place.

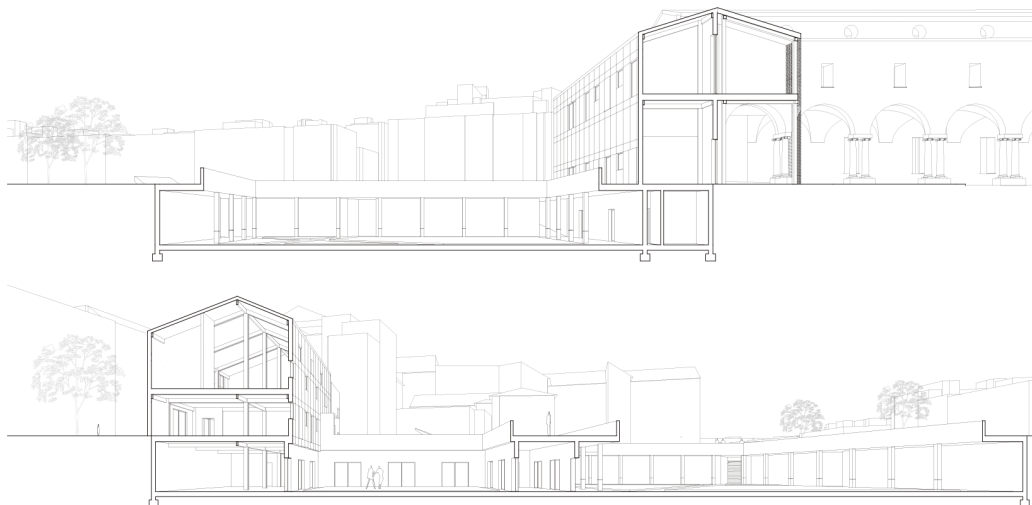
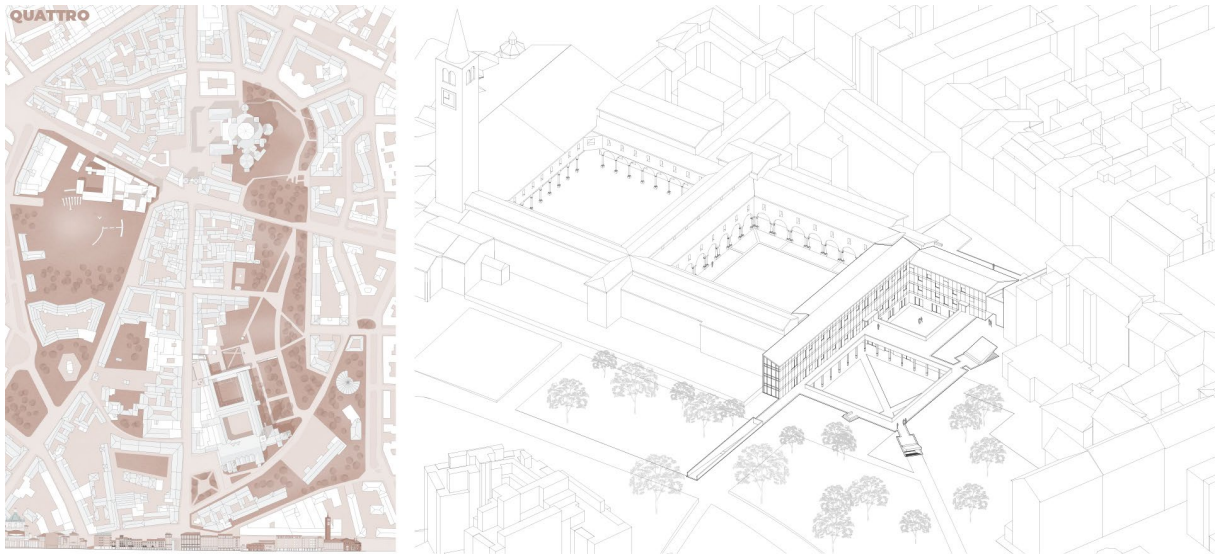
#### **4. All the integrated disciplines**

The Architectural and Urban Composition and Design module coordinates the framework of the training proposal. It is aimed at the themes of the transformation of the contemporary city, in particular, on the architectural heritage as a whole, understood in the interaction between individual buildings, neighborhoods and public spaces.

In the context of the architectural transformation and expansion project, the Built Heritage Preservation module intends to develop the architectural conservation project relating to the parts of the buildings that should be preserved. The course begins with the architectural survey of the complex – the essential foundation for understanding the transformations of the building in the city – and continues with bibliographic, cartographic, iconographic and archival research.

Fig. 1 and following – Project for Extension of Museo Diocesano in Milan. Plans and sections.

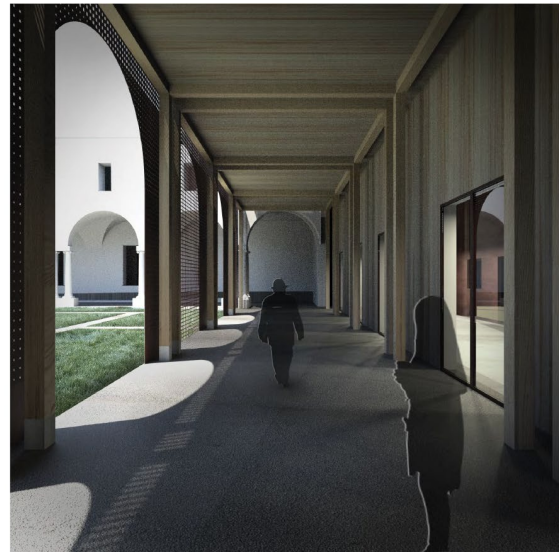
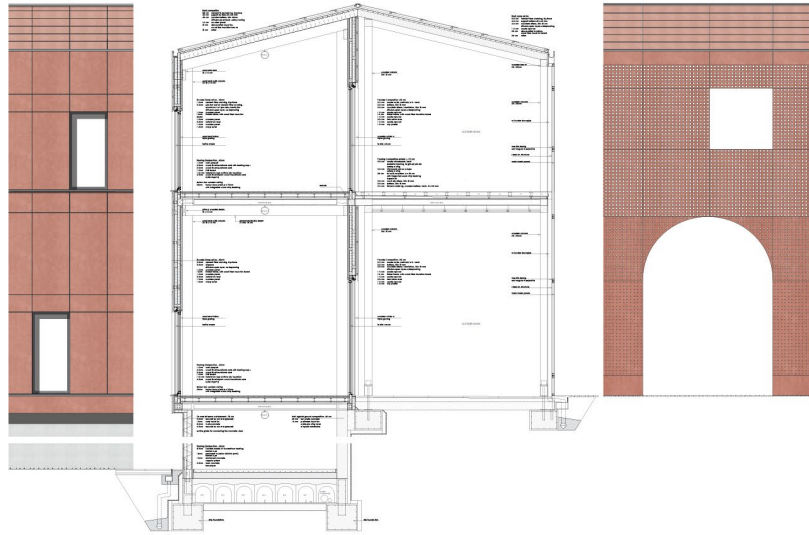
(Giulio Battiferri, Carolin Rode, Marco Russo, a.y. 2023-2024, ADS prof. V. Tolve, P.M. Calvi, A. Celani, S. Pistidda, L.A. Piterà, L. Toniolo)



The in-depth analysis of the Materials for Sustainable Built Heritage module will illustrate the properties and durability of the different building materials of historic buildings and those used in the second half of the XX century: the techniques and methods for carrying out in-depth investigations of materials and forms of deterioration will be presented, based on international standards, which, starting from the geometric survey carried out, will lead to the mapping of the state of degradation and conservation, as premises for the development of a programmatic framework of interventions, as well as the definition of the most coherent and appropriate materials for the new arrangements and new extensions proposed.

**Fig. 2 and following – Project for Extension of Museo Diocesano in Milan. Details and views.**

**(Giulio Battiferri, Carolin Rode, Marco Russo, a.y. 2023-2024, ADS prof. V. Tolve, P.M. Calvi, A. Celani, S. Pistidda, L.A. Piterà, L. Toniolo)**



Through the contribution of the Structural Design and Seismic Vulnerability module, students will come to understand the basic structural phenomena and all the technical implications of their project, especially in relation to the existing complex. Specifically, students will be able to understand how the existing structures were conceived and how they actually work; establish a correct structural strategy for the proposals for the expansion and completion of the former convent; prepare specific design documents as fundamental parts of the recovery project.

The knowledge and application of design methods relating to technological and plant systems supporting the building system represent the thematic focus of the Services Design for Sustainable Buildings module. The aim is to pursue the most coherent integration between architectural and plant solutions, favouring from the beginning the use of good building practices and passive techniques, in order to reduce the impact of technological systems, within a real vision of the concept of environmental and economic sustainability.

All these assumptions are directly connected to each other and to the contents of the Sustainable Technology teaching, aimed at developing the appropriate sensitivity towards the containment of means and resources. The pursuit of high levels of building performance in relation to the containment of the use of resources, as well as the definition of the most coherent construction system in relation to the physical and environmental context are the fundamental points of the defined teaching program, in full agreement with the intervention program and, above all, with the basic assumption of the regeneration of the heritage.

In this sense, the SDGs - objectives set for sustainable development contained in the UN Agenda 2030 - have been adopted as tools to guide, from the beginning, the choices of the project since they represent the concrete commitment to reduce distances and inequalities between countries and rebalance social differences.

Within our educational and training program we have decided to consider how the project can ensure the acquisition of the skills necessary to promote sustainable development and enhancement of the local cultural heritage (SDG 4.7); design and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products (SDG 8.9); strengthen efforts to protect and safeguard the world's cultural and natural heritage (SDG 11.4); provide universal access to safe, inclusive and accessible green and public spaces, in particular for women and children, the elderly and people with disabilities (SDG 11.7).

Each working group, in defining its own proposal from the initial stages, is therefore required to carry out a critical analysis of the objectives that the project intends to pursue and of the means and methods necessary for its pursuit, always in accordance with the general choices that underlie the architectural solution and its insertion into the context.

## **5. Conclusions**

The tool used for the interaction between project and theory was to consider the 10 challenges of the C4 International Competition "reinventing cities" (C4o, 2019), adapting the challenges to guide students in the creation of a project (Sedova, 2023) that respected all the parameters of sustainable design in an organized and organic manner with the overall project. The idea of a Smart, Sustainable City as a Resilience-Driven City has been applied in any project designed by students, considering energy efficiency as a part of the general

framework (Celani et Al., 2018). Integrating all the laboratory components allowed the students to work on the 10 reinventing challenges, integrating each part of the traditional project into a broader scenario, representing a standard for the future to integrate sustainability into courses of this type.

## **Acknowledgements**

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## **Conflicts of interest**

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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## Chapter 3

### Exploring the integration of sustainability in vocational education using two approaches: the SDG House and the TEAMIT+ training programme

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#### Abstract

This paper examines the integration of sustainability in education through two different approaches: the SDG House and the TEAMIT+ training program. The SDG House provides a framework and toolkit to incorporate Sustainable Development Goals (SDGs) into curricula. The TEAMIT+ training program emphasises developing entrepreneurial skills focusing on sustainability issues and innovation. During the SEED Conference, participants explored these approaches through interactive discussions in a two-hour workshop. The main findings show the effectiveness of the SDG House in reflection on the level of sustainability integrated into education. Additionally, the TEAMIT+ training programme links entrepreneurship with sustainability, preparing participants to discuss challenges their regions face and how sustainable entrepreneurship can provide solutions. The systemic view on the transition of sustainable education (Sterling, 2004) helps to reflect how both approaches may inspire to rethink education that is not only *about* sustainability. This paper highlights the importance of transforming vocational education to prepare future professionals with competencies to tackle environmental and societal challenges for a more sustainable future.

**Keywords:** future-proof professionals; sustainable education; SDGs; entrepreneurial skills.

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## **1. Introduction**

Educating professionals is crucial for the green transition of our society (Vanderplas *et al.*, 2022). The limits of our economic system worldwide confront us daily, causing ecological and social challenges such as climate change, biodiversity loss, depletion of raw materials, growing inequality and increasing pressure on social services. To prepare students in vocational education for the challenges that come with it, a transformation of education is necessary to ensure that education contributes to a sustainable future for everyone. In all domains, the aim is to achieve an ideal balance between economic, ecological, and social interests (United Nations, 2024). We need knowledgeable and competent professionals who can strive for universal human values in their practice. To achieve this, two sources of inspiration can help rethink education: the UN Sustainable Development Goals (SDGs) (United Nations, 2024) and entrepreneurial skills (Cedefop, 2012) to enable future professionals to find sustainable solutions for ecological and social challenges.

Professionals with entrepreneurial skills will be equipped to strive for SDGs, which enables these professionals to stimulate economic growth, boost innovation, enhance social and environmental sustainability, reduce poverty, and promote social equality and inclusion. In 2015, all 193 countries that are members of the United Nations (UN) endorsed these SDGs. The goals are designed to build a greener, fairer and better world by 2030 and emphasise that we all have a role in achieving that. This requires a paradigm shift from price to value in our economic thinking. Through initiatives focusing on business creation, innovation, technology development, and environmentally conscious products and services, entrepreneurship can advance specific SDGs such as SDG 1 (No Poverty), SDG 5 (Gender Equality), SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation, and Infrastructure), SDG 10 (Reduced Inequalities), and SDG 12 (Responsible Consumption and Production) (Rashid, 2019). Sustainable education using SDGs and entrepreneurial skills equips people with the necessary skills, aligning with the principles of the SDGs. (Rashid, 2019).

Sustainable education can be created with a clear vision, management support, and teacher capability. Education, sustainability, and entrepreneurship are linked in shaping sustainable societies. Education can create a mindset that promotes sustainability and innovation. Entrepreneurial competency may help address societal and environmental challenges. The sustainable transition in education moves from education *about* sustainable development via education for sustainable development towards an integral sustainable education (Sterling, 2004) for delivering future-proof professionals competent for the green transition. For the green transition, we need education about sustainability as well as education that is sustainable in itself. This article explores how to create sustainable education from two perspectives: the SDG House framework and the TEAMIT+ training program.

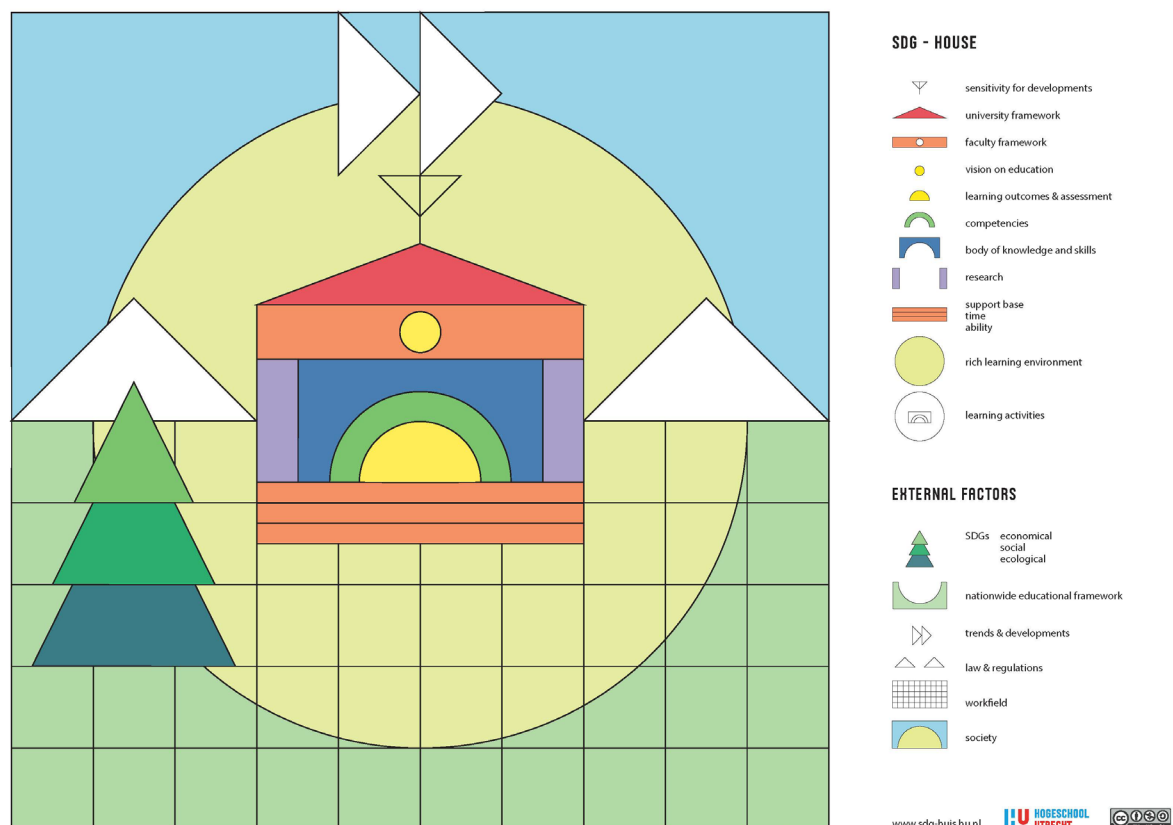
## 2. Two approaches to integrating sustainability in education

Two approaches can inspire and support educators to integrate sustainability into education: the SDG House and TEAMIT+ training program. The following sections elaborate on these two approaches.

### 2.1 The SDG House: a framework and toolkit

The first approach is the SDG House, a curriculum design framework to integrate SDGs into education (Figure 1). A team from HU University of Applied Sciences developed a framework called SDG House to integrate SDGs in all educational domains. In an iterative process, this team co-created with teachers, students, and management the SDG House framework and a practical toolkit. The SDG house framework and toolkit can be used to develop a more sustainable curriculum. The transition towards sustainable education starts with embedding SDGs in learning environments and results, student assignments and projects, and assessing student learning progress. The SDG House is a framework that facilitates discussing these elements and other aspects in your educational team, department, or faculty.

Fig. 1 – The SDG-house framework



Source: [www.sdg-huis.nl](http://www.sdg-huis.nl) artwork created by Marieke de Roos (2024)

The SDG House provides a toolkit for developing sustainable education. The toolkit includes a quick scan, question cards, concrete guidelines, and monitoring instruments to support designing a future-proof curriculum using the SDGs as a starting point. The framework supports educators in designing rich learning environments on different levels, such as drafting a vision for sustainable education, formulating competencies for educating change agents or creating sustainable assignments for students. The SDG House can be a source of inspiration and provides a toolbox to reflect on education and provide insights for developing a more sustainable education.

## **2.2 TEAMIT+ training program**

The second approach is the TEAMIT+ training programme, consisting of 3 modules based on the “learning by creating” methodology. TEAMIT+ is a project funded under the ERASMUS+ programme. The project started in 2023 and aims to highlight the connection between sustainability and entrepreneurship and encourage cooperation among participants to identify necessary skills related to climate issues. Students will develop skills related to resilience and the environment by becoming future entrepreneurs who will influence the market toward the green transition (Cedefop, 2012). The training program mobilises students so that they can place themselves in the position of entrepreneurs and discuss the necessary skills to tackle challenges related to sustainable development in their regions. Therefore, Entrepreneurship Education and Training (EET) are crucial components. EET enhances entrepreneurship-related human capital, skills, and behaviours, positively impacting entrepreneurship outcomes and startup performance.

Additionally, TEAMIT+ will bring together young people from different educational backgrounds from Spain, France, Finland, and Greece and boost the future creation of new innovative enterprises with cooperative values that respond to climate change and societal challenges. TEAMIT+ will also include highly demanded green, digital, and resilience skills and activities or learning methods to develop an entrepreneurial mindset to respond to the needs of European businesses. Module 1 focuses on understanding environmental and climatic issues from a global and a local point of view. This will be achieved through awareness-raising workshops and digital tools for collaboration, content creation and problem-solving. Module 2 is the so-called “24h of Innovation for the Planet”, an event lasting 24 hours. Student groups will work 24 hours on real-life topics from companies or organisations. The topics must concern a real business issue related to one of the SDGs. For this reason, they should develop creative and innovative solutions, products or services (software, new products, communication and marketing campaigns, new organisations, etc.). Module 3 aims to move from “innovation” to “impact innovation”. It consists of four online training sessions followed by online teamwork sessions assisted by coaches. It focuses specifically on developing project ideas with the potential to become real, sustainable

business projects, as the teams will learn how to use the Business Model Canvas tool to develop a viable business model. Each team's project will be finally presented to a jury, including impact investors.

### 3. Workshop

At the SEED conference, we held a two-hour workshop with seventeen participants to explore the two approaches to sustainable education (Figure 2). First, the approaches were introduced. Second, the group was divided into two groups, each exploring one approach in more depth. Finally, we shared the findings of each group, and the participants reflected on each approach.

Seventeen participants joined the workshop. Participants were project managers from other European projects, researchers, and educators (from vocational education and universities) from different programs (e.g. Mechanical Engineering and English) with different roles. They were from European countries: Finland, Spain, Austria, Italy, England, The Netherlands, Belgium, Greece and Germany.

Fig. 2 – Participants exploring two approaches for sustainable education



Source: SDG House Reflection Canvas (left)

Source: TEAMIT+ Training Program (right)

One group explored the SDG house with one tool from the toolkit, the Reflection Canvas. The canvas stimulates reflection on how sustainable your education is. In the workshop, the participants explored the canvas in three rounds. First, participants filled in the canvas individually for their education or project. Participants answered the following question: What do you think would be the impact of this approach? Second, the group listed ideas for improvement, answering the question: How can the approach be enriched? Third, the group brainstormed how to adopt the approach to their practice. Other countries and institutions might require an adjustment in order to apply in their context.

The second group explored the three modules of the TEAMIT+ Training Programme. Using this approach as inspiration, participants answered and discussed crucial issues that worry them the most regarding the future of their region and how these are connected to climate

change. They also tried to suggest solutions that include changes in entrepreneurial activity. Another topic discussed was acquiring entrepreneurial skills: What specific skills should future entrepreneurs acquire to influence society towards a sustainable future, and who is more suitable to provide these skills, higher or lower vocational education?

## **4. Results**

In the workshop, two groups explored the two perspectives on integrating sustainability in education. Ultimately, the groups exchanged their perspectives and reflected on the two approaches. We collected insights and summarised them below.

### **4.1 Insights for the SDG-house**

The first group reflected that they could use the SDG-house for a systemic review, to compare their education with other institutes, as a starting point for discussion and to zoom into courses or projects for evaluation. Although the SDG House framework was explained in an introduction presentation, the participants struggled to understand the framework immediately. By filling in the reflection canvas, they better understood each component. The quick scan made assumptions explicit, and then it motivated educators to investigate further and discuss how sustainable education is.

Furthermore, the participants made a few suggestions on how to adapt the Reflection Canvas for their context. Sometimes, a program or institutions have a few selected SDGs that can be included in the canvas. A surprising insight was that there is a nationwide meeting between similar programs only in the Netherlands. The participants recognized the value of nationwide meetings, particularly in learning from other programs and setting a national goal for sustainable education. Finally, participants made some suggestions for improving the clarity of the SDG House framework and canvas. The most important one is to clarify the words of the Legenda as they may be evident for employees at the HU University of Applied Sciences. However, elements of the SDG House are not always clear to educators of other institutions and countries.

### **4.2 Insights for TEAMIT+ training program**

The second group explored how education can stimulate sustainable thinking and thus impact entrepreneurship and the economy's future. Participants discussed crucial issues that their regions are facing. Among the most common were the heat problem, depopulation, the lack of job opportunities and a favourable investment environment. Regarding entrepreneurial skills, most participants agreed that collaboration between all levels of vocational education and universities is needed to provide both theoretical expertise and practical skills, bearing sustainability issues in mind. However, this is not common in any of the participants' regions. Participants highlighted many skills necessary for future

entrepreneurs, such as empathy, awareness, the ability to adapt to changes and provide solutions, the ability to think outside the box, being conscious about the environmental impact of their business, and being creative. As we can see, a particular emphasis is placed on soft skills and adaptability

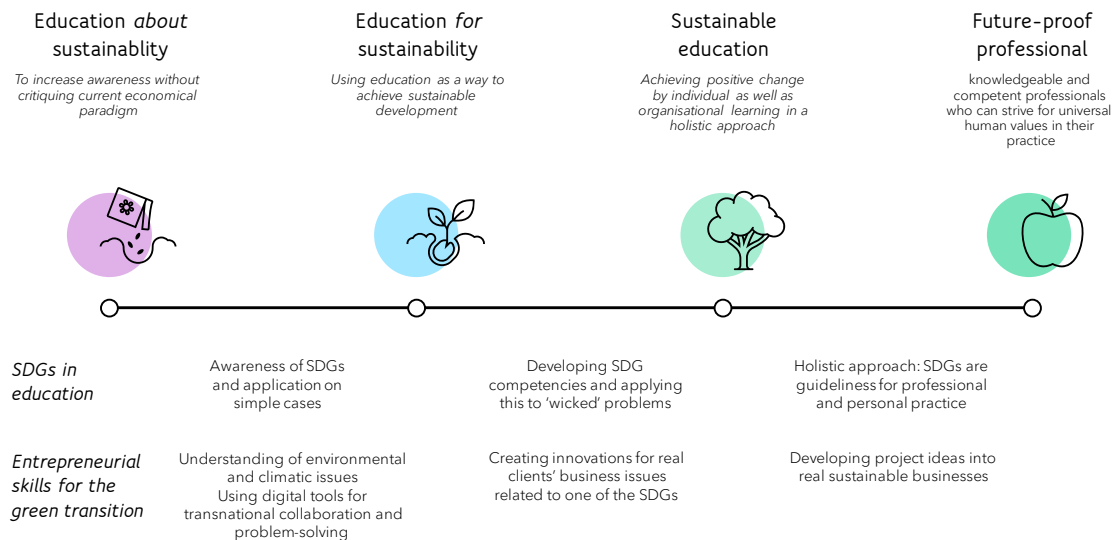
## 5. Insights for sustainable education

Both approaches emphasise the importance of integrating sustainability into education. Effective, sustainable education requires collaboration among educators, students, and researchers, as well as between the industry and the community.

The systemic view on the transition of sustainable education (Sterling, 2004) helps to reflect how both approaches may inspire to rethink education that is not only *about* sustainability but also develops skills for sustainable development and provides a framework to develop an integral sustainable education. Figure 3 shows how SDGs and entrepreneurial skills can support the transition to sustainable education, which will result in a future-proof professional.

Fig. 3 – Sustainability transition of education using SDGs and Entrepreneurial skills

## THE SUSTAINABILITY TRANSITION FOR HIGHER EDUCATION



Source: Sterling, 2004

## 6. Conclusion

The green transition requires educating students to become future-proof professionals and transforming education into an integral, sustainable education. We stress that both are necessary to educate future-proof professionals as quickly as possible. The integration of sustainability in education requires innovative approaches that take into consideration both

climate and societal issues. The SDG House provides a structured toolkit for incorporating SDGs into educational curricula, promoting a culture of sustainability. The TEAMIT+ training program emphasises the importance of entrepreneurial skills in promoting sustainability practices. The workshop findings indicate that these approaches can inspire educators to integrate sustainability in their education and rethink how sustainability is taught and applied on real-life issues. Both approaches promote a more sustainable future through sustainable education.

## **Acknowledgements**

We want to thank the workshop participants for their participation and contributions.

The HU reserved time and budget for the SDG House to develop a conceptual framework and several tools. The authors acknowledge the work done by the HU SDG House project team: Hetty Verboom, Malou van der Vegt, Marieke de Roos, Saskia Hanssen, Joris Gresnigt, and Eva Dijksterhuis. Additionally, we acknowledge the work of the second team that developed one tool: the sustainability monitor for education.

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## **Conflicts of interest**

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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## Chapter 4

### Game-based Learning for Sustainability in Management Education: Evidence on industry relevance and key competencies

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#### Abstract

This paper aims to provide recommendations for educators on creating business games focused on sustainable education. A qualitative cluster analysis of feedback from a workshop was conducted to achieve two primary objectives: identifying suitable industries and sectors for business games and determining the essential competencies to develop through these games. The analysis identified three major industry clusters: Public Utilities, Entertainment and Education, and the Product sector. Within the Public Utilities cluster, critical areas such as transportation, housing, and renewable resources were highlighted. The Entertainment and Education cluster, although distinct, intersect in areas like Edutainment. The Product sector focuses on consumer goods, particularly the food and beverage and the clothing industry. Additionally, five key competency clusters were identified: Decision-Making Skills, Hard Skills, Complexity Management Skills, Managerial Skills, and Social & Organizational Skills. These competencies range from technical knowledge and systems thinking to interpersonal and team management skills. The consistency between human and AI clustering analyses underscores the robustness of the findings. These findings offer practical advice for those designing business games with the aim of integrating sustainability concepts into management courses.

**Keywords:** business game; gamification; sustainable education; management education; learning.

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## **1. Introduction**

The need to develop innovative educational approaches is a topic of growing relevance in sustainable education. The benefits of using games for educational purposes have been widely studied in the literature. Educational games leverage Dewey's (1938) learning-by-doing theory, highlighting the importance of practical experience in education. This approach also aligns with Flow Theory, which shows that students learn more effectively and stay motivated when engaged in enjoyable and rewarding activities (Csikszentmihalyi, 2000). López et al. (2021) confirm that expectations about learning performance are the most influential factor in students' acceptance of gamification. According to Flood et al. (2018), games facilitate rapid learning by demonstrating how different variables interact without requiring strenuous quantitative activities. They use interactive models to encourage participation, reflection, decision-making, and visualization of results through feedback. Engaging students in conflict resolution and decision-making fosters self-learning and enhances satisfaction, positively impacting intrinsic motivation, critical thinking, and proactive behavior (Buil et al., 2019). The effectiveness of learning/experimental games in building managerial skills has been empirically evidenced in areas such as strategy and investments (Loon et al., 2015), marketing (Vos, 2015), and entrepreneurship (Pérez-Pérez et al., 2021).

The concept of business games originated with Carson (1969) as enhanced case studies incorporating feedback and a temporal dimension. Over time, various definitions have emerged, including simulation games, serious games, and management games. Ruohomaki (1995) differentiates simulation games from simulations by their inclusion of competitive and cooperative elements, rules, and roles (Greco et al., 2013). Serious games, as defined by Mortara et al. (2014), focus on objectives beyond entertainment, such as education and training. Management games, according to Baldissin et al. (2013), are designed for managerial learning through competitive and rule-based simulations. Fraccascia et al. (2021) emphasize that for a game to qualify as a business game, it must involve actions, rules, objectives, and challenges, allowing players to make decisions to meet learning outcomes.

The "Game-based Learning for Sustainability in Management Education (GAME-SME)" Workshop, held in Valencia as part of the SEED Conference 2024, aimed to provide a platform for participants to share their findings, thoughts, and personal experiences in utilizing business games for teaching sustainability principles in management courses. The primary objective was to investigate the intersection of two dynamic streams of research and educational trends: the utilization of learning/experimental games and the incorporation of sustainability themes in management education. Thus, the first focus was on exploring the benefits of using learning/experiential games to develop education and skills in the context of ecological transition.

During the first part of the workshop, three initiatives were presented, focusing on the development of serious games in management education: "Digital Entrepreneurship for Sustainability: A Gamification Perspective"; "Designing Serious Games to Foster Responsible Entrepreneurship for Urban Resilience: The Case of Resurbis"; and "An Experience of Serious Game as Sustainable Energy Education". Each paper was included in the Workshop Proceedings of the SEED Conference 2024.

This paper describes the results of the second part of the workshop, where over 20 participants were asked to discuss industries and sectors suitable for implementing business games on sustainability topics and to determine the skills to be developed and strengthened through such games. The contribution lies in providing educators and practitioners with the outcomes of an open discussion in an international workshop, resulting in a set of recommendations regarding the industries to focus on and the competencies to address for those interested in integrating sustainability into management education through game-based learning approaches.

## **2. Open discussion session**

In GAME-SME Workshop, the over 20 participants have been asked to suggest industries or sectors suitable for business games focused on sustainability, as well as key competencies to develop through these games. Each participant wrote their ideas on two Post-it notes—yellow for industries/sectors and green for competencies. These notes were then attached to a blackboard and discussed with the entire group, leading to a comprehensive set of recommendations for educators and practitioners on integrating sustainability into management education through game-based learning.

### **2.1 Industry/ Sector suggestions**

The public sector received particular attention, with participants highlighting its critical role in enforcing policies and regulations that promote sustainability.

Many participants highlighted the transportation sector, emphasizing its critical role in society and its significant impact on all three pillars of sustainability—economic, social, and environmental. Transport improves quality of life, provides access to essential services, and facilitates trade. However, it also heavily relies on non-renewable resources and contributes to increasing emissions, making it a prime candidate for business games that promote sustainable practices.

The waste industry was identified for its role in managing waste efficiently to minimize environmental impact and recover valuable resources. Energy production was also noted, particularly the shift from fossil fuels to renewable energy sources, which is crucial for reducing greenhouse gas emissions and ensuring access to affordable energy.

Participants also highlighted the building and housing sectors due to their significant impact on energy consumption and job creation. Improving energy efficiency in buildings and ensuring affordable housing are key sustainability challenges.

Other sectors mentioned included HVAC for its role in emissions reduction, materials engineering for developing sustainable products, and renewable resources for public spaces for their environmental benefits.

The event sector was also noted for its broad impact on resource consumption and waste generation. The gaming and streaming sector was mentioned for its potential economic growth and social interactions, despite the environmental challenges posed by electronic waste. Education and language learning were suggested for their role in driving economic growth and promoting social equity.

Lastly, the product and consumer goods sectors, particularly food and beverage and the clothing industry, were highlighted for their economic significance and substantial environmental impacts. The food and beverage industry is a critical area for sustainability due to its influence on agricultural practices, resource use, and waste management. Business games in this sector can simulate supply chain management, promoting sustainable sourcing, and reducing food waste. Similarly, the clothing industry, known for its high resource consumption and water pollution, presents opportunities for business games to address issues such as circular business models and ethical sourcing.

## **2.2 Skills/Competencies suggestions**

Participants identified several key skills that business games should develop. Selective classification was highlighted for its ability to enhance decision-making by focusing on relevant factors. Forecasting and evaluating the impact of decisions were also emphasized as critical for anticipating trends and mitigating risks.

Critical thinking and change management were noted for their importance in analyzing situations deeply and implementing transitions smoothly. Generating profit, market analysis, and competitive advantage were also identified as essential business skills.

Managing people and teams, understanding social layers, and teamwork were highlighted for their role in fostering a productive and motivated workforce.

Energy awareness, including energy consumption of building materials and battery knowledge, was also emphasized for promoting sustainable practices. Life cycle assessment (LCA) analysis was noted for its importance in reducing environmental impact through informed decision-making.

System thinking and interdisciplinary abilities were highlighted for their role in managing complex, interconnected processes and solving multifaceted problems. Understanding

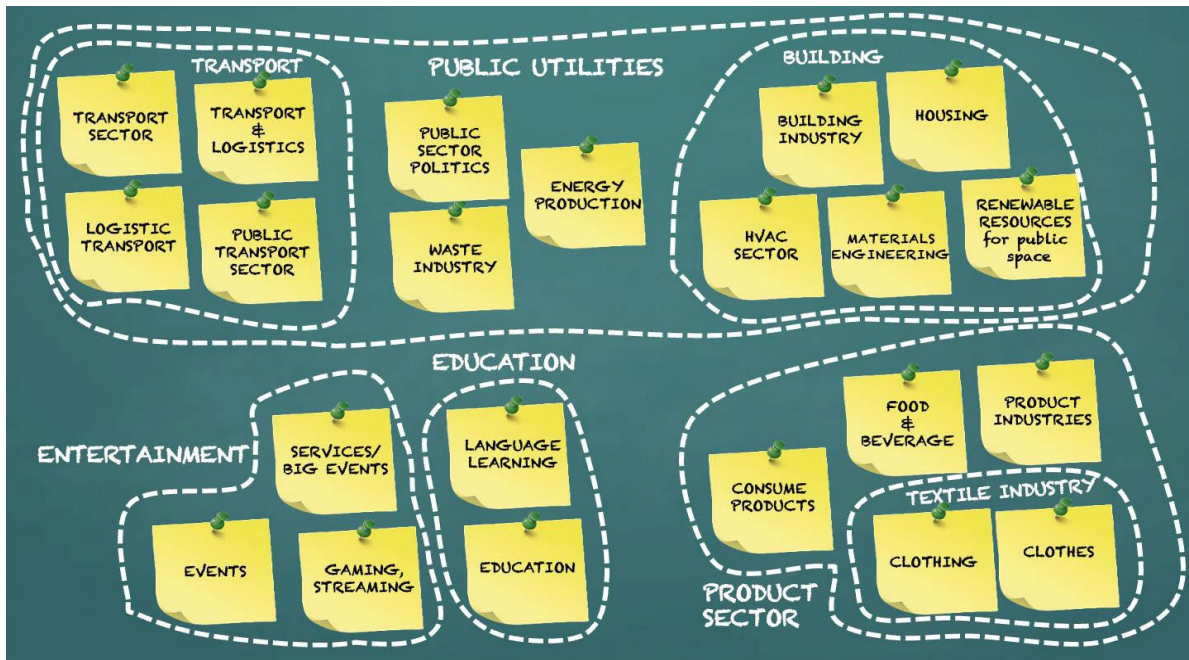
dependencies within supply chains and having an overview of complex situations were also mentioned as critical skills for navigating intricate scenarios and making strategic decisions.

### 2.3 Qualitative cluster analysis

During and after the workshop, participants' answers were analyzed to develop recommendations for creating business games in the field of sustainable education. A qualitative cluster analysis was conducted to achieve two key objectives: 1) identifying suitable industries and sectors for these business games, and 2) determining the essential competencies to be developed through such games.

For the first objective, Figure 1 illustrates the outcomes of the brainstorming session, revealing three main clusters: Public Utilities, Entertainment and Education, and the Product sector.

Fig. 1 – Cluster analysis results for industries and sectors



Source : Own elaboration

The Public Utilities cluster was further divided into two sub-clusters: Transport and Building. The Transport sub-cluster includes sectors like "Transport sector", "Transport & Logistics", and "Public transport sector". This cluster is critical due to its substantial economic and environmental impact, particularly in terms of reducing carbon emissions and improving operational efficiencies. The Building sub-cluster encompasses industries such as "Housing", "HVAC" (Heating, Ventilation, and Air Conditioning), and "Building industry", as well as more theoretical fields like "Materials engineering science" and "Renewable resources for public spaces". Additionally, other relevant sectors within Public Utilities included "Public sector politics", crucial for policy-making; "Waste industry", essential for proper waste

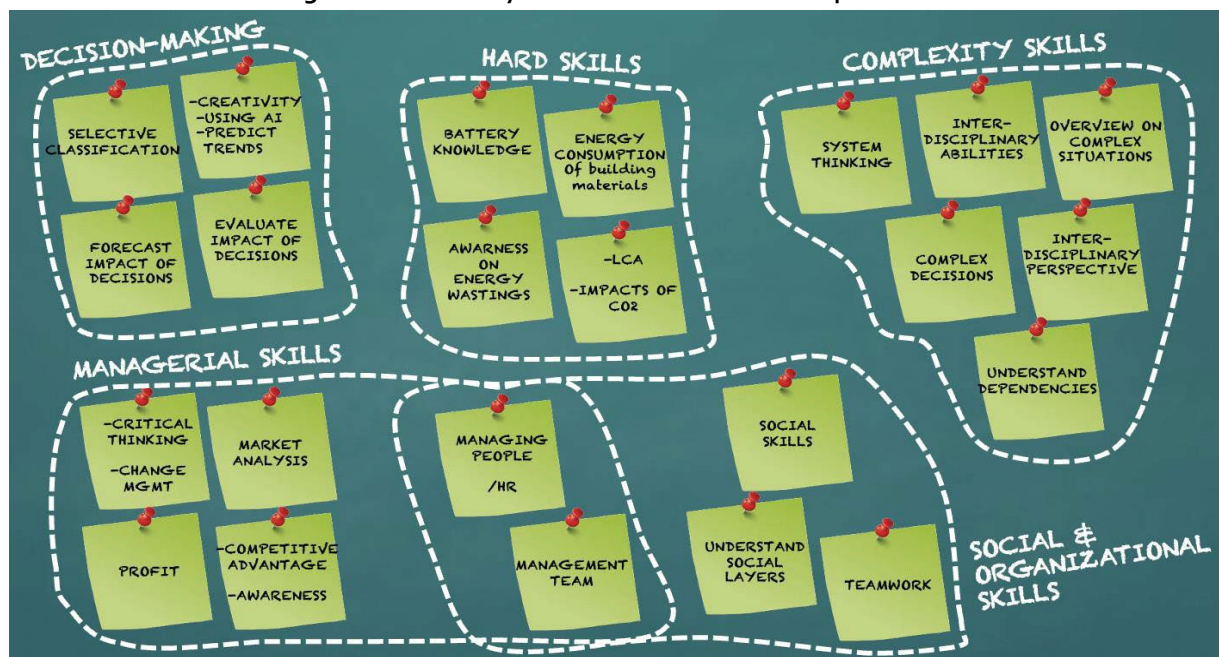
management; and “Energy production”, relevant for providing sustainable energy solutions. The Entertainment and Education cluster, while distinct, was grouped together due to their combined potential in gamified learning contexts. The Entertainment sub-cluster includes “Events” and “Gaming/Streaming”, both of which have substantial social impacts and are rapidly evolving. The Education sub-cluster, featuring “Language learning”, addresses social sustainability by bridging cultural gaps and fostering communication.

Finally, the Product sector cluster includes consumer goods industries such as “Food and beverage” and “Clothing”. These sectors were noted for their significant economic impact and environmental footprint. The food and beverage industry is crucial due to its role in sustainable agriculture and waste management, while the clothing industry is relevant for its resource consumption and waste issues.

Business games focused on these industries can effectively address sustainability challenges and promote responsible management practices.

For the second objective, Figure 2 presents identified clusters of skills and competencies, divided into five primary categories: Decision-Making Skills, Hard Skills, Complexity Management Skills, Managerial Skills, and Social & Organizational Skills.

Fig. 2 – Cluster analysis results for skills and competencies



Source: Own elaboration

The Decision-Making Skills cluster includes competencies like “Selective classification”, “Predict trends”, and “Forecast and evaluate the impact of decisions”. These skills are crucial for making informed choices that align with strategic goals and address both short-term and long-term outcomes.

The Hard Skills cluster encompasses general technical knowledge such as “Battery knowledge”, “Energy consumption of building materials”, “Awareness on energy wasting”, as well as more advanced capabilities like conducting “LCA analysis”. These skills are essential for understanding and managing technical aspects of sustainability.

The Complexity Management Skills cluster includes “System thinking”, “Interdisciplinary abilities”, “Understand dependencies”, and “Overview on complex situations”. These competencies are vital for navigating and managing complex and interconnected systems. The Managerial Skills cluster and the Social & Organizational Skills cluster share core competencies like “Managing people” and “Management team”. Managerial Skills also encompass “Critical thinking”, “Market analysis”, and generating “Competitive advantage”, while Social & Organizational Skills focus on “Social skills”, “Teamwork”, and understanding “Social layers”.

After the workshop, participants' answers were analyzed using AI software (ChatGPT-4o). The software was instructed to generate clusters based on the keywords provided, organizing them into groups according to their thematic "family" and allowing for intersections and sub-clusters within these groups. This approach aligns with emerging research on using AI for text classification (Zhao et al., 2023). Interestingly, the AI-generated clusters confirmed similar groupings as those identified through human analysis, reinforcing the validity of the findings. Therefore, although detailed results are not provided due to space constraints, it is worth noting the consistency between the AI-generated and human-driven results.

### **3. Conclusions**

This study underscores the potential of business games as powerful tools for integrating sustainability into management education. By analyzing the results of the open discussion session during the GAME-SME Workshop, we identified key industry sectors and competencies that can enhance the effectiveness of such educational tools. The findings offer actionable recommendations for educators and practitioners aiming to design impactful business games that align with sustainability goals. Overall, leveraging game-based learning in these contexts can significantly contribute to advancing management education.

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### **Conflicts of interest**

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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## Chapter 5

### Digital entrepreneurship for sustainability: a gamification perspective

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#### Abstract

Digital entrepreneurship is changing how companies create and capture value in all sectors, transforming traditional businesses into digital ones. New entrepreneurial and digital competencies are needed to start or transform businesses and compete in the market. Learning through play is an effective way to transfer, develop, and enhance these competencies. This article aims to show the design, development, and testing process of the digital business game 3E-Learning, designed to develop secondary school students' digital entrepreneurship competencies. Results show that the game impacts the development of digital businesses that solve sustainability problems.

**Keywords:** business game; game-based learning; digital entrepreneurship; digital business model; sustainability.

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## **1. Introduction**

Digital transformation has enabled disruptive changes in the global business landscape (Autio, 2018). Entrepreneurs have begun to use digital technologies as a leading resource to overcome challenges and power their businesses, transforming traditional businesses into digital ones (Paul et al., 2023). The term digital entrepreneurship describes this phenomenon. Digital Entrepreneurship is the creation of a venture to produce and generate revenue from digital goods across electronic networks (Guthrie, 2014). However, these new businesses require entrepreneurial competencies to start and run a business over time and digital competencies to exploit the potential of applying technologies in business (Paul et al., 2023). Entrepreneurial and digital competencies are crucial elements of education (Song, 2019; European Commission, 2015) because they are fundamental to fostering societal change. However, as digital entrepreneurship competencies are multi-sectoral and multidisciplinary, it is difficult to transfer them through only formal study. More significant results could be achieved by combining the two types of learning, i.e. formal and informal, because study and action are also combined with reflection and experience in its execution (Caldana et al., 2023), as in the case of learning through games. Games develop knowledge, competencies and the ability to understand situations. Learning through play also allows for exploration and experimentation with the guidance of a facilitator and in a safe environment. This allows participants to receive immediate feedback on their actions and decisions (Kolb, 2014) and quickly develop competencies. This paper aims to show the conception, design and testing process of the digital business game 3E-Learning. The game was developed to introduce digital entrepreneurship to students in secondary schools (aged between 14 and 19). The basic idea is to teach the principles of starting and structuring a digital business idea, managing it over time, learning how to read the market, making decisions, and seizing opportunities and innovations.

## **2. Methodology**

To create the digital entrepreneurship game, we merged literature analysis and practitioner input from interviews and workshops with testing and evaluation. The process was divided into three phases: Exploration, Game Conceptualization and Development, Test, Evaluation, and Game Impact. Each phase involved specific activities, tools, participants, and outputs, detailed in Table 1 and explained chronologically in this section.

**Table 1 – Summary of design, development and game impact of the digital business game “3e-learning”**

Step	Aim	Activities	Tools	Participant type	Output
1. Exploration	Understanding of practical and theoretical requirements	<ul style="list-style-type: none"> <li>Expert interviews</li> <li>Literature reviews about digital entr. competencies</li> <li>Literature reviews about digital business models</li> </ul>	<ul style="list-style-type: none"> <li>Discussion</li> </ul>	<ul style="list-style-type: none"> <li>Game designers</li> <li>Academic researchers</li> </ul>	<ul style="list-style-type: none"> <li>Technical game requirements</li> <li>List of competencies to develop through the game</li> <li>Digital Business Model Canvas</li> </ul>
		<ul style="list-style-type: none"> <li>Stakeholder interviews</li> </ul>	<ul style="list-style-type: none"> <li>Survey</li> <li>Structured interviews</li> </ul>	<ul style="list-style-type: none"> <li>Secondary school students</li> <li>Secondary school teachers</li> </ul>	<ul style="list-style-type: none"> <li>Existing competencies assessment</li> <li>Learning requirements</li> </ul>
2. Game Conceptualisation and Development	Creation of the game structure	<ul style="list-style-type: none"> <li>Mapping of existing games</li> <li>Expert interviews</li> </ul>	<ul style="list-style-type: none"> <li>Discussion</li> </ul>	<ul style="list-style-type: none"> <li>Academic researchers</li> <li>Game designers</li> </ul>	<ul style="list-style-type: none"> <li>Game structure</li> </ul>
3. Test, Evaluation and Game impact	Improve the game performance	<ul style="list-style-type: none"> <li>Stakeholder workshops</li> <li>Competencies survey</li> </ul>	<ul style="list-style-type: none"> <li>Game session</li> </ul>	<ul style="list-style-type: none"> <li>Secondary school students</li> <li>Secondary school teachers</li> </ul>	<ul style="list-style-type: none"> <li>Stakeholder feedback</li> <li>Competencies assessment (before and after game)</li> <li>Game impact</li> </ul>

Source: Own elaboration

## 2.2 Phase 1: exploration

The initial phase sought to grasp the theoretical and practical essentials for crafting a digital entrepreneurship game. Interviews with game designers from "The Business Game" were conducted to gauge technical necessities such as game mechanics, completion time, and potential learning tools. Simultaneously, a literature review was undertaken using Scopus database keywords on digital entrepreneurship competencies and business models (refer to Table 2).

**Table 2 – Search String**

Concept to investigate	String
Digital entrepreneurship competencies	TITLE-ABS-KEY ((( "entrepreneurship" AND "digital" ) AND "competence*" ) AND ( LIMIT-TO ( SUBJAREA, "SOCI" ) OR LIMIT-TO ( SUBJAREA, "BUSI" ) OR LIMIT-TO ( SUBJAREA, "ECON" )) AND ( LIMIT-TO ( LANGUAGE, "English" ))
Digital Business model	TITLE-ABS-KEY ("digital business model") AND ( LIMIT-TO ( DOCTYPE, "ar" ) OR LIMIT-TO ( DOCTYPE, "re" ) ) AND ( LIMIT-TO ( SUBJAREA, "BUSI" ) ) AND ( LIMIT-TO ( LANGUAGE, "English" ) )

Source: Own elaboration

### **2.3 Phase 2: Game conceptualization and development**

This phase focused on designing the game's structure and learning tools to enhance digital entrepreneurship competencies identified through the literature review and questionnaire. Initially, existing digital entrepreneurship and management games were mapped to identify useful aspects for incorporation into the "3E-Learning" game. Subsequently, the results of this mapping were analysed in collaboration with game designers to define the game's structure and confirm anticipated mechanics and dynamics from the previous phase.

### **2.4 Phase 3: Test, evaluation and game impact**

This phase aimed to test and evaluate the game's performance and impact. Multiple workshops were conducted: one with teachers and eight with students (326 total) from various countries. The teacher workshop included a project introduction and game testing. In contrast, the student workshops comprised five segments that include activities supplementary to just testing the game: introduction to digital entrepreneurship, initial competencies test, team group game session, digital business conception and development, and final competencies test along with evaluation of students' digital businesses.

An important activity for evaluating the effectiveness of the game was conceiving and developing one's own business idea. Researchers evaluated the business ideas developed during competency building to ensure alignment with game concepts. Feedback gathered at the end of each workshop was used to enhance the game and overall experience.

## **3. Results**

This section presents the main results of the three phases. Feedback received during all workshops or information received during informal discussions will not be reported.

### **3.1 Exploration results**

#### **3.1.1 Entrepreneurial and Digital Competencies**

Creativity is identified as a critical competence for entrepreneurship, and it is defined as the ability to explore and imagine processes that consider one's knowledge, motivations, emotions and experiences and that lead to the creation of new, useful and valuable products,

ideas or solutions (Runco and Jaeger, 2012). Creativity is necessary for starting a new business but also for sustaining the company into the future and using technology in alternative ways (Androutsos and Brinia, 2019; Prendes-Espinosa et al., 2021; Comesaña- Comesaña et al., 2022). Creativity has to be integrated with strategic thinking competence, which means knowing how to implement strategies and actions that can lead to business development. The entrepreneur must also be equipped with problem-solving, which is the ability to analyse a problem and find the best solution, strategically defining ideas and business models (Castillo-Vergara et al., 2014). In practice, problem-solving involves identifying the root cause through rational and systematic approaches. Another competence for entrepreneurship is prospecting. Possessing this competency means imagining the future and acting in an anticipatory and preventive manner (e.g., Hamburg et al., 2019; Prendes-Espinosa et al., 2021). Digital competencies complement these competencies. Digital competencies are related to information and communication technology (ICT) and are divided into generic ICT competencies, relating to the use of digital technologies for professional purposes; specialised ICT competencies, necessary for the production of ICT products and services; complementary ICT competencies for the performance of tasks associated with the use of ICT and essential competencies such as digital literacy enable the use of digital technologies (Mir et al., 2022). Added to these is technical-ethical competence, which refers to the ability to understand and apply ethical principles in the management and use of technology (Prendes-Espinosa et al., 2021).

### **3.1.2 Digital business model canvas**

The Digital Business Model Canvas (DBMC) is a visual tool (see Fig. 1) outlining the core components of a digital business. It comprises ten building blocks that guide the transition from an idea to a market-ready business.

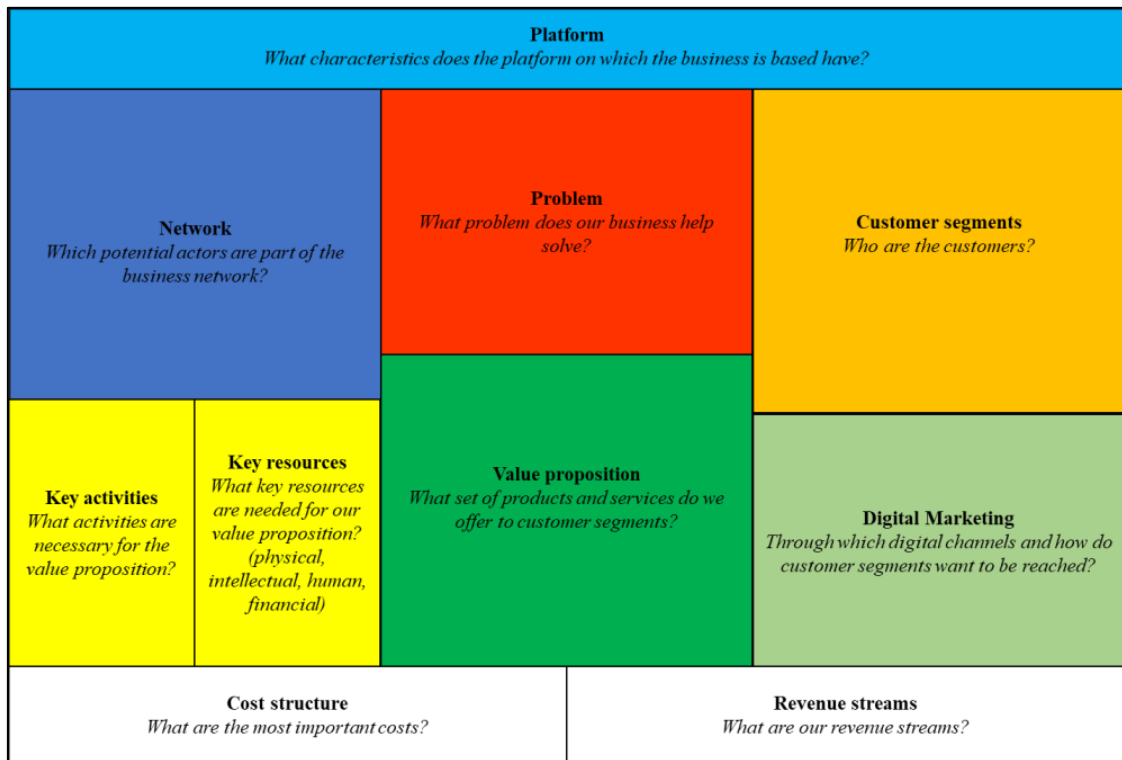
Firstly, identifying problems to solve (Building block: problem) sets the groundwork. This is followed by crafting a value proposition (Building block: value proposition) and determining products and services tailored to address the identified problems. Targeting specific customer segments (Building block: customer segments) is essential and facilitated by digital marketing across various channels (Building block: digital marketing).

In the digital environment, networks play a crucial role (Building block: network), encompassing external actors providing resources (physical, intellectual, financial, and human; Building block: essential resources) and engaging in activities to deliver value to customers (Building block: key activities). Platforms (Building block: platform) act as vital connectors between actors and customers, necessitating the identification of platform features to support business objectives.

Additionally, the DBMC tracks cost structure (Building block: cost structure) and revenue

streams (Building block: revenue streams) to ensure financial viability.

Fig. 1: Digital Business Model Canvas



Source: Own elaboration

### 3.1.3 Students' competencies assessment and learning requirements

This step delineated the scope of students' existing competencies in digital education and management. Simultaneously, teacher interviews provided insights into the game's required features for school use and anticipated outcomes regarding students' acquisition of strategic and transversal competencies.

Key findings from the questionnaire include Proficiency in utilizing online platforms for information access and sharing. The popularity of content creation but a notable need for more technical competencies. Strong confidence in personal data protection. Limited distribution of technical problem-solving competencies. Enthusiasm for instigating change, with some deficit in long-term vision. Proactive attitudes despite lower technical competencies. Willingness to confront challenges but struggle with uncertainty. Preference for collaborative work in facing challenges.

Despite recognizing the significance of entrepreneurship, there needs to be more related knowledge among students and many educators. Nevertheless, most teachers favour integrating new teaching tools and are open to using business games as a resource. Additionally, most are willing to allocate up to 2 hours for both in-play and out-of-play activities related to these tools.

### **3.2 Conceptualisation and development results**

#### **3.2.1 Game structure**

The digital business game "3E-Learning" comprises two integral parts aimed at imparting an understanding of a digital business's ideation, startup, and growth using gamification and realistic market simulation. Participants assume the role of students aspiring to establish an online tutoring business.

In Part 1, "From Idea to Market," participants receive theoretical information interactively through text, video, and quizzes. They then navigate a process akin to the Digital Business Model Canvas, fostering reasoning about various business model components.

Part 2, "Executing the Business," requires participants to make strategic decisions affecting business performance. This fosters competition among players in real-time game sessions, and scoring mechanisms enhance student engagement throughout the game.

#### **3.3 Test, evaluation and great impact**

After defining the game's structure and implementation, each partner organized multiple gaming workshops with high school students from their nation. The purpose of these sessions was to test the technical operation of the game, verify the achievement of its educational goals, and gather feedback from the students on how it could be improved.

##### **3.3.1 Competencies assessment before and after game**

To assess the game's educational performance, students completed a pre - and post-game questionnaire to assess their awareness of the game's main themes. Feedback revealed a significant improvement in evaluations, indicating that the game effectively achieves its educational objectives.

##### **3.3.2 Game impact**

The students can develop their business ideas using the competencies acquired during the game. In some of the workshops conducted by the partners, activities supplementary to the game were carried out. In these activities, students could develop their business ideas based on the framework introduced in the game.

The ideas originated from the identification of today's problems or needs. Seventy per cent of the problems identified by the students relate to sustainability. Among these,

students came up with, for example, an application that allows the geolocation of bins to sort waste correctly. Others conceived a platform that allows people to exchange unused goods freely. The 3e-learning digital business game aims to prompt the development of competencies the European Union identified as sustainability competencies. These include the capacities for problem-solving, creativity, teamwork and imagining the future (Bianchi, 2020). In addition, encouraging digital business development fosters a push toward

sustainable business creation. Indeed, as Brenner and Hartl (2021) state, sustainability and digital businesses are tightly linked, and their interrelationship is highly relevant.

#### **4. Conclusion**

This paper presented the design, development and testing process of the digital business game 3E-Learning. Among the results, we found that digital entrepreneurship competencies developed through the game enable the creation of sustainable businesses. This is in line with recent research on digital entrepreneurship. According to studies by Fernandes et al. (2022) and Holzmann and Gregori (2023), digital entrepreneurship can generate economic value through digitalising traditional businesses and social and environmental value. This is because new technologies enable sustainable business through the reuse of resources or the tracking of waste.

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#### **Conflicts of interest**

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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## Chapter 6

### Designing serious games to foster responsible entrepreneurship for urban resilience: the case of Resurbis

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#### Abstract

The paper illustrates the use of narratives and process modeling to develop a serious game on urban resilience and responsible entrepreneurship. The development of serious games, following the educational paradigm of active learning, is as potentially effective as it is inherently complex. Responsible entrepreneurship and urban resilience turn out to be intricately multidisciplinary subjects, and the development of teaching-pedagogical tools requires a plural effort by experts with different professional and cultural backgrounds. Moreover, the domains of urban resilience and responsible entrepreneurship have blurred semantic boundaries and lend themselves to be approached by adopting multiple perspectives. Exploring these issues on a purely theoretical level could, however, erode the entertainment purposes that should distinguish game-based educational approaches. Delving into the single case of Resurbis, the paper presents the ways in which the game development team overcame the main critical issues. Specifically, as part of the development, process modeling was employed to support the synthetic representation of the narratives developed to enable the emotional involvement of learners as well as to ensure smooth communication in the multidisciplinary team.

**Keywords:** urban resilience; entrepreneurship education; game based learning; narrative; process modeling.

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## **1. Introduction**

Urban environments are increasingly exposed to factors that undermine their inhabitants' well-being and environmental and social sustainability. Urban resilience is widely referred to as the capability of cities to absorbing, responding and transforming themselves, while ensuring the well-being of their human and nonhuman actors (Zeng et al., 2022). Entrepreneurship, a cross-cutting and foundational socioeconomic phenomenon of market economies, is a centrally important tool for the creation, development, and diffusion of sustainable technological and social innovations (Si et al., 2023). Entrepreneurial initiatives, if managed appropriately, enable sustainable systemic changes even at the urban scale. For these reasons, education for resilience and entrepreneurship constitutes a crucial element for achieving sustainable development.

One of the most promising active learning strategies to transfer complex, multidisciplinary knowledge and skills is Game Based Learning (GBL). GBL involves the development and delivery of educational activities that integrate teaching aspects with playful and engaging mechanics, dynamics, and aesthetics. The purposes of GBL require significant commitment in the design phases of game activities, especially when the knowledge and skills to be transferred pertain to heterogeneous domains. Educators rarely have the resources needed to develop an educational game: on the other hand, game designers must interface with domain experts to develop effective educational products (Theodosiou & Karasavvidis, 2015). The paper presents two solutions used by a multidisciplinary team in the development of an educational game - entitled Resurbis - on the themes of urban resilience and entrepreneurship. In particular, the use of narratives as useful tools to support the development of games that engage learners on an emotional and empathic level is illustrated. By adopting narratives, it is possible to avoid the use of approaches that focus solely on logical simulation and fail to fulfill the entertainment purposes intrinsically linked to GBL approaches. To support the development of the narratives and facilitate intra-team communication of narratives, the use of process modeling is also illustrated. Among the process modeling languages, the extended-event driven process chain (EEPC) was used. Such a language proves to be a valuable design support tool that can enable communication among team members heterogeneous in professional background.

## **2. Background**

### **2.1 Urban resilience and entrepreneurship**

The urban resilience concept has undergone an evolution over time. According to Chelleri and Baravikova (2021) three main resilience conceptualizations can be historically identified: i) engineering resilience, ii) ecological resilience, and iii) socio-ecological resilience. The latter considers urban resilience as the ability of the urban socio-ecological system to withstand

shocks, adapt and transform (Folke et al., 2010). According to ARUP (2014) resilience is “the capacity of individuals, communities, and systems to adapt, survive, and grow in the face of stress and shocks, and even transform when conditions require it”. Considerable efforts have been made by a variety of institutional and non-institutional actors (e.g., governments, NGOs, citizens associations) to develop tools and initiatives to increase the resilience of urban systems. Within this context, entrepreneurship constitutes one of the fundamental tools of socio-cultural change in market economic systems. Through business activity, economic agents may create shared social and environmental value as well as, of course, contribute to the economic and employment growth of territories. In addition, some forms of entrepreneurship prove to be drivers of social innovation that connect different stakeholders, fostering communication and matching their mutual needs. Although entrepreneurship can, and, for some, should (Benz, 2009), play such a role, the business world has largely and until now been concerned with maximizing economic results, often ignoring aspects of social and environmental sustainability, and sometimes, even, unscrupulously depleting natural capital and exacerbating inequalities and social tensions. For these reasons, the education of entrepreneurs who sense their role as agents of social change and who are not reduced to understanding their business as merely economic therefore becomes a task of central importance. Activities aimed at maturing entrepreneurial awareness and responsibility can contribute to the generation of resilient economic fabrics that, in turn, ensure the resilience of the social and environmental systems on which they work.

## **2.2 Urban resilience and entrepreneurship**

One of the most effective active learning strategies is GBL. While using games for educational purposes is not new and has roots dating back thousands of years (Djaouti et al., 2011), the widespread adoption of digital games and a growing recognition of pedagogical approaches that foster interactive teaching have reignited interest in using games for education (Qian & Clark, 2016). GBL involves utilizing games as a teaching tool to facilitate the transfer of knowledge and skills through content and activities (Greco et al., 2013; Greipl et al., 2020; Shaffer et al., 2005). It often includes problem-solving activities, challenges, and playful mechanisms designed to engage players (Qian & Clark, 2016). Therefore, games developed for educational purposes must align with educational objectives while balancing entertainment and instruction. GBL emerges as a promising tool for the transfer of skills and knowledge related to entrepreneurship, sustainability, and urban resilience. In particular, the domains of entrepreneurship and resilience present themselves as inherently multidisciplinary and oriented toward empowerment, participation and knowing how to act in changing and complex environments characterized by conflicting interests (Pauw et al., 2015).

### 3. The case of Resurbis

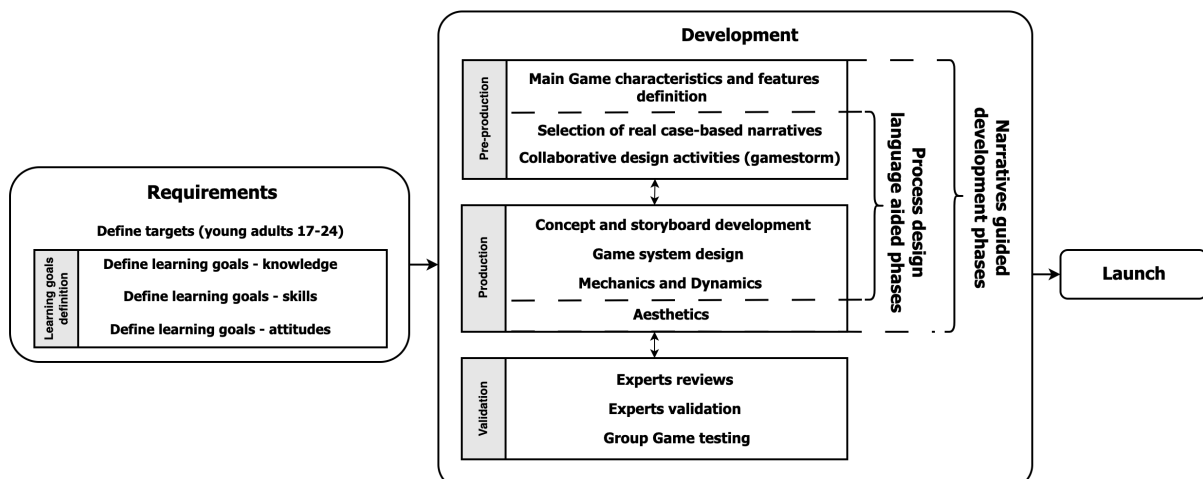
#### 3.1 Problem definition

Resurbis was developed in the context of the Research project reCITY - Everyday Revolution, whose aim is to foster the development of resilient urban communities. The project aims to design and develop interactive tools that, by leveraging the paradigm of GBL, can engage young adults in activities with educational value. Such activities, from design requirements, had to insist on knowledge and skills pertaining to active citizenship, entrepreneurship, and social and environmental sustainability at the urban scale. The design team, which involved members from very different backgrounds (e.g., software developers, urban planners, management engineers, GBL experts), was therefore faced with the delicate task of identifying a proposal that would simultaneously combine heterogeneous themes with the entertainment needs typical of a video game. The project was thus characterized by a considerable heterogeneity of i) the themes to be covered, and ii) the backgrounds of the development team members. Such heterogeneities evidently constitute, as demonstrated in other project settings (Christensen & Ball, 2016), a precious asset, clearly reflecting the multidisciplinary nature of the themes to be addressed. However, the development setting together with the breadth of the topics covered imposed the identification of solutions that would allow: i) smooth communication among team members; ii) considerable flexibility in terms of writing and storyline in order to ensure the transfer of skills and knowledge.

#### 3.2 Proposed approach

The development of the game followed the steps shown in Fig. 1.

Fig. 1 – Development pipeline of the serious game Resurbis.

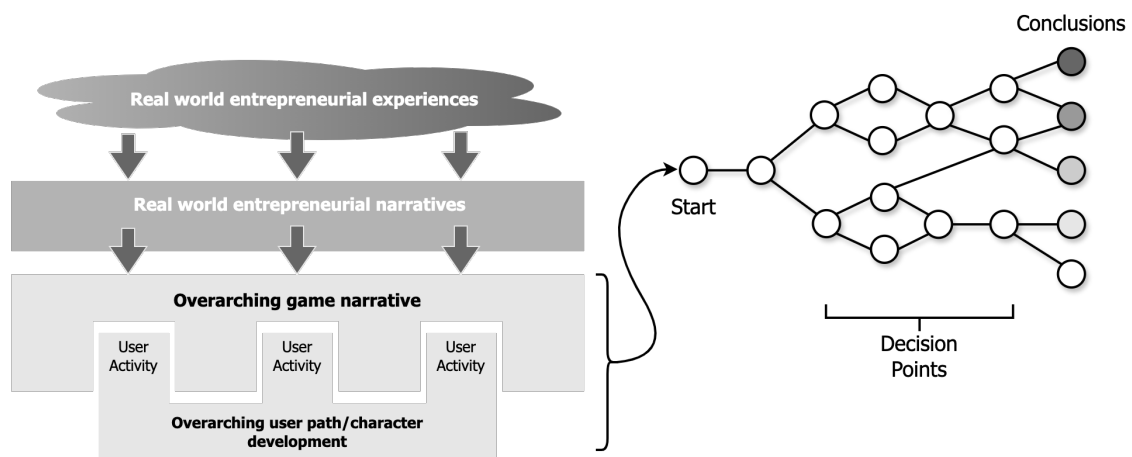


Source: Authors' production. Derived from (Brauner & Ziefle, 2022).

Primarily, the research team developed an orderly and structured list of the learning goals to be set. This list, primarily sketched out, was subject to modifications, even radical ones,

during the early stages of game development. The defined learning objectives were classified into knowledge to be transferred (e.g. urban resilience characteristics, social entrepreneurship), skills (e.g. capability to recognise the resilience features of an urban system, understand social impacts of entrepreneurial activities), and attitudes (e.g. being able to empathize with different stakeholders). From the very early stages of game development, the team was oriented toward writing a narrative adventure. The use of narratives in the context of games has already been discussed, as evidenced by the existing literature (Simons, 2007), and there are numerous alternatives of narrative schemes that game designers may choose to adopt. In addition, the development of narratives requires deciding on numerous aspects concerning, for example, the degree of verosimilitude, the degree of player intervention in the progress of the story, and the manner in which educational content is delivered (Greco et al., 2013). In the case of Resurbis, the development team opted for field research of real stories of responsible entrepreneurship in order to ground the narrative in reality. This research activity, which included documentary analysis, interviews, and meeting moments with entrepreneurs, allowed for the collection of material that then fed into the game's narrative line. A schematization of the process of developing the narratives that characterized the game is contained in the Fig. 2. At the level of narrative morphology, the team opted for a branching narrative: the player, through their decisions, determines their own narrative strand.

Fig. 2 – Resurbis narrative genesis and structure.



Source: Authors' production.

With reference to Fig. 3, the morphology of the decision tree (decision points) can be complicated to the game designer's preference. If the players perceive the narrative structure as overly simple and their actions as not affecting the progress of the storyline, then they may lose interest in the interactive and decision-making components of the game, so compromising the entire learning experience. For these reasons, the decision graph must maintain a certain degree of complexity, complexity that implies, in the design phase, the use

of cross-team communication tools, so that each member can be aware of the development of the various branches, collaborate in their development, and appreciate their changes. In the development of Resurbis, the EEPCC was used for that purpose. The research team framed the entire script of the serious game as a process. According to Van de Ven (1992), a process can be defined as “a sequence of events or activities that describes how things change over time, or that represents an underlying pattern of cognitive transitions by an entity in dealing with an issue”. Visual mapping is a strategy that can be used to model and analyze process data (Langley, 1999). The visual (or graphical) representation of a process, a strategy commonly adopted to properly manage business processes (Dumas et al., 2013) allows the presentation of the entire process in relatively short space. That, in turns, makes the analysis of a process easier and facilitate the exchange of information on the process (e.g. to validate the process model) among process analysts and process actors. To ensure clear communication, visual representations should adhere to several principles: be precise and concise, i.e. provide appropriate details while including only relevant information, maintain clarity and readability, and adhere to syntactic and semantic correctness. Different techniques to model processes can be found in the literature, each with specific characteristics. In the paper, Extended- Event driven process chain (E-EPC) is adopted. Such a methodology was developed by prof. Scheer at the university of Saarland in the 1990s (Davis, 2001). Among process mapping languages, E-EPC stands out for its simplicity and straightforwardness. These characteristics make E-EPC particularly useful in multidisciplinary contexts and teams, where transferring process knowledge among heterogeneous members with diverse backgrounds and disciplines is necessary. The E-EPC is a visual representation featuring key elements: i) events that trigger the start or end of an activity; ii) activities that represent the actions carried out; iii) actors that are the organizational units/roles/persons that execute activities; iv) information and physical resources needed for the activity executions; v) workflows that show the sequence of activities; vi) gateways (based on OR, XOR, AND Boolean logic) that indicate how the workflow splits or joins.

## **4. Results**

### **4.1 Resurbis' overarching storyline**

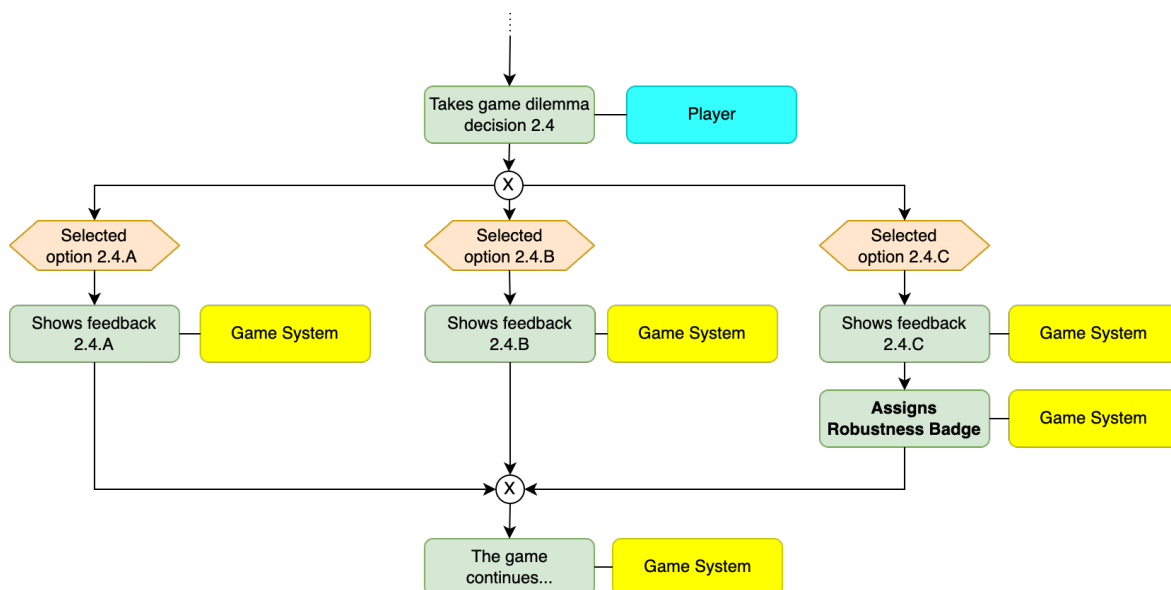
Resurbis is a narrative adventure with a finite teleology: the player is called to live an immersive experience during which he or she is required to make complex decisions that require taking into account ethical, cultural, strategic, and entrepreneurial aspects. In Resurbis the player is thrown into a paradoxical and metaphysical reality: the game's protagonist is a man who, on the day of his death, makes acquaintance with Urgency, a spirit of the time (zeitgeist). Urgency guides the player to retrace some milestones of his life as a

human, entrepreneur and citizen. At several moments the player will be called upon to make choices thinking that he or she is playing the role of an urban actor, only to discover that in exploring the infinite possibilities of existence, the game has already changed its point of view. The player will gradually discover that he or she is now an entrepreneur, then a fisherman, or even a dolphin: the constant changes in perspective allow the player to experience the consequences of his or her actions, in a journey of empowerment and awareness. The game narrative closes in a moment of high symbolic and lyrical value during which the player discovers how the various space-time strands explored in the game combine to tell the protagonist's story.

#### 4.2 Narratives, EEPC, and gamified consultive tools

The development of the various space-time strands required considerable effort for the narratives to be consistent. As anticipated, from this point of view, the use of EEPC supported the structured representation of the narratives. An excerpt from the game's technical documentation is shown in Fig. 3. The team used the EEPC to structure moments of player-game interaction to keep track of the progress of narrative threads and the effects that decisions have on obtaining in-game reward elements (badges).

Fig 3 – Excerpt from the EEPC representation of the game script.



Source: Authors' production.

The use of badges and collectible elements represents one of the main gamification mechanics used to ensure player engagement. Specifically, in Resurbis the player has access to two game elements that keep track of the player's progress. The first, in the game called Anhanger (German for talisman) takes the form of an element to be completed through the collection of badges. Each collectible badge refers to one of the resilience features identified in (ARUP, 2014). The badges are unlocked when the player makes, within the game, certain

virtuous choices. The second element, called the Omnium (Latin for of all things) is a tool for discovery, aid, and collection of knowledge scattered throughout the game. In particular, the Omnium serves as the game's glossary, and within it the player finds terms and concepts related to entrepreneurship and urban resilience already encountered throughout the adventure. The use of narratives and process modeling enabled game-related challenges to be solved as shown, schematically, in Fig. 4.

**Fig. 4 – Challenges and solutions inherent Resurbis’ game design.**

<b>Challenge Source</b>	<b>Challenge</b>	<b>Solution</b>	<b>Meta Solution</b>
<b>Team heterogeneity</b>	Provide suitable communication support	Adoption of EEPC for storylines representation and communication	<b>Process Modeling</b>
	Provide suitable narrative design support		
<b>Themes heterogeneity</b>	Taking different stakeholders perspectives	Adopting depersonalizing narratives	<b>Narratives</b>
	Gather knowledge inherent in different disciplines	Setting narratives in changing space-time strands	
		Developing narratives coherent with consultive game elements	
	Keeping players engaged	Integrating gamification dynamics in narratives	
		Develop lyrical and real-case based narratives	

Source: Authors’ production

## 5. Conclusions

The game design experience that led to the creation of the Resurbis game was an opportunity to experiment with the adoption of process modeling as a tool for game design and communication in heterogeneous teams. The use of narratives for the development of serious games, aided by the use of such a language, proved, at least conceptually, to be useful to address the challenges posed by the achievement of training objectives. In particular, certain narrative solutions, such as changes in perspective and space-time jumps, have proven conceptually useful in fostering an understanding of the systemic consequences of business activity and decisions made within a city. However, the aspects presented so far are to be considered entirely preliminary: while the contents of Resurbis have been validated by the experts involved in the game design process, a pilot game session has been planned but not conducted so far. Such a session will help prove or disprove the goodness of the solutions adopted.

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## Conflicts of interest

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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## Chapter 7

### An experience of serious game as sustainable energy education

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#### Abstract

This paper describes a serious game suite focused on sustainability, renewable energy sources, and fuel technologies, and developed in the framework of Horizon Europe Project – RES<sub>4</sub>CiITY. The serious game suite has been designed in order to be used both in educational and corporate contexts, promoting sustainability and providing innovative and engaging tools to develop and boost technical and soft skills of students, professionals and employees. Serious games include all the fundamental topics of the RES<sub>4</sub>CITY project (renewable energy systems, fuel technologies, green transition, circularity, etc.), and are useful to simulate specific scenarios and to allow users to play in a realistic simulated environment where they have to make decisions and take specific actions: the main objectives are assessing learners' skills and competence to suggest possible upskilling training programs, while also promoting the sustainable transition.

**Keywords:** serious game; business simulation; sustainability; gamification

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## **1. Introduction**

Serious games belong to the big family of Gamification tools (Navarro-Espinosa et al., 2022). They have immersive narratives, scenarios, or simulations that help learners acquire specific knowledge, skills, or attitudes. For the previous reasons, serious games are used extensively in both the educational and corporate sectors due to their effectiveness in engaging learners, promoting skills development, and achieving different educational and training goals. From an educational point of view, the application of serious games achieves the following benefits (Welbers et al., 2019):

- Unconventional and innovative educational activities: by combining elements of play, interactivity, and educational content, serious games offer an unconventional and innovative approach to education that can captivate students' interest and enhance their learning experiences.
- Learning by doing and learning by playing: serious games promote "learning by doing" and "learning by playing" approaches, which are highly effective educational methods that emphasize active engagement and practical experience.
- The learning experience is more effective and involving than traditional teaching alone: when used in educational settings, serious games offer a unique and engaging approach to learning, that maybe integrated with traditional methods.
- To face the changing scenarios and develop flexibility: serious games simulate realistic scenarios, including dynamic and changing environments. By engaging with these scenarios, individuals can develop adaptability and learn to respond effectively to new and unexpected situations.
- To learn different and complex concepts in an easy and involving way: serious games create a dynamic and effective learning environment that simplifies complex concepts and promotes a deep understanding of the subject matter. This approach is particularly valuable in educational contexts where complex topics need to be conveyed in an engaging and accessible manner.
- To stimulate, boost and develop technical and soft skills: these games offer an engaging learning environment that encourages the acquisition and refinement of a wide range of skills.

Serious games can cover a wide range of technical subjects, exposing learners to different areas of expertise and encouraging interdisciplinary learning (Saleem, Noori and Ozdamli, 2022). At the same time, they can stimulate problem solving and decision-making skills and many more. On the other hand, from a corporate point of view, the application of serious games achieves the following benefits:

- Unconventional and innovative corporate activities: incorporating serious games into corporate activities can create a more interactive, creative, and engaging training and recruitment process. It benefits both employers and candidates by improving skills development and assessment and promoting a positive employer brand.
- To assess the technical and soft skills of the candidates: serious games can be used for performance assessments, allowing organizations to evaluate candidates' skills, knowledge, and competencies in a gamified environment.
- To stimulate, boost and develop the technical and soft skills of the employees: by incorporating serious games into corporate activities, organizations can make learning and development more engaging, foster innovation and creativity, and address specific organizational needs while providing employees with an enjoyable experience.
- Team working and team building: serious games encourage teamwork and collaboration, fostering interpersonal skills and the ability to work effectively in groups.
- To make the talent acquisition process more engaging and increase the candidate experience: companies who incorporate serious games into the hiring process can enhance the employer brand, attracting top talent who value creativity and forward-thinking.

This paper presents all the features, technologies methodologies and objectives of a suite of serious games developed in the framework of Horizon Europe Project – RES4CITY. By focusing on sustainability, renewable energy systems, advanced fuel technologies, the green transition, and the principles of circularity, the suite offers innovative tools designed to enhance and develop both the technical and soft skills of students, professionals, and employees.

## **2. Serious game suite for RES4CITY project**

In the framework of Horizon Europe Project – RES4CITY, a serious game suite has been designed in order to be used both in educational and corporate contexts, embracing all the central topics of the RES4CITY project, from the renewable energy systems to the circularity (De Rosa et al., 2024): the main objective is to promote the attitude towards sustainability in all its dimensions. Three specific tools compose the suite: Warm Up Game, Business Simulation Game and Role Play Game.

### **2.1 Warm Up Game**

Warm Up Game (WUG)<sup>1</sup> is a single-player tool that trains users on specific topics. The game is composed of four different training modules: Design and Analysis, Social Science, Energy

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<sup>1</sup> <https://webinbasket.res4city.eu/warmupgame>

Economics, and Energy Policy. The WUG platform, as a simulation-based learning tool, offers several key benefits for users (Table 1).

**Table 1 – Key benefits for users**

<b>Benefits</b>	<b>Description</b>
Increased engagement	The platform fosters active engagement and encourages the user to be more involved in the learning process. This engagement leads to better retention and understanding of the material
Problem solving	Users are presented with complex problems and case studies. This challenges them to analyze, think critically, and come up with solutions. Problem-solving is a valuable skill that is honed through this process.
Skills development	Users can learn the key concepts per each module of the game, developing and boosting their technical skills.
Feedback and reflection	The inclusion of a final report in the simulation serves as a tool for feedback and reflection. Users can assess their performance, identify areas for improvement, and make adjustments. This feedback loop supports continuous learning and self - improvement.
Versatile and convenient web platform	The web-based platform offers accessibility and convenience. Users can access and participate in the simulations from various devices with internet connectivity. This flexibility makes learning more accessible and user-friendly.
Motivation	Users are more likely to be engaged and enthusiastic about the learning process, which can lead to better outcomes and a deeper understanding of the material.

Source: Own elaboration

Overall, the WUG platform provides an effective and engaging educational tool that promotes active learning, skills development, and critical thinking. It is a valuable resource for educators and learners looking to enhance the quality of education and training.

The Warm Up Game platform is accessible through web browsers, making it highly convenient for users and eliminating the need for proprietary software installation. The platform is designed with a multi-layer structure, consisting of the presentation layer, business layer, and persistence layer. This separation of functions into layers allows for independent development and updates, promoting scalability and maintainability.

The user interface is designed for participants and is accessible through modern web browsers (e.g., Google Chrome, Mozilla Firefox). The simulation platform provides a digital environment where users can engage in educational simulations assessed.

Each module is a stand-alone module composed of a set of exercises. A report is generated at the end of each module, indicating the final score, skills mapping and suggestions.

## **2.2 Business Simulation Game**

Business Simulation Game (BSG) is an innovative and engaging educational and training tool that allows users to replicate the dynamics and logics of a specific business scenario. Users, individually (single player version) or in team (multiplayer version), face a competitive

situation in order to stimulate the application of their problem-solving, creativity, strategic analysis and decision-making skills. The task is to lead a virtual firm analysing data and making strategic decisions within the game, which have consequences on the outcome.

Business Simulation Gaming activity is composed of simulation steps: at the end of each step, it is possible to analyse the achieved results.

BSG has been developed using Artémat's proprietary web-based platform with client-server architecture Business Game Studio (BGS). The Business Game Studio platform (BGS) was developed and implemented by Artémat using Java technology. BGS uses a specific formal language, BGLa – Business Game Language, developed by Artématto design and implement the economic models (virtual scenario).

In particular, the new business simulation game scenario is called "RES<sub>4</sub>CITY Business Simulation Game" (RES<sub>4</sub>CITY BSG). RES<sub>4</sub>CITY BSG has been designed and developed with a specific focus on the food sector, and in particular the pasta industry. This sector is evolving towards prioritizing quality over quantity, emphasizing sustainability, environmental aspects and quality aspects of food, and leveraging innovation to meet market demands while maintaining affordability. The user faces a competitive situation in order to stimulate, develop and boost their technical and soft skills.

The user plays the role of Sustainability Advisor, checking and evaluating "Pasta" industry and four company profiles. The industry and each company profile are characterized by a specific and detailed "fact-sheet"

- Industry fact sheet: user can check an overview, a section on sustainability and the main trend for the next virtual years. In particular, the overall demand (per each round), the "Energy price" and the customer sensitivity are indicated. The potential trend of the customer sensitivity is showed over three virtual years.
- Firm fact sheet: users can review an overall description of the company, the analytics and key performance indicators of the previous virtual year. Energy consumption and carbon footprint are indicated. Each firm is seeking a Sustainability Advisor to start a growth plan for the next two years.

RES<sub>4</sub>CITY BSG is composed of three rounds, each round simulates one year of operability of the firm on the market:

- First round: the user must analyse and evaluate the industry, and the fact sheets of a number of firms – and then select one in order to lead that firm in the second and third rounds.
- Second and third rounds: users must lead the selected firm competing against 4 virtual players in the same industry. The task is the complete management of the business with the aim to maximise the Market Value in the subsequent 2 virtual years (2 rounds of simulation –

each round is a year). The strategic choices are grouped into Human Resources, Marketing, and Innovation and Sustainability.

### **2.3 Role Play game**

The Role Play Game is a single player tool that simulates a specific and realistic scenario where the user is called upon to make decisions, organize work, assign priorities, delegate, manage information and solve critical issues. Users play the role of the main character in the simulation: this role-play element enhances the immersive experience and encourages users to make decisions and take actions based on limited information within predetermined timeframes.

The Role Play simulation is a powerful and immersive approach for skill assessment and development: it requires active engagement from users, encouraging them to apply and test both hard and soft skills.

The Role Play Game simulation scenario, called "The Fabian Energy Community Game"<sup>2</sup> has been developed using Artémat's proprietary web-based platform "Web InBasket", designed and built with a mobile-responsive layout for diversified accessibility (smartphones, tablets, and desktops). The user plays the role of energy manager of a fictional sustainable energy community. The task is to reduce energy consumption and adopt renewable energy sources, developing and implementing a comprehensive energy plan.

The goal is to engage users with different backgrounds in adopting more sustainable energy behaviors. The model is structured with a scoring system that rewards the completion of activities related to renewable energy, such as the installation of solar panels, energy efficiency, and consequently, consumption reduction, taking into consideration the economic impact.

### **3. Skills assessment**

The serious game suite is meticulously crafted to replicate real-world challenges in energy sustainability, offering an effective means to assess and enhance essential skills. Each serious game immerses users in environments that mirror the complexities and dynamics of the energy sector. This is especially crucial in the realm of sustainability, where professionals must navigate multifaceted issues involving renewable energy sources, efficient fuel technologies, and green infrastructure. Traditional skill assessment methods, such as exams and interviews, often fail to capture the full scope of these challenges. In contrast, serious games engage participants with realistic simulations that require them to apply their knowledge, make strategic decisions, and adapt to evolving situations.

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<sup>2</sup> <https://webinbasket.res4city.eu/index.html>

In the context of energy sustainability, theoretical knowledge is important, but true competence is demonstrated through practical application. Serious games provide a safe and controlled setting where users can experiment with different approaches to solving energy problems without the risk of real-world consequences.

Additionally, serious games excel at assessing soft skills, which are increasingly recognized as vital in the sustainability sector. By observing how individuals perform in these scenarios, educators and employers can gain valuable insights into their soft skills, which are often challenging to measure through traditional assessments.

Fig. 1 – Skills mapping – Report



Source: Own elaboration

The data generated by serious games adds another layer of depth to skill assessment. These games can track a variety of metrics, such as decision-making processes, response times, and success rates. This detailed data allows for a comprehensive analysis of a participant's performance, highlighting strengths and identifying areas for improvement. For example, in a game focused on optimizing energy efficiency in a building, the data might reveal how effectively a player can implement energy-saving measures and their ability to adjust strategies based on feedback. This level of analysis is invaluable for both participants, who receive personalized feedback, and educators or employers, who can tailor their training programs to address specific needs.

**Table 2 – Serious Games – Skills Assessment.**

<b>Serious Game</b>	<b>Skills</b>
Warm Up Game	Problem Solving, Specific Knowledge on Design and Analysis, Social Science, Energy Economics, and Energy Policy
Business Simulation Game (Single and Multiplayer version)	Analysis and Decision Making, Critical Thinking and Problem Solving, Flexibility and Adaptability, Knowledge in the field of renewable energy and sustainability, Marketing and Strategy, Economy and Finance, Sustainability, Collaboration and Communication, Team Working and Team Building.
Role Play Game	Communication, Results Orientation, Cooperation and Synergies, Knowledge in the field of renewable energy and sustainability, Energy Analysis.

Source: own elaboration

## **4. Conclusions**

This paper has outlined the development and application of a serious game suite focused on sustainability, renewable energy sources, and fuel technologies, developed within the Horizon Europe Project – RES4CITY.

Serious games provide numerous benefits in educational and corporate contexts by offering unconventional and innovative educational and training activities: they help learners develop flexibility and adaptability, understand complex concepts easily, and enhance both technical and soft skills. The main objectives are to assess learners' skills and competencies to suggest possible upskilling training programs and to promote the sustainable transition.

Warm Up Game, Business Simulation Game, and Role Play Game collectively aim to instill a sustainability mindset across various dimensions and contexts, making them valuable resources for both educational institutions and corporate organizations committed to advancing sustainability and innovative skill development.

In conclusion, the RES4CITY serious game suite represents a significant step forward in utilizing gamification to foster sustainability education and corporate training, proving to be an effective means of developing essential skills while promoting a sustainable future.

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## Chapter 8

### Unveiling Training and Skill Requirements for Driving the Adoption of Emerging Technologies in the Renewable Energy Sources field, RE-SKILLS workshop

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#### Abstract

The RE-SKILLS workshop, organized by LOMARTOV as part of the [SolDAC project](#), addressed the growing need for skilled professionals in the renewable energy sector. Bringing together industry experts, academics, and professionals, the workshop aimed to identify essential skills for integrating cutting-edge technologies.

The event featured presentations on advanced technological proposals and included interactive sessions for mapping necessary skills. It emphasized the interdisciplinary nature of modern energy projects, requiring expertise in engineering, digital science, sustainability, and business management.

Key skills identified encompassed materials and processes modeling, thermodynamics, engineering design, novel materials synthesis, and the integration of dynamic solar energy systems. Additionally, digital skills such as data analytics, machine learning, AI, digital twins, and robotics were highlighted, along with business skills in regulatory compliance, policy development, and project management.

The workshop stressed the importance of updating and expanding educational programs to include these skills, promoting continuous learning and collaboration among academia, industry, and policymakers. This approach aims to support the rapid growth and technological advancements in the renewable energy sector, ensuring a skilled workforce capable of driving the industry's future.

**Keywords:** Renewable energy skills, Technological integration, Interdisciplinary education, Capacity building, SolDAC project.

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## **1. Introduction**

The "Unveiling Training and Skill Requirements for Driving the Adoption of Emerging Technologies in the Renewable Energy Sources field" (RE-SKILLS workshop) was part of the [SoldAC project](#), emphasizing social sustainability, responsible research, and technology acceptance. Held during the International Conference on Sustainable Energy Education (SEED) in Valencia from July 3-5, 2024, and hosted by the Polytechnical University Valencia, the event was led by LOMARTOV. The workshop addressed the growing need for skilled professionals in renewable energy by uniting industry experts, academics, and professionals to identify essential skills for integrating new technologies. It showcased groundbreaking proposals and trends, emphasizing the interdisciplinary nature of modern energy projects requiring expertise in engineering, digital science, sustainability, and business management. Key findings highlighted the importance of skills in materials and processes modeling, thermodynamics, engineering design, novel materials synthesis, dynamic solar energy systems integration, chemical and electrochemical engineering, and sustainability assessments, along with digital skills like data analytics, machine learning, AI, digital twins, and robotics, and business skills in regulatory compliance, policy development, and project management. The workshop underscored the need for strategic investment in training and reskilling programs to keep pace with the sector's rapid growth. Updating educational programs and fostering industry-academic collaborations are crucial to align education with industry needs. Policymakers play a vital role in securing funding, removing market adoption barriers, and developing training programs for new sectors. Continuous learning and collaboration are essential for integrating new technologies into educational programs and ensuring a skilled workforce for the sector's future.

## **2. Workshop concept, objectives and audience**

The workshop aimed to meet the growing need for skilled professionals in renewable energy. Integrating SoldAC's Work Package (WP)6 on sustainability and WP7 on capacity building, the workshop brought together industry experts, academics, and professionals to identify key skills for implementing advanced technologies. It showcased groundbreaking proposals and supported the integration of emerging renewable energy solutions into education. Interactive sessions emphasized the need for interdisciplinary expertise in engineering, digital science, sustainability, and business management, and explored ways to incorporate these skills into educational curricula to align with the sector's evolving demands.

### **Objectives:**

- Determine essential skills and capabilities for successful adoption of renewable energy technologies.

- Promote interdisciplinary collaboration among industry, academia, and policymakers.
- Create pathways for integrating identified skills into educational programs to align with sector needs.

#### **Audience:**

The workshop engaged 25 diverse participants, including industry professionals, academic researchers, and students from various institutions. It aimed to foster collaboration between industry and academia, address emerging technology challenges, and further involve policymakers in implementing recommendations to accelerate progress.

### **3. Workshop methodology and Agenda**

The workshop, with a duration of approximately 3 hours, was structured in two sessions:

- **Session 1: Showcase of renewable energy breakthrough innovations.** The main EU projects advancing their developments and connecting them with the skills set needed were:
  - **Renewable energy for direct air carbon capture and utilisation – SOLDAC project demo case** - Carbon-neutral ethylene and ethanol production using solar energy.
  - **A micro-credential upskilling framework for life-long learning in the urban renewable energy sector, RES4CITY** - Upskilling for green transition through a micro-credential framework.
  - **Renewable fuels - ALL- in – Zero case-** Renewable fuels technology for multisectoral decarbonization.
  - **Novel high efficiency Perovskite technology – HEPAFLEX project demo case** – High-efficiency perovskite photovoltaic technology.
  - **Green ammonia production using renewable energy – DARE2X project demo case,** - Green ammonia production using renewable energy and advanced catalytic technology.

These insights were completed by two presentations from industry representatives, stating the needs and challenges in ensuring sustainability and implementing the renewable energy solutions:

- **Implementing sustainability strategies: Challenges in adopting sustainability and renewable energies in Istobal Group.**
- **Innovation for the energy transition at the Port of Valencia.**

- **Session 2: Bridging the Gap - Identifying Training/Skills Needs and Setting Best Practices to boost technology adoption.**

Participants collaboratively identified and ranked training needs for each innovation and discussed strategies for integrating these into educational curricula. They assessed the feasibility of best practices and defined roles for academia, policymakers, and industry. Emphasis was placed on leveraging EU-funded projects to align emerging technologies with educational programs for rapid skill development.

#### **4. Workshop results**

Session 1 highlighted that the diverse technological solutions in the renewable energy sector require new skillsets for market adoption. Key skills identified include materials and processes modeling, thermodynamics, engineering design, synthesis and characterization of microporous solids like zeolites and MOFs, integration of dynamic systems in solar energy, chemical and electrochemical engineering, sustainability assessments, intellectual property management, process optimization, and commercialization strategies.

Session 2 emphasized the urgency of updating academic and lifelong learning programs to ensure the workforce remains current. The preliminary analysis revealed:

- The renewable energy sector employed 1.5 million people in 2021, growing 12% from 2020 (EurObserv'ER, 2023).
- Clean energy manufacturing jobs grew 12% between 2015-2020, compared to 4% for overall manufacturing jobs (Eurostat, 2023).
- 500,000 skilled employees are needed for heat pump rollout (European Heat Pump Association, 2023).
- The battery sector requires 800,000 trained or reskilled workers by 2025 (European Battery Alliance, 2022).
- The solar workforce grew 39% in 2022, with over 1 million workers needed by 2025 (Solar Power Europe, 2023).
- 574,000 technicians will be required in the wind energy sector by 2027 (Global Wind Organisation, 2023).
- The hydrogen value chain is expected to create 1 million jobs by 2030 (Fuel Cells and Hydrogen 2 Joint Undertaking, 2019).

Two main risks identified were:

- Skills obsolescence: 22% of plant operators, 20% of electrical trade workers, and 20% of science and engineering technicians risk obsolescence without continuous learning (Centeno et al., 2022).

- Gender disparity: In 2019, only 13% of inventors in Europe were female, compared to higher shares in China and South Korea (EPO, 2022).

A survey from the SOLDAC project on CCUS technologies and targeting students and early-stage researchers identified that:

- 64% viewed accelerating renewable energy adoption as crucial for combating climate change.
- 50% had basic knowledge of CCUS, with 57.1% encountering CO<sub>2</sub> capture in curricula.
- 85.7% believed CCUS should be further integrated into engineering education.
- 53.6% considered careers or research in CCUS technologies.

This underscores the need for improved education to equip future engineers and researchers to address climate change effectively. **Table 1** is showing the mapping exercise done previously as a common starting point in the prioritisation process with the participants. Further, the participants were invited to comment on the skills list and to vote on the priority skills at the moment in the renewable energy sector.

**Table 1 – Skillset identified for each major renewable energy area**

Research and innovation skills	Technical skills	Engineering skills	Data analysis and digital skills	Business and Management skills	Environmental and Social skills
<ul style="list-style-type: none"> <li>• Material science</li> <li>• Efficiency improvement</li> <li>• Innovation of existing technologies</li> <li>• Cell manufacturing</li> <li>• New and emerging battery materials &amp; technologies</li> <li>• Battery testing</li> </ul>	<ul style="list-style-type: none"> <li>• Solar PV System Design and Installation</li> <li>• Wind Turbine Technology</li> <li>• Battery Storage Systems</li> <li>• Hydrogen Production and Storage</li> <li>• Smart Grid Technology</li> <li>• Energy Modeling and Simulation</li> <li>• Engineering and cell design</li> <li>• Battery quality control &amp; testing</li> <li>• Recycling and decommissioning processes</li> </ul>	<ul style="list-style-type: none"> <li>• Electrical Engineering</li> <li>• Mechanical Engineering</li> <li>• Civil Engineering</li> <li>• Systems Engineering</li> <li>• Manufacturing technicians</li> <li>• Installation and maintenance technicians</li> </ul>	<ul style="list-style-type: none"> <li>• Data Analytics</li> <li>• Machine Learning and AI</li> <li>• Cybersecurity</li> <li>• IoT</li> <li>• Digital Twins</li> <li>• Robot co-working</li> </ul>	<ul style="list-style-type: none"> <li>• Project management of renewable energy projects</li> <li>• Regulatory compliance</li> <li>• Financial Analysis and Investment</li> <li>• Legislation permits</li> <li>• Policy development</li> <li>• Lobby and advocacy</li> <li>• Market analysis</li> <li>• Business development</li> </ul>	<ul style="list-style-type: none"> <li>• Sustainability Assessment</li> <li>• Community Engagement and Stakeholder Management</li> <li>• Raw materials extraction and processing</li> <li>• Social impact</li> </ul>

Source: LOMARTOV (2024)

Key research and innovation skills identified include material science, emerging battery materials and technologies, and efficiency improvement. Educational programs need enhancement, especially in these areas. Critical technical skills include solar photovoltaic systems, smart grid technology, and recycling and decommissioning processes, with significant gaps noted in hydrogen production and storage. Electrical and mechanical

engineering skills, and technician training for manufacturing, installation, and maintenance, require significant improvement and promotion.

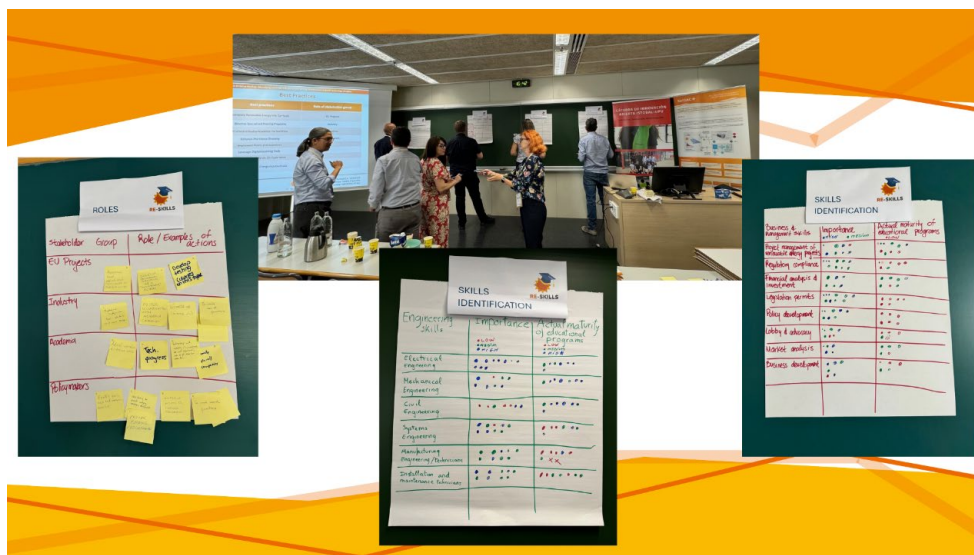
Digital and data analysis skills, such as data analytics, machine learning, and AI, are crucial for new training programs. Enhanced understanding of digital twins and robot collaboration in renewables is needed. Business skills like regulatory compliance, policy development, and project management are essential, requiring strong educational support and partnerships.

Sustainability assessment expertise is vital for meeting environmental and circularity goals, alongside community engagement and stakeholder management for new solutions. Safety and insurance training for new technologies is also critical. Improved training is needed for raw material extraction and processing, sustainability assessment, and community impact engagement.

Proposed best practices (Fig. 1), mostly feasible to replicate, include:

- Integrating renewable energy into curricula, especially postgraduate programs.
- Developing specialized training for all worker levels.
- Promoting industry-academic partnerships by reducing administrative barriers and increasing student remuneration.
- Ensuring financial resources for field training and hands-on experience.

**Fig. 1 – Voting process and discussion during the interactive session**



Source: RE-SKILLS workshop (2024)

EU-funded projects aim to advance research and innovation, but workforce and industry readiness is essential for market success. Participants suggested mandatory educational resource development in these projects, establishing industry testing courses early, and formulating educational requirements during technology development.

Continuous industry-academia collaboration is crucial, with industry supporting research questions and financially backing research interests. Experienced employers can mentor newcomers and aid in scaling new solutions. Aligning education with future needs through closer industry relationships is essential, emphasizing technological advancements and practical applications, facilitated by spin-off companies.

Policymakers, though not present at the workshop, are vital for funding emerging technologies, removing market adoption barriers, and pioneering training programs in new sectors.

## **5. Conclusions and Recommendations**

Advancing the renewable energy sector requires substantial upgrades in research, innovation, and technical skills. Key areas include material science, emerging battery technologies, efficiency improvements, solar photovoltaic systems, smart grid technology, and recycling and decommissioning processes, with a focus on hydrogen production and storage. Enhancing digital skills like data analytics, machine learning, AI, digital twins, and robotics is crucial, along with business skills such as regulatory compliance, policy development, and project management. Sustainability assessment, community engagement, and safety expertise are also essential. Best practices suggest integrating renewable energy topics into curricula, developing specialized training programs, and fostering industry-academic partnerships.

Interdisciplinary skills are increasingly necessary, combining technical, digital, business, and sustainability knowledge. Recommendations based on participant contributions include:

1. Expand educational curricula to cover material science, emerging battery technologies, and efficiency improvements. Introduce specialized training for all expertise levels.
2. Require EU-funded projects to develop educational resources. Establish testing courses for industry representatives and define clear educational requirements during new technology development.
3. Reduce administrative barriers and increase financial support for students. Promote field training and hands-on experience with adequate funding.
4. Incorporate data analytics, machine learning, AI, and the use of digital twins and robotics into educational programs.
5. Emphasize regulatory compliance, policy development, and project management in educational programs.
6. Enhance training in sustainability assessment, raw material extraction, and community impact to meet environmental and circularity goals and gain community acceptance.

7. Engage policymakers to secure funding, remove market adoption barriers, and develop training programs for new sectors. Their involvement is crucial for integrating innovative solutions.

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## **Conflicts of interest**

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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## Chapter 9

### Harmonising Through Education: T-Shore's Approach to Wind Turbine Technician Training

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#### Abstract

The "Harmonising Through Education: T-Shore's Approach to Wind Turbine Technician Training" workshop, held at the SEED Conference, focused on the innovative efforts of the T-Shore project to standardise wind turbine technician training across Europe. This session introduced the project's mission and showcased the initial set of four comprehensive learning scenarios aimed at equipping technicians with essential skills for the sustainable energy sector. Through practical activities and group discussions, participants engaged deeply with the material, providing valuable feedback on the scenarios' adaptability and effectiveness.

Feedback from the workshop was overwhelmingly positive, with participants rating the overall workshop at 4.13 out of 5 and the T-Shore project at 4.63 out of 5. All attendees reported that the workshop met their expectations and provided ideas applicable to their educational contexts. The majority saw the need for harmonisation in their fields, particularly within various energy transition sectors.

Key takeaways from the session included the importance of a critical approach to harmonisation, recognising the value of diverse educational practices across different countries, and the need for developing both technical and soft skills. The feedback and insights gathered will be instrumental in refining the T-Shore project's curriculum, ensuring it meets the diverse needs of the wind energy industry while fostering a well-rounded, skilled workforce ready to support Europe's sustainable energy future.

**Keywords:** Offshore Wind Technician Training, Educational Harmonisation in Offshore Wind, Standardised Offshore Wind Curriculum, Cross-Border Training for Offshore Wind, Vocational Education in Offshore Wind, Harmonised Learning Scenarios for Offshore Wind

Workshop Videos: <https://www.youtube.com/watch?v=3jcMIJgyEWo>



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## 1. Introduction

The "Harmonising Through Education: T-Shore's Approach to Wind Turbine Technician Training" workshop, held during the SEED Conference, showcased the efforts of the T-Shore project aimed at harmonising the training of offshore wind turbine technicians across Europe. This document outlines the workshop's structure, key findings, and participant feedback, providing a comprehensive overview of the project's initial steps towards harmonising education in the offshore wind industry.

## 2. Workshop Overview

The T-Shore project is dedicated to harmonising wind turbine technician training by developing a standardised yet adaptable curriculum. The workshop presented the first set of four learning scenarios, each designed to address essential skills required for the wind energy sector. These scenarios are part of a broader Entry Level Offshore Wind Technician Training Programme. D

### Workshop Agenda:

- **Introduction** Overview of the T-Shore project and the importance of harmonising training across Europe.
- **Presentation of Learning Scenarios** Detailed walkthrough of four modules integrating technical skills, soft skills, digital literacy, and leadership.
- **Breakout into Working Groups** Practical activities and discussions on specific learning scenarios.
- **Group Feedback Session** Sharing insights and feedback on the adaptability of the learning scenarios.
- **Closing Remarks** Summary of insights and next steps for the T-Shore project.

### Learning Scenarios Presented:

1. **Mechanical Gearbox and Bearings:** Focus on inspection and maintenance.
2. **Inspection of Hydraulic Brakes:** Evaluation of rotor brake pad thickness and detection of hydraulic leaks.
3. **Yaw Motors Fault Diagnosis:** Diagnosing and rectifying common faults.
4. **Rotor Speed Sensor Replacement:** Hands-on experience in replacing rotor speed sensors.

5. Posters





### Gearbox and Bearing Maintenance

**Competencies Covered:** Mechanical, HSE, Communication

**Learning Outcomes:** Gearbox technology and maintenance, troubleshooting, inspections, risk assessments

The gearbox plays a vital role in the operation of the turbine, and any issues with it can lead to significant downtime and costs. Our goal is to equip students with the necessary skills and knowledge to maintain and inspect gearboxes effectively.

**The Problem**

The gearbox is a critical component in wind turbines, and any breakdown can lead to significant financial and operational consequences. Regular service and maintenance by skilled experts are essential to prevent such issues.



**Scenarios**

**Deep Knowledge Scenario:**

- Risk assessment and HSE planning.
- Visual and video inspections.
- Familiarisation with gearbox components.
- Reassembly and documentation.

**Inspection & Maintenance Scenario:**

- Exterior and interior gearbox inspections.
- Sensor and lubrication system checks.
- Comprehensive reporting.

**Evaluation:**

Periodic evaluations and final assessments with feedback.



**Learning Methods Used**

**Theoretical Training:**

- E-learning content for foundational knowledge.
- Classroom discussions on advanced topics.
- Written assignments on teamwork, communication, and HSE aspects.

**Practical Skill Training:**

- Hands-on training to apply theoretical knowledge.
- Scenario training for real gearbox inspections, simulating operational conditions of a turbine.




**Equipment Needed**

- Personal Protective Equipment (PPE)
- Hoisting equipment and slings
- Borescope for video inspections
- Gearbox with sensors and lubrication system
- Inspection hatch and associated tools



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### Hydraulic Systems in Wind Turbines


**Competencies Covered:** Hydraulic Systems

**Learning Outcomes:** Basic hydraulic principles, maintenance and repair, safety protocols

In this module, we focus on hydraulic brakes, which are crucial for controlling rotor speed, ensuring safe stops during emergencies, and providing stability during maintenance and inspections. Our goal is to equip students with the skills and knowledge needed to maintain and inspect hydraulic brakes effectively.

**The Problem**

Hydraulic brakes in wind turbines are essential for controlling rotor speed, ensuring safe stops during emergencies, and providing stability during maintenance and inspections. Proper maintenance and inspection are crucial to prevent system failures and ensure the safety and reliability of the turbines.



**Scenarios**

**Hydraulic Brake Inspection Scenario:**

- Visual inspection of the brake system.
- Measurement of brake pad thickness.
- Detection and repair of hydraulic leaks.
- Practice bleeding procedure to remove air from the hydraulic system.

**Pitch Hub Hydraulic System Scenario:**

- Inspection of oil tank level and quality.
- Checking for possible leaks.
- Analysing hydraulic pressure and system response.
- Performing hand pump tests to ensure system functionality.

**Learning Methods Used**

**Theoretical Training:**

- Classroom lessons on general hydraulic principles.
- E-learning modules for independent study and deeper theoretical understanding.
- Flipped classroom method to promote active learning and accommodate different learning styles.


**Practical Skill Training:**

- Simulations using FluidSim software for designing and testing hydraulic circuits.
- Hands-on hydraulic exercises with equipment from Festo and Bosch Rexroth.
- Real-life scenario simulations at Festo Nacelle and Festo hydraulic pitch hub.
- Practical exercises emphasizing cooperation, communication, and HSE guidelines.

**Equipment Needed**

- FluidSim software for hydraulic simulations
- Hydraulic practice setups from Festo and Bosch Rexroth
- Multimeters and multifunction meters
- Hydraulic fluid inspection tools
- Personal Protective Equipment (PPE)

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### Yaw Motor Systems

**Competencies Covered:** Electrical, Safety, Communication

**Learning Outcomes:** Inspection and testing of yaw motor brake, use of multimeter, HSE procedures, teamwork, communication, task reporting.

Yaw motors, which are essential for rotating the nacelle of a wind turbine to face the wind. Typically, 4 to 8 yaw motors work together, and any malfunction can halt turbine operation. Our goal is to equip students with the skills and knowledge needed to inspect, test, and maintain yaw motors effectively.

**The Problem**

The yaw motors in wind turbines are crucial for rotating the nacelle to face the wind. Typically, 4 to 8 yaw motors are used, and they must function together seamlessly. Any malfunction can halt turbine operation, requiring wind technicians to diagnose and fix the issue promptly to minimize downtime and operational losses.



**Scenarios**

**Fault Diagnosis Scenario:**

- Check SCADA system for fault details.
- Inspect fuses and perform lock-out procedures.
- Test magnetic brakes and motor windings.
- Replace dysfunctional yaw motors if necessary.
- Confirm fault resolution through SCADA and update reports.

**Learning Methods Used**

**Theoretical Training:**

- E-learning modules for foundational knowledge.
- Flipped classroom method to encourage active learning.
- Classroom discussions, group work, and self-directed study.
- PowerPoint presentations and demonstrations for complex elements.

**Practical Skill Training:**

- Hands-on tests and inspections of yaw motors and system components.
- Use of 3-phase motors, multimeters, and multifunction meters.
- Practical skills training in workshops or electrical/mechanical laboratories.

**Equipment Needed**

- 3-phase motors (with and without built-in faults)
- Multimeters with diode testing function
- Multifunction meters (Megger or Fluke)
- SCADA system access
- Personal Protective Equipment (PPE)



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### Sensor Technology in Wind Turbines

**Competencies Covered:** Sensor Technology

**Learning Outcomes:** Purpose and use of sensors, diagnosing malfunctions, drafting service orders and reports

Rotor speed sensors, which are crucial for monitoring and reporting the operational status of wind turbines. Malfunctioning sensors can lead to unscheduled maintenance and operational disruptions. Our goal is to equip students with the skills and knowledge needed to diagnose, repair, and replace these sensors effectively.

**The Problem**

Sensors in wind turbines play a crucial role in monitoring and reporting the operational status of various components. A malfunctioning sensor can lead to unscheduled maintenance and operational disruptions. Understanding sensor technology and effectively diagnosing and repairing sensor faults are vital for maintaining turbine efficiency and reliability.

**Scenarios**

**Sensor Fault Diagnosis Scenario:**

- Check errors reported by the sensor using the Nacelle trainer display.
- Review the repair history in the database.
- Draft a service order highlighting probable causes and need for visual inspection.
- Draft an unscheduled service order detailing error description, tools needed, technician hours required, and work priority.

**Learning Methods Used**

**Theoretical Training:**

- Basic knowledge provided through the Festo Training Nacelle infrastructure and LN Sensor learning and testing equipment.
- Electronic learning environment (Electude) covering the basic theory.

**Practical Skill Training:**

- Real-life scenarios focusing on diagnosing and repairing sensor malfunctions.
- Tasks include checking sensor errors, reviewing repair history, drafting service orders, and performing visual inspections.

**Equipment Needed**

- Festo Training Nacelle infrastructure
- LN Sensor learning and testing equipment
- Lucas-Nullte CO 4204-BU module
- Personal Protective Equipment (PPE)
- Database access for repair history
- Tools for sensor inspection and replacement



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## 2.1 Participant Feedback and Findings

The workshop received responses from participants, reflecting its relevance and impact on the field of wind turbine technician training. T-Shore partners and workshop organisers gained great insight for their work, benefiting from invaluable participation, interaction and discussions throughout the workshop.

### Participant Ratings [Online Feedback Form]:

- **Overall Workshop Rating:** Participants rated the workshop highly, with an average score of 4.13 out of 5, indicating strong approval.
- **Relevance to Educational Needs:** The content resonated well with attendees, receiving a relevance score of 4.00 out of 5.
- **T-Shore Project Rating:** The T-Shore project itself was rated a 4.63 out of 5, highlighting its promising approach and potential.

### Expectations and Ideas:

- **Meeting Expectations:** The workshop met or exceeded the expectations of all participants, with 100% affirming that it fulfilled their anticipations.
- **Inspiring Ideas:** Every participant left the workshop with new, applicable ideas for their own educational contexts, underscoring the practical value of the sessions.

### Awareness and Practical Application:

- **Prior Knowledge:** Before the workshop, only 25% of participants were aware of the T-Shore project, demonstrating the event's effectiveness in raising awareness.
- **Educational Applicability:** A resounding 87.5% of attendees believed that the practical approach of the T-Shore learning scenarios would work in their educational institutions, showcasing the widespread applicability of the methods discussed.

### Need for Harmonisation:

- **Support for Harmonisation:** A majority (62.5%) agreed on the need for harmonisation in their fields, particularly within the energy transition sectors. Only a small minority were unsure or saw no need, reflecting a general consensus on the importance of standardisation.

**Relevant Sectors for Harmonisation:** Participants represented a variety of sectors, each seeing the value in harmonising training standards:

- **Energy Transition in Haven and Offshore**
- **Energy Transition as a Whole**

- HU Afdeling WTB
- Sustainability
- MBO Techniek
- Energy Transition in Technical Sector

## 2.2 Highlights from Verbal and Written Feedback

The workshop's format encouraged participants to share their insights and suggestions:

- **Achievement Acknowledgment:** Participants supported the project's progress in developing ten modules to meet industry requirements, recognising the challenge of harmonising education across regions.
- **Cross-Sector Learning:** Attendees suggested looking at other sectors such as nursing and aviation for effective standardisation models. They noted that these sectors have clear standards, facilitating smoother transitions and interpretations across institutions and countries.
- **Soft Skills Development:** There was a strong emphasis on the need for soft skills development. Participants recommended encouraging student exchanges to foster international teamwork skills, as technicians will likely work in diverse, multinational teams.
- **Technical Training Innovations:** Suggestions included exploring cooperative learning scenarios and examining military training methods for enhancing teamwork skills.
- **Future Recognition:** Attendees highlighted the importance of gaining recognition from companies for the modules, ensuring that the training is valued by employers.
- **Pathways and Roadmaps:** Looking ahead, participants advocated for a roadmap detailing multiple career paths within wind energy, from entry-level positions to innovation-driven roles.

### Key Takeaways:

- **Critical Harmonisation:** Participants advised a critical approach to harmonisation, questioning whether uniformity is always necessary. They noted that differences across countries might not be negative and could offer valuable diversity in training methods.

These insights and recommendations will be instrumental in refining the T-Shore project's curriculum, ensuring it remains responsive to the diverse needs of the wind energy industry

while fostering a well-rounded, skilled workforce ready to support Europe's sustainable energy future.

### **3. Conclusions**

The "Harmonising Through Education: T-Shore's Approach to Wind Turbine Technician Training" workshop at the SEED Conference achieved its goals, offering participants valuable insights and fostering a collaborative environment for feedback. The positive reception and constructive suggestions will guide the T-Shore project in its mission to create a harmonised and effective training program for offshore wind turbine technicians across Europe.

We invite you to watch the workshop recap video to hear from the participants

Fig. 1 – workshop recap video to hear from the participants



Source: Workshop Videos: <https://www.youtube.com/watch?v=3jcMIJyEWO>

Fig. 2 – workshop recap video to hear from the participants



Source: Workshop Videos: <https://www.youtube.com/watch?v=3jcMIJyEWO>

## Acknowledgements

We extend our sincere gratitude to the SEED Conference organizers for the opportunity to present the T-Shore workshop, Harmonising Through Education: T-Shore's Approach to Wind Turbine Technician Training. We would also like to thank all participants for their active engagement, insightful feedback, and valuable discussions, which have greatly enriched the outcomes of this workshop.

Special thanks go to the T-Shore project partners, whose dedication to advancing offshore wind technician training has been instrumental in the development of this initiative. Their expertise and commitment to harmonising educational standards across Europe have been vital to the progress and success of this project.

Finally, we acknowledge the support of the European Union, whose funding and vision for a sustainable energy future have made the T-Shore project possible. Together, these contributions are paving the way for a skilled, standardised workforce prepared to meet the evolving needs of the offshore wind industry.

## Conflicts of interest

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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Workshop Videos: <https://www.youtube.com/watch?v=3jcMIJgyEWo>

## Chapter 10

# Challenges of International Master's Degree Courses in Renewable Energy Systems

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### Abstract

International student mobility has triplicated in the last twenty years and will be experiencing further growth rates in the future. At the same time, English-taught Bachelor's and Master's courses are offered by an increasing number of non-English speaking countries, especially in Europe, attracting students worldwide. Due to different social and academic backgrounds in the countries of origin, but also due to difficult general conditions, students face numerous challenges at their host universities. According to a survey conducted among international students enrolled in Master's Degree courses in renewable energy systems the English language is rarely a challenge, but sometimes the contents taught do not meet the expectations or the demand. Furthermore the students' prior university education might not be adequate for the Master's course, not only in terms of technical knowledge, but also regarding the students' general hard skills due to different teaching and examination styles in their home countries. This raises not only the question of what students and lecturers can do to fill the gap, but also what responsibility the institutions themselves have.

### Keywords:

International student mobility; English-taught Master's courses; Master's courses in renewable energy systems; Students' challenges

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## **1. Introduction**

### **1.1 International student mobility**

The number of tertiary education students worldwide has increased from 100 million in the year 2000 to 236 million in 2020. This steep growth of 136% in twenty years is even exceeded by the percentage increase of international students in the same period, which has tripled from 2.1 million in 2000 to 6.3 million in 2020. (Guillerme, 2022) The definition of "international students" follows that of the UNESCO Institute for Statistics:

«Internationally mobile students are individuals who have physically crossed an international border between two countries with the objective to participate in educational activities in the country of destination, where the country of destination of a given student is different from their country of origin. The country of origin of a tertiary student is the country in which they gained their upper secondary qualifications. This can also be referred to as the country of prior education.» (UNESCO Institute for Statistics, 2024)

In 2020, 39% of international students chose a European host country, 25% an Asian one, 20% moved to North America and 8% to Oceania. There is very little international student movement towards Latin America (4%) and Africa (4%). 52% of the international students came from Asia, 16% from Europe and 10% from Africa. In terms of single countries the top destinations are USA, United Kingdom, Australia, Germany, Canada and France, the most common countries of origin are China, India, Vietnam, Germany, France and USA. (Guillerme, 2022)

As obviously countries with a large population and a wide range of academic courses are on top of the list, it is more significant to analyze the share of international students relative to the national student population: In Australia the share of incoming mobile students on the total number of students is more than 25%, followed by United Kingdom, Canada, Switzerland, Austria (each of them 15-20%), the Netherlands and Germany (both 10-15%). Switzerland and Austria have also got the largest share of outgoing students (around 6%), followed by Malaysia and Ukraine (both 5%). The data refer to 2020, before the Russian invasion of the latter country. (Guillerme, 2022)

### **1.2 English-taught tertiary education programs**

The growth of international student mobility goes hand in hand with the growing offer of English-taught tertiary education programs in most countries. Still the "Big Four" (USA, United Kingdom, Canada and Australia) count for 78% of the total number of English-taught tertiary education programs worldwide, but the number of programs in non-English-speaking countries is growing fast (+48% from 2019 till 2024). (British Council, 2024)

Considering a decline in 2020 and 2021 due to reduced mobility during the Covid-19 pandemic, this growth is even more impressive.

Germany is already offering more English-taught tertiary education programs (2269) than New Zealand (ca. 2100) where English is the predominant national language. The average number of English-taught programs per institution is 34 in Turkey and 38 in the Netherlands (these number are referring to the year 2024). (British Council, 2024)

Unlike in countries where English is the mother tongue, the offered range of English-taught tertiary education programs in non-English-speaking countries follows the global demand for certain subjects and the marketing opportunities of the organizing universities. For example, a comparison of the English-taught programs in non-English-speaking countries with the "Big Four" (USA, United Kingdom, Canada and Australia) shows a clear oversupply of courses in Business and Management (18% of all courses in non-English-speaking countries, 12% in the Big Four) and Engineering and Technology (15% non-English-speaking countries, 7% Big Four). (British Council, 2024)

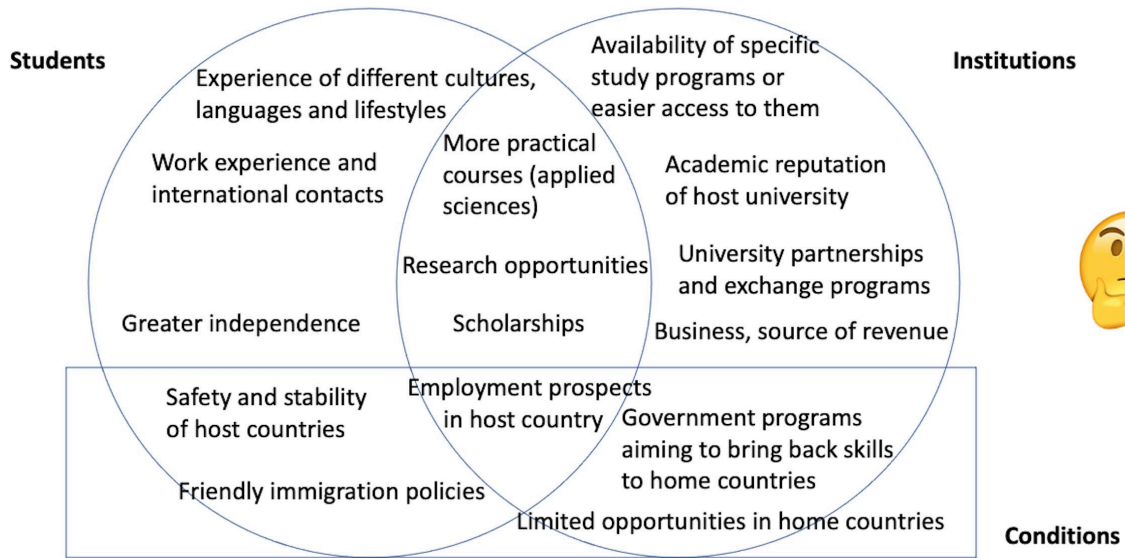
The business idea behind offering English-taught programs by universities in non-English speaking countries cannot be denied. English-taught programs attract foreign students. English as a globally accepted and widely spoken language is not only suitable to sell goods, but also the ideal tool for commercializing study programs to attract new target markets which are students from all over the world. Have the universities considered all the challenges that international student mobility entails?

## **2. Reasons and challenges**

### **2.1 Reasons for international student mobility**

What drives students to continue their academic or vocational training abroad? Together with the workshop participants, the following reasons have been identified:

Fig. 1 – Reasons for international student mobility

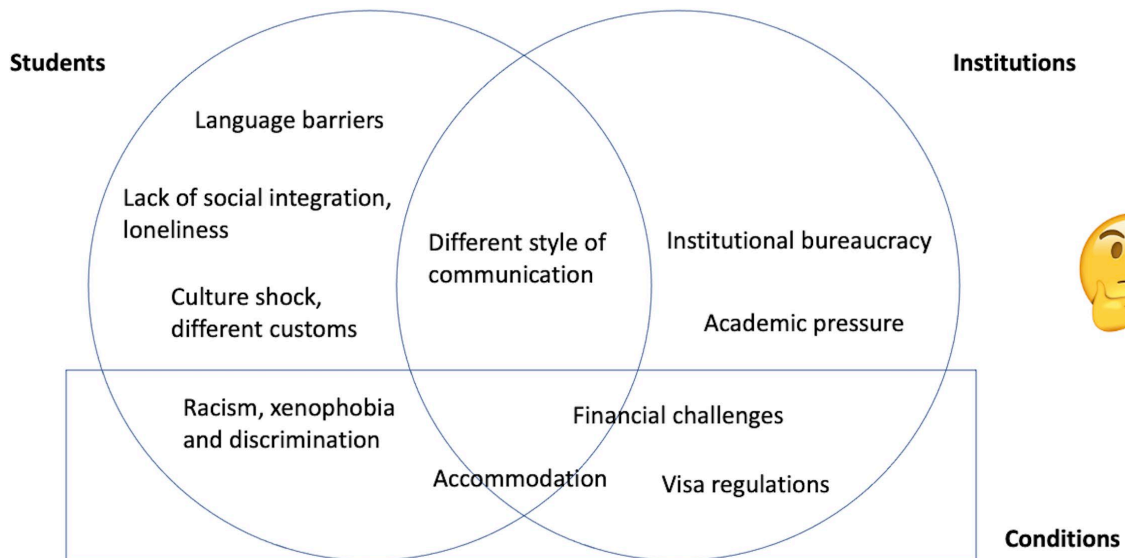


Source: SEED Workshop, Valencia, July 5, 2024

## 2.2 Social challenges of international students

Once the students have arrived at the place of study, they face a wide variety of social challenges:

Fig. 2 – Social challenges of international students

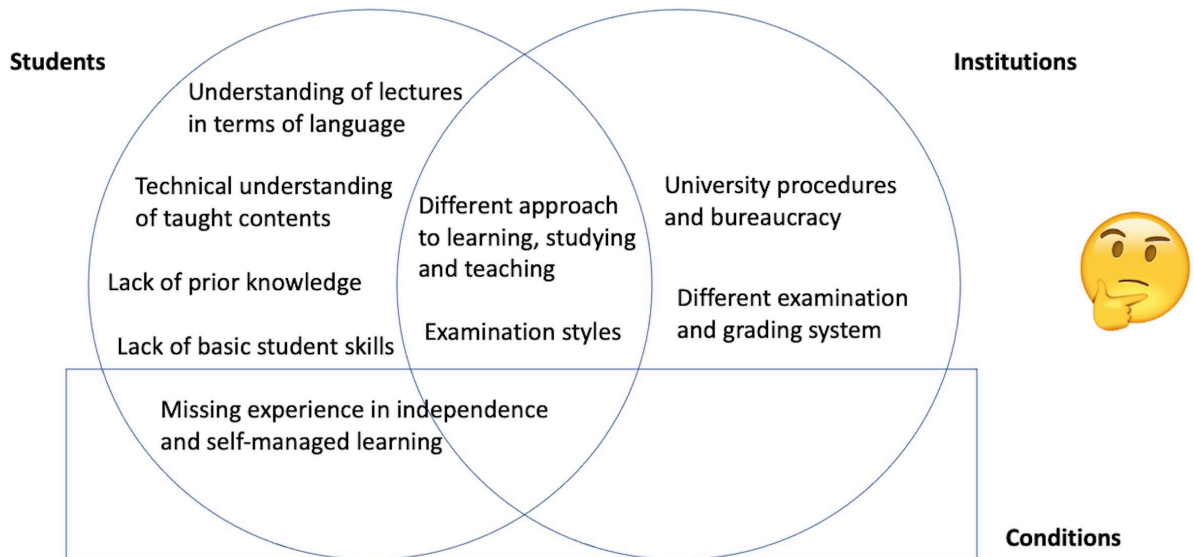


Source: SEED Workshop, Valencia, July 5, 2024

### 2.3 Technical challenges of international students

Separately from the social challenges, the technical, academic and professional challenges were analyzed:

Fig. 3 – Technical challenges of international students



Source: SEED Workshop, Valencia, July 5, 2024

### 3. Survey

In April 2024 an anonymous survey has been conducted among students enrolled in English-taught Master's Degree courses in renewable energy systems offered by universities in United Kingdom, Sweden, Denmark, Germany and Portugal. 46 students have replied; due to the limited length of this paper, only the most significant results are presented here. In case of interest the complete and detailed answers can be requested from the author.

Although 42 students (91.3%) have stated that English is not their mother tongue, 18 students (39.1%) find it "very easy" and 20 students (43.5%) "easy" to follow the lectures in terms of language understanding. In terms of contents taught, only 3 students (6.5%) find the lectures "very easy" and 7 students (15.2%) "easy". According to those students understanding the contents is a greater challenge than the language skills.

This could be caused by the different academic background which might not always be suitable. The interviewed students come from more than 40 institutions from the following countries: USA, Colombia, Norway, Sweden, Germany, France, Portugal, Italy, Romania, Greece, Egypt, Iran, Pakistan, India, Sri Lanka, Thailand, Malaysia, Indonesia, Australia. Students from China and Vietnam which are among the most common six countries of origin (see chapter n. 1.1 "International student mobility") are missing. This should be taken into account when the results of the survey are evaluated.

Lecturers teach very heterogeneous classes of students with different prior knowledge, who are also used to different teaching styles. Even if there are no or hardly any language barriers, lecturers and students do not necessarily understand each other on a technical level.

The answers to the question „Which country would you like to work in?“ were rather balanced at first sight: 13 students (28.3%) replied “In my home country”, 18 students (39.1%) stated “In another country” and 15 students (32.6%) are “undecided”. Analyzing the answers more in detail, it becomes clear, that they are actually quite unbalanced: All students who have replied “In my home country”, come from Northern, Western or Central Europe or Australia. Those students who have replied “In another country”, come from Asia (11), Africa (1) or Southern Europe (6) and their preferred destinations are countries in Northern and Central Europe. It is evident that there is a brain drain from countries with lower wages towards countries with higher wages.

Two further questions were related to the renewable energy technologies which are mostly required in the students' home countries and which are being taught during the university course. Multiple answers were allowed. The differences between the answers to the two questions are remarkable concerning solar thermal energy. It is taught in most courses (84.8% for domestic hot water applications), but considered mostly not required by the students for use in their home countries (17.4% for domestic hot water applications). This leads to the question if the contents should be adapted to follow the market or if the contents should be kept and offer an input to push less considered technologies.

The last question was an open one to give the students a chance to comment on the courses in general: “What are you missing in your current university course?” Out of the numerous answers a few noteworthy ones should be mentioned here (in brackets the country of origin of the student):

- “Coming from areas in the world where the climate and resources are opposite to those present/needed in the UK, the technologies relevant to our home countries need can be overlooked or not taught at all here.” (Malaysia)
- “I believe that incorporating on-site visits would enhance the learning experience. Additionally, assigning each lecturer to teach only one subject within a module could improve clarity and depth of instruction.” (Iran)
- “Hands on and practical experience, and most important large scale solar power plants study.” (India)
- “More laboratory experiments.” (India)
- “Exposure to industry and integration.” (Sri Lanka)
- “More contact with companies.” (Portugal)
- “Industrial insight and practical knowledge.” (Norway)

## 4. Solutions

What can students, teachers and institutions do to overcome the above-mentioned challenges? The following list provides some inputs:

- General support for international students from the universities before, during and after the studies concerning visa, immigration, housing, socialisation, counselling and other issues
- Orientation days or week to get acquainted with the university and the city
- Study buddies to help individual students to socialise faster, practice foreign languages and find their way around in a new place
- Student clubs and associations for involvement in social and humanitarian work
- Language courses offered by the university
- Tutorials teaching essential student skills such as assignment writing, doing research, studying methods, preparing for examinations and other basic academic skills
- Learning by doing: hands-on activities, laboratories, practical exercises, interactive software tools, field studies, excursions
- Internships and generally more connections and exchange between universities and companies
- Gamification techniques to stimulate students to learn, socialize, compete, have success and achieve goals
- Artificial intelligence from automatic translation tools to innovative learning applications which do not provide simple answers to difficult questions, but help to understand and to deepen complex issues
- Staff training: new teaching methods for lecturers to adapt seminars and tutorials to be better prepared for the specific challenges of courses with large numbers of international students

Most universities provide already a great part of the above-mentioned solutions, but not all of them put a lot of effort into them. Generally housing remains a great challenge for most international students, as they do not have the chance to view an apartment before they arrive at the destination, and the accommodation offered by the universities is usually not sufficient. Concerning student clubs and associations some universities offer many (for example CentraleSupélec in France more than 150 (CentraleSupélec, n.d.)), others hardly any. Language courses are common, but it is noteworthy if an institution offers 20 weeks of English language courses at no cost for international students, as the University of Tasmania does. (University of Tasmania, n.d.) Also more frequent tutorials providing essential student skills (as they are offered by Edith Cowan University in Western Australia (Edith Cowan

University, n.d.)) are urgently required for international students who have to deal with totally different teaching and examination styles at their host universities compared to their original institutions in their home countries.

## **5. Conclusions**

Students who travel thousands of kilometers to gain a foothold in a new country with an unfamiliar culture, often stretching their own financial resources, are usually highly motivated to continue or complete their studies successfully. The circumstances could make life difficult for them and usually they cannot solve the problems without any help. Lecturers and local students can support them, but above all the universities themselves need to take responsibility. It is not enough to offer great study programs to attract students from all over the world, they must also take care of them during their studies. Accommodation for students is rarely accessible in the required numbers, but a room should be available for every international student enrolled. Furthermore, universities should scrutinize the admission requirements more closely - do international students really have the necessary prior knowledge and essential skills? Of course, there is a lucrative business model behind the recruitment of international students, but the business model is flawed if it results in dissatisfied customers - in this case students and lecturers.

In view of the discrepancies between required and taught topics, the question also arises as to who should adapt professionally - students widening their own horizon or university program managers modifying the curricula? Should students learn something so that they can find their way in the target country and acquire new know-how or should they learn something that is useful for their home country?

Last but not least, we all have a role to play, society as a whole. Unfortunately, international students repeatedly experience discrimination through social exclusion or even xenophobia and racism. All people are foreigners as soon as they cross their own national border. All people are entitled to dignity and equality anywhere in the world, especially in a country they have chosen to live in. What sense does the Universal Declaration of Human Rights make if it is not applied?

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## **Conflicts of interest**

The author declares that he has no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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## Chapter 11

### Build your own Learning Ecosystem taking Action for the Future

Linette Bossen<sup>a</sup> and Saskia Postema<sup>b</sup>

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#### Abstract

The urgent sustainability challenges that students as future professionals are expected to face, solve or cope with in their lifetime require holistic interventions. However, current modes of higher education do not sufficiently prepare students for actioning their knowledge in such a way. At TU Delft, learning communities are developed as part of a wider ecosystem to offer our students the opportunity to collaborate, learn and innovate on equal footing with all sorts of knowledge partners. Involvement from applied sciences and vocational education students, as well as private sector, government, and citizens ensures that they experience the complexity of the real world and can put technology in a wider societal context. Imperative to this are the development of green transformative skills (Kwauk & Casey, 2021), and a cross-boundary identity.

During the Conference on Sustainable Energy Education 2024, we offered a workshop in the form of a simulation game that walks participants through the process of setting up a learning ecosystem on climate action education, building on our experience with implementing co-creation, facilitation and co-design (De Hei & Audenaerde, 2023; Smeenk, Koppchen & Gene, 2020). Participants experienced the various requirements, steps, and challenges that one may face when wanting to set up a dynamic learning ecosystem that includes all sustainability stakeholders. Stepping into the world of vocational education, industry, public entities, NGOs and civil society, helped attendees understand how to form their own working ecosystem.

**Keywords:** Learning Communities; Cross-boundary identity; Co-creation; Green Transformative Skills; Multilevel learning

How to cite: Bossen, L.; Postema, S. (2024) Build Your Own Learning Ecosystem taking Action for the Future. In De la Poza Plaza, E., Blazquez-Soriano, A. and Wang, R. (Eds.), *SEED Workshops: Designing a transnational learning strategy*, 89-97. <https://doi.org/10.4995/SEED2024.2024.19558>

## **1. Introduction**

Learning communities are increasingly being developed in the Netherlands to respond to complex challenges. They traditionally combine Working, Innovating and Learning (WIL triangle), functioning as public-private partnerships that include knowledge institutions (Konings et al., 2022). As the WIL triangle implies, the reasoning for learning communities is rooted in accelerating innovation. By bringing together those who work, learn and innovate; new solutions can be developed, tested and implemented at a much higher speed.

This is particularly relevant for such pressing issues as sustainability, energy and climate. Technology alone cannot solve these challenges – context is needed to understand whether or not the implementation of new tech in society will be successful. This has led to the adoption of the quadruple helix model, in which different types of partners come together; including (1) knowledge institutions, (2) private sector, (3) public sector, and (4) civil society (Bharosa & Jansen, 2020).

Each of these stakeholders can provide a unique perspective to the learning community. For knowledge institutions, learning communities offer a direct pathway to operationalize ongoing research. Additionally, the learning community can inform new, impactful research topics. For private sector stakeholders, these communities can help provide answers to pressing questions in their daily work, on which they can inform the other parties. The same goes for public sector stakeholders, who can put forward governance and policy related questions of their own, and also keep abreast of the latest developments, so as to become more responsive to them (Kerngroep Netwerk Learning Communities, 2023).

An important element of learning communities is, therefore, that all participants establish a common goal together (De Hei & Audenaerde, 2023). It underscores the importance of long-term commitment by all parties, which can be difficult to realise. Each stakeholder has their own personal perspective, background, expertise and experience, and will have varying financial/temporal means. So when can we view the community as having been successful at addressing [a specific aspect of] a wicked problem? When is something a learning community, rather than a community of practice? And who should be included in said community? Who decides on convening a community? During the SEED workshop, Bossen and Postema set out to answer these questions by sharing the Delft University of Technology (TU Delft) model for learning communities.

### **1.1 TU Delft Learning Communities**

More often than not, learning communities focus on offering professionals an alternative, informal learning environment (Endedijk, M., 2023). However, we argue that learning

communities can also offer amazing experiential learning opportunities that combine research, education and society. Students and professionals from different learning levels and backgrounds work together in what is sometimes referred to as the 'quintuple' helix: An environment that includes education/knowledge institutions, public sector, private sector, civil society, and the environment itself as stakeholders (Carayannis et al., 2012).

Whereas challenge-based approaches to education have long since been introduced in higher education, working with *authentic*, complex, unknown questions is rather novel. As it requires higher education institutions (HEIs) to invite the outside world in, it also brings a certain sense of uncertainty (Fenten et al., 2021). Educators are tasked not to evaluate the project outcome or solution, but rather the process and reasoning as to why certain solution pathways were found. Through the creation of learning communities, students are introduced to a more thematic, cross-boundary approach to understanding and responding to urgencies. Moreover, the thematic approach means there is ample opportunity to build on or scaffold the work that students have done previously throughout their degrees, and to reflect on different modes of knowledge.

Key features of the TU Delft learning communities are its focus on long-term commitment, reciprocity and equitability (Even Groene Vrienden, 2024). It means that different types of knowledge, be it based on experience or academic texts, are equally respected and taken into consideration. Bridging the gap between praxis and theory is therefore another fundamental objective of learning communities. Also referred to as cross-boundary learning, students are tasked with exploring plurality and understanding their own personal and professional role in addressing a wicked problem (Akkerman & Bakker, 2011; Gulikers & Oonk, 2019), see also Figure 1. As a result, students who participate in learning communities put additional emphasis on problem framing through co-creation with the other stakeholders, prior to designing their project plan.

Fig. 1 – Student Journey to Develop a Professional Cross-Boundary Identity



Source: Own elaboration

## Facilitator role

The introduction of facilitators as a vital element of the learning community infrastructure has been crucial in safeguarding the key features as mentioned above. Rather than asking educators to not only coach, teach and assess their students, but also manage a fluctuating learning environment – the facilitator takes on the role of ensuring meaningful participation amongst a vibrant and diverse group of stakeholders. As true relationship managers, they guide co-creation sessions with the various partners in order to identify their wants and needs, and to establish a common language and collective ambition. They exemplify the importance of cross-boundary work, as they frequently have to engage in ‘code switching’ in order to find common ground.

Fig. 2 – Visualisation of TU Delft Learning Communities, centering education as a bridge between academia, praxis and society.



Source: Own elaboration

As such, TU Delft’s learning communities aim to increase and accelerate students’ capacity to be innovative, adaptive and responsive future professionals through practicing co-creation. Moreover, the communities provide a space for life-long learning, as it also invites professionals, citizens as well as academics to all engage in the process of finding new solution pathways together.

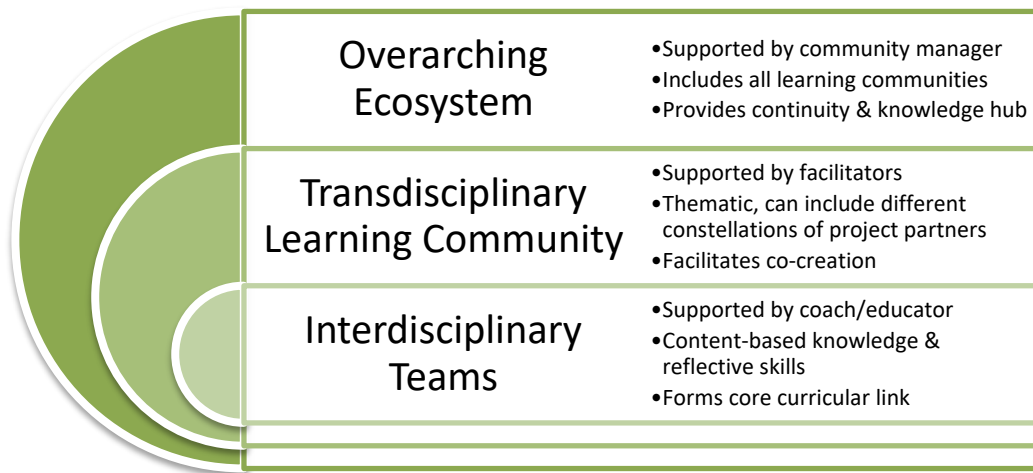
## 1.2 Learning Ecosystems Taking Action for the Future

Sustainable Energy and Climate are two main themes that are of particular relevance to the students of TU Delft, the University’s motto even reads “Impact for a Sustainable Society” (TU Delft, 2024a). A few years ago, TU Delft kickstarted its Climate Action Programme (CAP), which focused primarily on innovative research regarding climate adaptation, climate mitigation, climate science, and climate governance (TU Delft, 2024b). However, this left students unable to directly contribute to or benefit from this rigorous programme through education. Students were not provided with tools, ideas or pathways as to how they could

action such knowledge. In order to respond to these needs and to further promote the integration of education, research and sustainable societies, learning communities were transformed to an overarching learning ecosystem focused on future (climate) action.

Aptly named LEAF (Learning Ecosystems Taking Action for the Future), this ecosystem is designed to provide continuity and a hub to collect all acquired insights and knowledge from various learning communities. This is particularly relevant for sustainable energy and climate, as these themes reach across the different transdisciplinary learning communities. Moreover, this structure allows a clear pathway from curricular links to the wider societal relevance of challenges put forward by the learning communities (see also figure 3). In doing so, we provide future generations the tools to not only address urgencies today, but also those of tomorrow.

Fig. 3 – LEAF infrastructure



Source: Own elaboration

## 2. Workshop

### 2.1 Workshop Objectives

The workshop was designed to introduce participants to the Delft model of LEAF, and inspire participants to discover and embrace its capacity to help accelerate inclusive knowledge exchange between climate science and society. How do we build bridges and educate students and professionals to become resilient and responsible citizens that can work across boundaries, on the intersection of climate and other disciplines? The approach we have taken promotes equitable partnerships and provides a concrete framework on how to action this within existing curricula.

Participants were able to not only learn about the model, but also experience it themselves through a game. Through exploring different perspectives, weighing everyone's interests and expertise, the learning community facilitated them in converging to find common ground.

This experience can help the participants put the provided blueprints into action with regards to co-creation, co-canvassing and facilitation, enabling them to establish their own sustainable learning communities.

## **2.2 Approach to Building LEAF**

During “Build Your Own LEAF”, participants were provided with a step by step approach to building a learning ecosystem:

**Table 1 – Step by step approach to building a learning ecosystem**

Step 1	Define the topical issues or themes, and explore what potential perspectives would be relevant to the topic.
Step 2	Map out the relevant stakeholders externally, as well as internally (in knowledge institutions).
Step 3	Find the space in the curriculum, and define what is needed to successfully plug in urgent, authentic challenges. What learning objectives do students need to obtain? How could these relate to the challenges at hand? Or perhaps new space in the curriculum is needed to facilitate this new way of integrated, authentic learning.
Step 4	Build your community – talk to the people you had mapped out, and ask them what their concerns or questions are on this topic in particular. Who or what do they think is needed to help solve their problem?
Step 5	Start a co-creation trajectory, bringing education into the fold. Co-creation starts with diverging and identifying possible ways to understand the problem, prior to converging and reframing the problem collectively. Finding a common language for the urgencies is key!
Step 6	Together, start developing various solution pathways in line with the perspectives and urgencies outlined earlier. Students can do the research, create prototypes – the community can learn together and provide information or new questions throughout.
Step 7	Organise frequent knowledge exchange, culminating in a closing session where students present their final work + initiate new pathways or perspectives for the next iteration. The ecosystem also serves as a knowledge bank and Open Access platform for the newly created or found insights.

Source: Own elaboration

Participants were given a complex challenge during the workshop, which they would try to address as a learning community, followed by a short reflection. Based on existing learning communities, the complex challenge of heat transition in urban space was chosen. Heat resilience and transition sometimes seem to be in conflict with one another – both requiring urban space to be repurposed. Moreover, infrastructural changes inside people’s homes, behind their front door, are needed. But these require behavioral change and increased support/legitimacy. Home owners and renters have financial concerns, need more information on the long-term returns and necessity of these major changes.

### 2.3 Results

Because our workshop was attended by a smaller group than expected (N=8), we decided to focus on the process of facilitating co-creation within a learning community. This highlighted the crucial role of a facilitator in modelling cross-boundary work and finding common ground.

Participants initially were tasked with brainstorming what actors could play a role in the presented challenge, through writing them down on individual Post-its. These were then clustered and prioritised by the workshop participants themselves. This led to a final selection of seven stakeholders who would be active in the game: (1) Citizens, (2) municipality, (3) electricity suppliers, (4) banks, (5) engineers, (6) teachers from different knowledge institutions, and (7) environmentalists.

Each workshop participant stepped into the shoes of one of these defined stakeholders, and was given time to think about their (changed) positionality and relationship to the challenge at hand. The remaining participant was appointed the role of facilitator, and given additional instructions on our chosen method for co-creation; the co-canvas [Smeenk, 2023]. The group had thirty minutes to then experience what a convening learning community normally goes through in the build-up phase, i.e. defining common ground and the direction of the learning community – where is the urgency? The co-canvas questions that were eventually used by the group to find new pathways or problem frames included e.g.:

- what technical, economic and societal challenges do you foresee
- what is the result/outcome/impact you'd like to see
- who needs to be involved to solve these challenges
- what can you contribute (e.g. knowledge, network, influence, materials) [Postema, 2024]

### 2.4. Reflection

When asked to reflect at the end of the workshop, the facilitator noted that the provided questions and co-canvas method aided them in gaining insight into the interests of each stakeholder. Moreover, it helped concretise the context of the issue. Conversely, all participants complimented the facilitator in making everyone feel heard and involved, which made them more willing to work together. It should be noted that this is not always the case in reality, but role-playing does aid in empathizing with other (unknown) perspectives. While not all participants felt immediately as comfortable or well-suited to the role they were given, it did make them reflect on how they perceive each stakeholder.

Unfortunately, limited time kept us from discussing any discrepancies between the perception of interests versus actual interests of each stakeholder – in as far as they were present in the workshop. Moreover, the limited number of participants made for a limited

amount of plurality in the learning ecosystem. Various participants noted that they would have liked to do the game again with more people in the future.

Most importantly, each participant highlighted that the model and approach itself was experienced as quite helpful in evidencing the need for cross-boundary, joint solutions. In the future, it would be valuable to trial different methods of co-creation with groups running in parallel. This could provide new insights in what should be offered as part of a Build Your Own LEAF toolkit moving forward. It would be imperative to include a diverse audience in these workshops, representing the various modes of knowledge included in LEAF as well.

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## **Conflicts of interest**

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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## SEED conference workshops: a powerful tool for building community and enhancing a transnational learning strategy

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### Abstract

As the global demand for green energy continues to rise, sustainable energy education plays a pivotal role in achieving carbon neutrality goals. This study investigates effective strategies for fostering transnational learning communities by organizing a large-scale workshop and employing a mixed-method approach that combines questionnaires and case studies. The findings reveal that highly interactive workshops are instrumental in facilitating the creation and growth of learning communities. This research offers practical insights into transnational collaboration, particularly in the education sector, and demonstrates significant potential for broader applications.

**Keywords:** workshop, transnational learning community, educational collaboration, sustainable energy education

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## **1. Introduction**

The CoVE SEED<sup>1</sup> project (Centers of Vocational Excellence for Sustainable Energy Education) aims to establish a learning community focused on sustainable energy education through global collaboration. Its core objective is dedicated to high-quality, innovative education and training aligned with Europe's strategy to phase out fossil fuels, contributing to the development of a fossil-free continent.

The SEED project seeks to create a model for excellence in sustainable energy education by bringing together experts from five European regions to foster cross-border cooperation and knowledge sharing. Within this framework, designing a strategy for a sustainable learning community is particularly important. Establishing such a community requires a clear learning strategy, concrete action plans, and effective monitoring and evaluation mechanisms. In developing the strategy, we must consider the long-term sustainability of the learning community and its adaptability to changes in the educational landscape to meet the needs of industries and society.

To advance this vision, the SEED project held its first International Conference on Sustainable Energy Education at the Universitat Politècnica de València, Spain. This conference not only provided an international platform for participants to exchange ideas, experiences, and research but also introduced the workshop sessions as a practical feature, enriching the overall content (De la Poza Plaza et al., 2024). These workshop sessions, as an integral part of the transnational learning community strategy's action plan, enhanced the depth of learning and the sharing of outcomes, injecting vitality into the realization of SEED's mission.

This chapter aims to explore workshops as an effective tool for creating sustainable transnational learning communities, analyzing their design, execution processes, and contributions to enhancing the overall impact of the conference.

## **2. Workshops**

### **2.1 Workshop conceptualization**

A workshop can be defined as an interactive and structured meeting format designed to engage participants in collaborative activities aimed at solving specific problems, advancing projects, or achieving defined objectives (Lewis, I., 2012). Workshops are versatile in application and are commonly used for purposes such as skill development, strategic planning, and fostering creative problem-solving (Beatty et al., 2009.). Unlike traditional meetings, workshops emphasize interactivity and collaboration, creating an environment where participants actively contribute and exchange ideas.

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<sup>1</sup> You can check more information about the project at the CoVE SEED official webpage: <https://coveseed.eu/es/>

The structure and style of a workshop can vary widely, depending on the goals, organizers, and composition of participants. However, workshops generally share key characteristics: they are goal-oriented, focus on active participation, and are meticulously designed to ensure that outcomes align with the objectives. Participants may engage in activities such as group discussions, hands-on exercises, role-playing, or scenario-based problem-solving to deepen engagement and maximize productivity.

Workshops are typically facilitated by a designated leader or facilitator, whose role is critical to the success of the session. The facilitator is responsible for maintaining participant involvement, guiding discussions, and ensuring that activities remain aligned with the workshop's objectives. Skilled facilitators also adapt to on-site conditions, making real-time adjustments to the agenda or approach to achieve the desired outcomes.

In terms of duration, workshops are highly flexible and can range from a few hours to several days, depending on their complexity and purpose. This adaptability allows workshops to be tailored to various contexts, from small, focused groups to larger, multi-day events with diverse stakeholders. By fostering a collaborative and goal-driven environment, workshops serve as a powerful tool for knowledge exchange, skill enhancement, and collective problem-solving, making them an integral component of modern organizational practices

## **2.2 Embedding workshop sessions into a conference: The value of workshops and the limitations of traditional conference models**

Academic conferences traditionally aim to gather researchers, scientists, and professionals with shared interests in a specific field to exchange research findings, engage in intellectual discussions, improve professional skills, and expand professional networks. However, the traditional conference model has certain limitations in fostering multifaceted interaction and generating outcomes.

From a content production perspective, traditional conferences often limit outcomes to conference proceedings, usually published before or during the event which doesn't include any outcome derived from the event. In other words, discussions and new insights generated during the conference are rarely effectively recorded and disseminated in the form of publications. The main traditional presentation formats—oral presentations and poster sessions—offer limited opportunities for in-depth interaction, as most presentations allocate only 5 to 10 minutes for Q&A sessions. Even though keynote speeches and panel discussions provide longer timeframes, their sessions are few in number and have limited participant coverage. This traditional format restricts both the depth and breadth of knowledge sharing.

From a network-building perspective, traditional conference models also fall short in fostering interpersonal connections and cross-country collaboration. Successful network building requires ample time for interaction, deep exchanges, and the establishment of trust.

The one-way reporting and limited bilateral discussion structure of traditional formats restrict opportunities to showcase participants' project collaborative abilities, which are crucial for international projects. This limitation negatively impacts the development of post-conference collaborations among participants.

As transnational event organizers, how can we create a platform and space that effectively promotes and inspires interaction and creativity among participants? How can we ensure participants gain more knowledge and benefits from their engagement while also enabling outcomes to be disseminated to a broader audience beyond the conference?

After analyzing the traditional conference format, we sought optimization solutions. The traditional conference format (oral sessions and poster sessions) has been in place for a long time, proving its merits and becoming a familiar format for participants. Thus, major changes to this component are challenging to implement. Based on our exploration of existing tools that enhance learning efficiency, combined with over a decade of conference participation experience as attendees, we unanimously concluded that workshops are a feasible, effective, and implementable solution to address these challenges. Workshops not only enhance content generation and exchange but also excel in promoting deep interaction and building international learning networks.

### **2.3 Workshop design and implementation**

To ensure that workshops were well integrated into the overall structure of the SEED conference and achieved the desired outcomes, the conference organizing committee becoming also workshop organizing committee approached the design from four key perspectives: who, when, where, and how.

#### **2.3.1 Preliminary workshop sessions' design before call for workshop proposals**

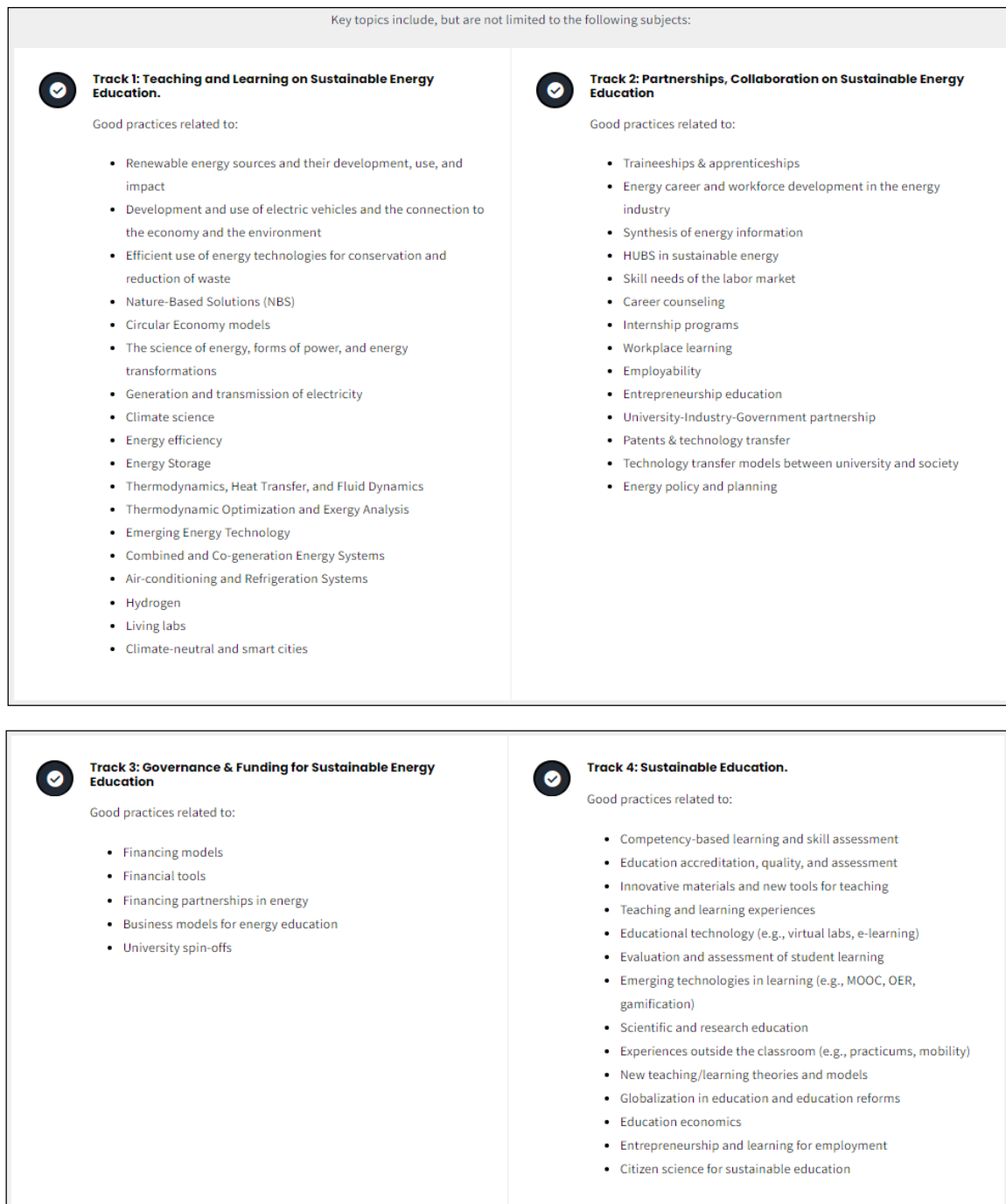
- Target Participants

Workshops were designed to attract two different audiences: those who wanted to deliver workshops (trainers/speakers) and those who wanted to attend them (trainees/attendees). Through global promotional campaigns, we opened an international call for workshops with the aim of receiving proposals from experts and practitioners in the field of sustainable energy education. The proposals should align with the conference's tracks (Fig. 1):

1. Teaching and learning on sustainable energy education
2. Partnerships and collaboration on sustainable energy education
3. Governance and funding for sustainable energy education
4. Sustainable education

Special attention was given to attracting participants from business and government sectors to strengthen collaboration between academia and industry. Promotional channels included professional social media platforms (e.g., LinkedIn) and local educational institutions' networks. Our goal was to achieve high-quality diversity while addressing practical market needs.

Fig. 1 – Framework of the theme for the workshop proposals



Source: <https://www.seedconference.eu/call-for-papers/>

- Preliminary planning of location and scheduling

Considering budget control, resource availability, and facilitating participation, workshops were held at the Faculty of Business Administration at the Universitat Politècnica de València, the same location as the main conference venue. The featured workshops interspersed with oral presentations and poster sessions to maintain schedule variety and avoid monotony or fatigue during a three-day event

- Preliminary planning of workshop conduction format

Workshops were designed to last 1.5 to 3 hours, with content and formats aimed at stimulating multilateral discussion and innovative ideas generation. A template was designed for this purpose. Resources provided by the SEED conference to the workshop organizers and requirements were clearly and timely published on the conference website to ensure they understood workshop sessions expectations.

### **2.3.2 Workshop proposals & final design**

We received 36 proposals globally. From them, 18 workshops were selected based on proposal quality, the potential to engage a broad community, and practical feasibility factors, such as logistics and space requirements. These workshops were hosted by organizers from seven European countries and South Africa, European countries include Spain, Germany, France, the Netherlands, Italy, Greece and Switzerland. This reflects a diverse range of collaborations.

- Adjustment and confirmation of the workshop location and time plan.

After estimating audience sizes and resource needs, the final schedule and rooms allocations were confirmed. Workshops were strategically arranged across three afternoons to maximize participant engagement (Fig. 2). The sequence was designed to offer diverse content and varied organizer organization types.

Fig. 2 – SEED 2024 conference program integrated with the workshop sessions.

Program of Wednesday, July 3rd.

**Wednesday, July 3**

Home > Program > Wednesday, July 3

**Important dates**

- January 26, 2024  
February 2, 2024 - NEW!  
Extended abstract submission deadline
- February 2, 2024  
Workshop proposals due
- March 15, 2024  
Author notification
- April 26, 2024  
Final version submission deadline
- April 26, 2024  
Early registration deadline for authors
- July 3-5, 2024  
Conference dates

+ 08:30 – 14:30 | Accreditation at the Faculty Hall

+ 09:00 – 10:30 | Opening and Keynote: The Nordic approach to sustainable energy education by Prof. Fco. Beltrán

+ 10:30 – 10:45 | Coffee Break and Gallery Walk

+ 10:45 – 11:45 | Parallel Oral Sessions - I

+ 11:45 – 12:45 | Parallel Oral Sessions - II

+ 12:45 – 13:45 | Lunch

+ 13:45 – 14:30 | Poster Session I and coffee

– 14:30 – 16:30/17:30 | Workshops - Session I

Name of sessions: Workshops - Session I

Room	Title	Chairs
0.0 (ground floor)	WS07 - Build your own LEAF: Learning Ecosystem Taking Action for the Future	Linette Bossen and Saskia Postema
0.1 (ground floor)	WS05 – Game-based Learning for Sustainability in Management Education (GAME-SME)	Fabio Nonino, Luca Fraccascia, Mirko Giagnorio
0.2 (ground floor)	WS01 – Enabling the flow of knowledge for the Energy and Hydrogen Transition	Marsha Wagner, Jan Geurt van Kessel, Pim Opraus and Yvette Lanting
0.3 (ground floor)	WS03 – ESExNBS@NEB – Exploring Sustainable Education implementing the Nature-Based Solution in the New European Bauhaus perspective	Elena Mussinelli and Ellie Mavroudi
0.4 (ground floor)	WS02 – Sustainable Energy Education: Delivering the energy workforce of the future.	Mascha Moorlach and Jacqueline Garcia
Seminar 0.2 (ground floor)	WS04 – MINDS – Meaningful Immersive Narratives Driving Sustainability	Karolien Van Riel and Rob De With

Source: <https://www.seedconference.eu/program/wednesday-july-3/>

- Final planning of workshop format

To address attendance management, Professor Lenny van Onselen from HU University of Applied Sciences Utrecht was consulted. The finalized procedure was as follows: Participants interested in attending workshops would read the basic information online and collect tickets

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at the reception desk on the morning of the same day of the workshop. Tickets were distributed on a “first-come, first-served” basis. Participants were encouraged to explore workshop options in advance and prepare alternative choices if tickets ran out. For instance, tickets for workshops on July 4 were distributed on the morning of July 4, not earlier.

Fig. 3 shows the list of workshops offered to SEED conference participants resulting from the call for workshops.

Fig. 3 – SEED conference, workshops list (partial)

The screenshot displays the SEED conference website's 'Workshops' page. At the top, the SEED logo (sustainable energy education) is on the left, and a navigation menu includes 'Call for participation', 'Authors', 'Registration', 'Program', 'Proceedings', 'Venue', and 'Organization'. The main heading is 'Workshops' with a breadcrumb trail 'Home > Program > Workshops'. Below this is an 'Important dates' section with six boxes: 'January 26, 2024 February 2, 2024 - NEW! Extended abstract submission deadline', 'February 2, 2024 Workshop proposals due', 'March 15, 2024 Author notification', 'April 26, 2024 Final version submission deadline', 'April 26, 2024 Early registration deadline for authors', and 'July 3-5, 2024 Conference dates'. The main content area shows six workshop cards, each with a title, reference code, chair, and organization, and a 'READ MORE' button.

Workshop Title	Ref. code	Chair	Organization
Enabling the flow of knowledge for the Energy and Hydrogen Transition	WS01	Marsha Wagner, Jan Geurt van Kessel, Pim Opraus and Yvette Lanting	Energy Innovation NL, GroenvermogenNL, HAN University of Applied Sciences
Sustainable Energy Education: Delivering the energy workforce of the future.	WS02	Mascha Moorlach and Jacqueline Garcia	Transforming Energy Access – Learning Partnership (TEA LP)
ESEXNBS@NEB - Exploring Sustainable Education implementing the Nature-Based Solution in the New European Bauhaus perspective	WS03	Elena Mussinelli and Ellie Mavroudi	ENVI-Reg Observatory ( Politecnico di Milano) & Cluster of Bioeconomy and Environment of Western Macedonia (CluBE)
MINDS – Meaningful Immersive Narratives Driving Sustainability	WS04	Karolien Van Riel and Rob De With	AP Hogeschool Antwerpen
Game-based Learning for Sustainability in Management Education (GAME-SME)	WS05	Fabio Nonino, Luca Fraccascia, Mirko Giagnorio	Sapienza University of Rome
Empowering Through Education: T-Shore's Approach to Wind Turbine Technician Training (T-shoreEdu)	WS06	Gerben Huiszoon	The T-shore Project partners

Source: <https://www.seedconference.eu/program/workshops/>

### **2.3.3 Challenges in workshop design and implementation**

One of the primary challenges lies in ensuring the quality of workshop performance. Although the scientific committee conducted thorough background research on workshop organizers and their content to the greatest extent possible, there was still a lack of sufficient information to definitively assess the performance and organizational capabilities of the workshops. This limitation was acknowledged during the selection process, where all available information was used to conduct the most comprehensive evaluation achievable at the time.

Another significant challenge was managing the workshop participants (the audience). Precise control over workshop participation proved difficult, particularly given the constraints of high workloads and limited budgets. To address this issue, the committee sought advice from experts within the SEED project, ultimately arriving at a feasible and effective management approach.

Finally, during the scheduling phase following the collection of workshop proposals, the organizing committee made concerted efforts to accommodate the specific requests of workshop organizers. The objective was to maximize workshop organizers' satisfaction with the limited resources available. This was achieved by enhancing resource efficiency, optimizing their use, and introducing flexibility in addressing detailed needs. These measures were carefully balanced within the relatively fixed structure of the conference to ensure a harmonious and effective implementation process.

## **3. Workshop results and outcomes**

This section presents the results of various surveys, including the overall conference survey and a specific survey targeting workshop organizers.

### **3.1 Analysis of overall participant satisfaction**

Post-conference survey results indicated an average satisfaction score of 8.7 out of 10. Among the 75 respondents (28% of registered participants), 46 identified workshops as one of their favorite activities in the conference, ranking second only after the parallel oral sessions. The detailed information is shown in Table 1 as follows:

**Table 1 – Conference feedback survey analysis. Question 2: “Which elements of the event did you like the most?”**

Which elements of the event did you like the most?	Votes number	Percentage	Cumulative percentage
Parallel oral sessions	46	16%	16%
Workshops	46	16%	33%
Cocktail reception	41	15%	48%
Panel session	34	12%	60%
Conference dinner	33	12%	71%
Keynote session	23	8%	80%
Conference reception	18	6%	86%
Poster sessions	18	6%	93%
Farewell reception	11	4%	96%
Closing	7	3%	99%
Number and profile of participants	1	0%	99%
Organization in general	1	0%	100%
The good atmosphere in general throughout the conference	1	0%	100%
<b>Total general</b>	<b>280</b>	<b>100%</b>	<b>100%</b>

Source: Own elaboration

Workshops were also rated as one of the most inspiring activities during the conference. In the SEED conference, workshops ranked third among the top three elements that provided participants with new insights, following parallel oral sessions (62 votes, 28% of respondents) and panel discussions (49 votes, 22% of respondents) (Table 2). This underscores the importance of workshops in fostering knowledge sharing and sparking innovative ideas.

**Table 2 – Conference feedback survey analysis. Question 4.3: How SEED 2024 conference impacts your institution/ organization? The three top elements of the SEED conference through which I gained new insights were...**

The three top elements of the SEED conference through which I gained new insights were .....	Votes number	Percentage	Cumulative percentage
Parallel Oral Sessions	62	28%	28%
Panel: Priorities for Sustainable Energy Education	49	22%	50%
Workshops	48	22%	72%
Keynote speech: The Nordic approach to sustainable energy education by Prof. Fco. Beltrán	33	15%	86%
Poster Sessions	22	10%	96%
Networking	5	2%	99%
Social events (via networking)	3	1%	100%
<b>Total general</b>	<b>222</b>	<b>100%</b>	<b>100%</b>

Source: Own elaboration

### 3.2 Analysis of the workshop's organizer feedback

Feedback was collected from 12 organizers, achieving a response rate of 72%. The organizers represented diverse sectors and organization types, including universities, vocational education and training (VET) institutions, and companies. Notably, 50% of the organizers came from universities, and 25% from companies, this reflects the conference's strong collaboration with industry partners. The remaining 25% were split between VET organizations and CoVE (Centers of Vocational Excellence) projects.

According to workshop organizers' feedback, the primary purpose of these workshops was "Preparing learners, students, and professionals with skills and competencies for the future". The second most common objective was "Establishing an international learning community", followed by "Upscaling and promoting work-based education". Additional open-ended responses included objectives such as "To understand and overcome challenges of the growing community of international students", "get an overview of synergies and differences in Energy Education" and "Prepare some mobility, publicize our Erasmus+ project GreenTech".

Regarding the workshop attendance rate, 33% (4 out of 12) of the workshops had over 20 participants, with the highest attendance reaching 40 participants. Conversely, the number of participants of one workshop (8%) was under five. Attendance ranged from 2 to 40 participants. Based on our experience and observation, key factors influencing participation numbers included the attractiveness of the topic, the general relevance and scope of the theme, and the timing of the session within the conference schedule (Table 3).

### 3.3 Impact of the workshop's paper collection

To maximize the outcomes and influence of the workshops, a paper collection initiative was organized. A total of 11 high-quality papers were collected, representing diverse perspectives from universities, VET institutions, CoVEs, and enterprises. Notably, 54% of the papers were co-authored by contributors from different institutions, and 36% were co-authored by contributors from diverse institutions in different countries. These statistics highlight the value of the workshops in fostering transnational collaboration and knowledge sharing. Moreover, the workshop papers will be published online which is public and accessible to anyone.

**Table 3 – Workshop organizers’ feedback (workshop classification by attendees’ number)**

Grouping by attendee’s number	Institution / Organization’s type	3. Your workshop was useful for:	4. How many attendees have participated in your workshop?
More than 20	University	a) Preparing learners, students, and professionals with skills and competencies for the future, b) Empowering regional innovation based on regional needs	20-40 people
More than 20	Company	a) Preparing learners, students, and professionals with skills and competencies for the future, b) Empowering regional innovation based on regional needs	27 people
From 10 to 20	Company	To understand and overcome challenges of the growing community of international students	12 people
From 10 to 20	University	a) Preparing learners, students, and professionals with skills and competencies for the future	17 people
From 10 to 20	COVE program	a) Preparing learners, students, and professionals with skills and competencies for the future, d) The establishment of an international learning community, e) Establishment of Centres of Vocational Excellence (CoVES)	20 people
From 10 to 20	VET	a) Preparing learners, students, and professionals with skills and competencies for the future, d) The establishment of an international learning community	20 people
From 5 to 10	University	get an overview of synergies and differences in Energy Education	5 people
From 5 to 10	University	c) Upscaling and promoting work-based education, d) The establishment of an international learning community	5 people
From 5 to 10	University	a) Preparing learners, students, and professionals with skills and competencies for the future	6 people
From 5 to 10	University	c) Upscaling and promoting work-based education, d) The establishment of an international learning community	8 people
From 5 to 10	Company	a) Preparing learners, students, and professionals with skills and competencies for the future, c) Upscaling and promoting work-based education	9 people
Less than 5	VET	Prepare some mobility, publicize our Erasmus+ project GreenTech	2 people

Source: own elaboration

### 3.4 Contribution of workshops to network building

- Horizontal integration: expanding the network.

The SEED conference provided participants with an excellent opportunity to connect small-scale individual relationships into a broad and tightly-knit network. Through interactive activities such as workshops, the conference moved beyond the unidirectional interactions typically seen in traditional conferences—limited to listening and speaking—to create spaces

for multilateral communication and collaborative learning. This establishment of horizontal connections has made our community more cohesive and open.

- Vertical deepening: fostering diversity and bridging practice with theory.

The SEED conference emphasized the inclusion of diverse participants, with representatives from academia, industry, and various cultural backgrounds. Simultaneously, the conference actively strengthened ties with market-oriented practices, building bridges that balance practical and theoretical approaches. This design not only enhanced the diversity of our community but also provided a multidimensional network with greater depth and structure for sustainable development.

## 4. Conclusions

The SEED conference and its designed workshops have provided valuable insights and experiences for building transnational learning communities. The key conclusions are as follows:

### 4.1 The essential role of workshops in building transnational learning communities

The broad participation and high appraisal of the workshops highlight their indispensable role in fostering transnational learning communities. According to survey results, the workshops were among the participants' favorite activities and served as an essential platform for inspiration. This suggests that workshops, as highly interactive and participatory activities, effectively address the limitations of traditional conferences in terms of the depth and breadth of engagement. They not only facilitate the exchange of knowledge and experience but also The interactive nature of workshops fostered the creation of new professional networks and strengthened existing partnerships. These connections extended beyond the duration of the conference, laying the groundwork for future collaborations. By creating a space where stakeholders could engage in meaningful dialogue, the workshops contributed to the long-term sustainability of the SEED learning community.

### 4.2 Integration of high-quality diversity and market orientation

The workshops attracted organizers and participants from diverse backgrounds, including universities, VET organizations, COVE projects, and government entities, enhancing the conference's diversity and market orientation. This broad participation not only enriched the sharing of experiences but also deepened the connection between the education and industry sectors. Such integration has always been key to achieving the goals of sustainable energy education. The workshop content and format were closely aligned with market needs, Through these workshops, we achieved multi-stakeholder collaboration, strengthened trust and cooperative capabilities among institutions from different countries, and laid a solid

foundation for future project cooperation and network building. In other words, the workshops demonstrated that transnational learning communities could serve as platforms for aligning diverse interests and achieving shared goals.

#### **4.3 Generating practical tools and resources and continuous improvement**

The outputs of the workshops, including frameworks, toolkits, and policy recommendations, provided tangible resources for the broader community. These materials were disseminated through the SEED network, amplifying the impact of the conference and ensuring that the knowledge generated reached a wider audience.

Despite the significant achievements of the workshops, there remain areas for improvement. For instance, enhancing the efficiency of participant organization, optimizing the selection process for attendees, and improving the dissemination of workshop outcomes are priorities. Digital solutions could be integrated into the whole solution package, such as expanding reach through virtual platforms and providing opportunities for online interaction and learning for participants unable to attend in person.

In the future, we will continue to strengthen and optimize the use of workshops as a powerful tool, to enhance the workshops' contribution to the development of learning communities while providing stronger support for the long-term sustainability of the SEED project.

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#### **Conflicts of interest**

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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## Chapter 13

### Stakeholder Mission Mapping as a key tool for regional learning strategy

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#### Abstract

Sustainable energy education has become a key component in achieving carbon neutrality goals by continuously increasing demand for renewable energy. This study investigates effective strategies and action plans for building regional learning communities within the framework of transnational educational initiatives. The research demonstrates that workshops, when well-designed based on appropriate educational theories selected, co-design methodology, and high-quality implementation of workshops based on a rigorous organization and monitoring system, play a pivotal role in fostering the establishment and growth of regional learning communities, highlighting the designing and organizing a series of continuous and replicable workshops which were supported by data collection through participant feedback, questionnaires, and case studies. The findings offer practical guidance for scaling transnational education cooperation and impact from international project teams to regional (local) levels. Furthermore, this approach can broadly apply in other contexts, given appropriate adaptation to specific needs.

**Keywords:** replicable workshop, regional learning strategy, regional learning community creation

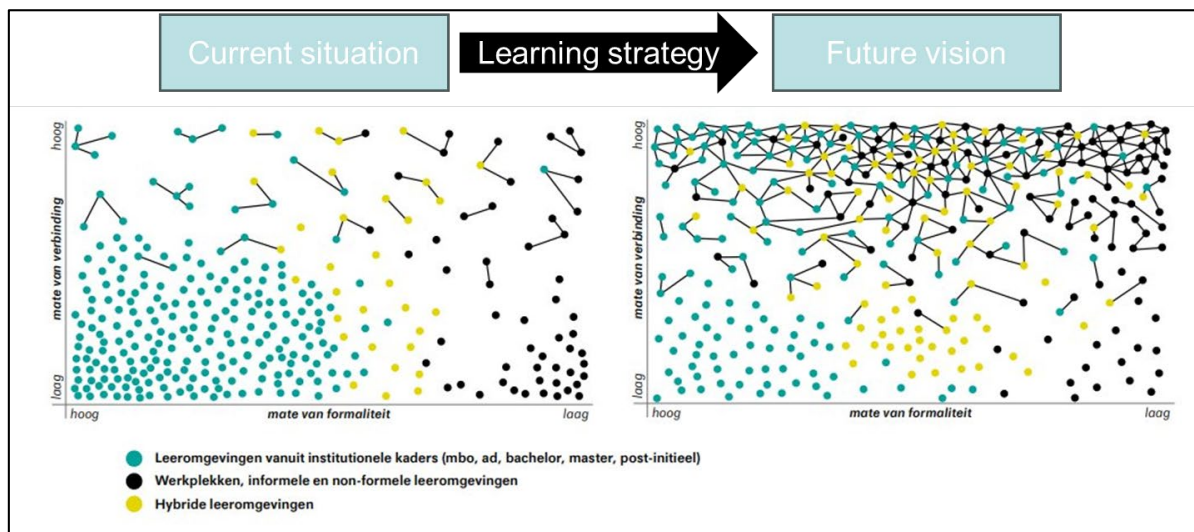
How to cite: Wang, R.; De La Poza, E.; Blazquez Soriano, A.; van Onselen, L; Celani, A.(2024) Stakeholder Mission Mapping as a key tool for regional learning strategy. In De la Poza Plaza, E., Blazquez-Soriano, A. and Wang, R. (Eds.), *SEED Workshops: Designing a transnational learning strategy*, 113-121. <https://doi.org/10.4995/SEED2024.2024.19558>.

## 1. Introduction

SEED is a CoVE (Centres of Vocational Excellence) program under Erasmus+, aiming to establish transnational platforms for regional development, innovation, and inclusion. Developing a strategic framework to establish a learning community within the CoVE SEED<sup>1</sup> project and ensuring its sustainable development is essential. Therefore, learning strategies, specific action plans, and corresponding monitoring and control systems must be designed. Notably, the strategy should focus not only on creating a community but also on ensuring its sustainability.

The CoVE program involves five partners, and each region requires its own learning strategy to transition from its current state to the envisioned future (CoVE establishment). In SEED, all regions are treated as one unit, necessitating a unified learning strategy emphasizing collective progress. The "learning together" approach is the key. The designed learning strategy should integrate and transform individual elements into a cohesive network, aligning perfectly with the project's objective of fostering community creation (Fig. 1).

Fig. 1 – The learning strategy: from one-to-one relationships to a network.



Source: Adapted from Zitter, I. & Hoeve, A. (2012)

<sup>1</sup> You can check more information about the project at the CoVE SEED official webpage: <https://coveseed.eu/es/>

## 2. Replicable workshop design and implementation

### 2.1 Replicable workshops: Train the trainers approach

When designing the learning strategy and action plans to build a learning community, the SEED project team needed to account for the program's impact across five regions. Managing such a wide scope requires an efficient, cost-effective approach. Large conference-style events involving many participants would demand significant resources and face logistical challenges, such as scheduling conflicts that could delay community creation and hinder SEED's progress.

To address this, the team adopted a "train-the-trainers" approach, dividing a large group into smaller, manageable units. Project team members were first trained, and then tasked with training educators who would engage regional stakeholders to build and develop a local learning strategy and the final target of creating local learning communities. After researching potential tools, workshops were identified as efficient, versatile instruments for skill development, strategic planning, and creative problem-solving. In the context of creating a national-level learning community, the workshop's characteristics were tailored to the project's needs:

- **Replicability:** The workshop's content and format should be standardized to enable project partners to develop regional learning strategies collaboratively
- **Scalability:** The workshop should accommodate varying participant numbers.
- **Accessibility:** Online participation should be an option to expand reach and enhance the project's regional impact.
- **Standardized Output Framework:** A standardized output template should be provided for all regions to ensure comprehensive results.

Based on this analysis, the goal was to design a complete workshop set for developing regional learning strategies and action plans. The master workshop, held in Kozani, Greece, in September 2024, trained participants to use appropriate tools for creating and implementing regional learning strategies, action plans, and monitoring systems. This workshop was then replicated with local stakeholders to refine and tailor regional strategies for maximum feasibility and relevance.

### 2.2 Workshop design

The CoVE SEED project aims to "develop excellent and innovative vocational training to achieve a fossil-free energy continent." A key sub-objective is to establish regional learning communities. The first step in achieving this is designing a dynamic regional learning strategy to consolidate networks, build strong connections, and adapt to changing circumstances.

Given the inevitability of external changes, continuous learning is essential for CoVEs to mature effectively.

To achieve this, the workshop structure was divided into three parts:

1. **Review of Regional Plans and Vision Definition**
2. **Strategic Analysis:** Answering critical questions to assess regional needs and progress.
  - a. Who needs to learn (priority groups)?
  - b. What knowledge or skills are required?
  - c. Is progress being made (best practice implementation)?
  - d. What barriers hinder faster advancement?
  - e. How will progress be monitored regionally?
3. **Actionable Outputs:** Participants complete a learning strategy and an action plan, including key activities and KPIs to monitor progress.

To ensure effective training, the workshop organizing team, which was composed by members of the Universitat Politècnica de València (UPV), collaborated with experts in the field, including Dr. Lenny van Onselen and Dr. Evelien Ketelaar from HU University of Applied Sciences Utrecht. The team selected "Mission Mapping" as the primary workshop tool to support designing and creating the regional learning strategy based on an overview of current activities and new ideas for regional learning.

### **2.3 Workshop's training material and training tool: Mission Mapping**

Mission Mapping is a tool used to support networked learning in new domains. The tool helps to create an overview of a network and the activities contributing to a learning mission. With the overview, it becomes possible to identify gaps and zoom in and out of a region, which not only allows people to see the details but also to analyze them in a general way, to adapt to new information and changing circumstances, and to define position. With a shared mission as a starting point, Mission Mapping can help create an overview of activities and group them into themes. Mission Mapping can also be followed by generating learning opportunities, creating bridging activities, and formulating regional learning objectives.

Workshop participants created their Mission Map online (using Miro board) and offline (with printed materials). The regional replicable workshops can adapt the tool to suit specific stakeholder needs, reflecting variations in size, culture, and development across CoVEs. Fig. 2 details the steps to follow in the Mission Mapping creation process.

Fig. 2 – Mission Mapping steps



Source: Kuijper et al. (Under review)

## 2.4 Implementation of the Master Workshop

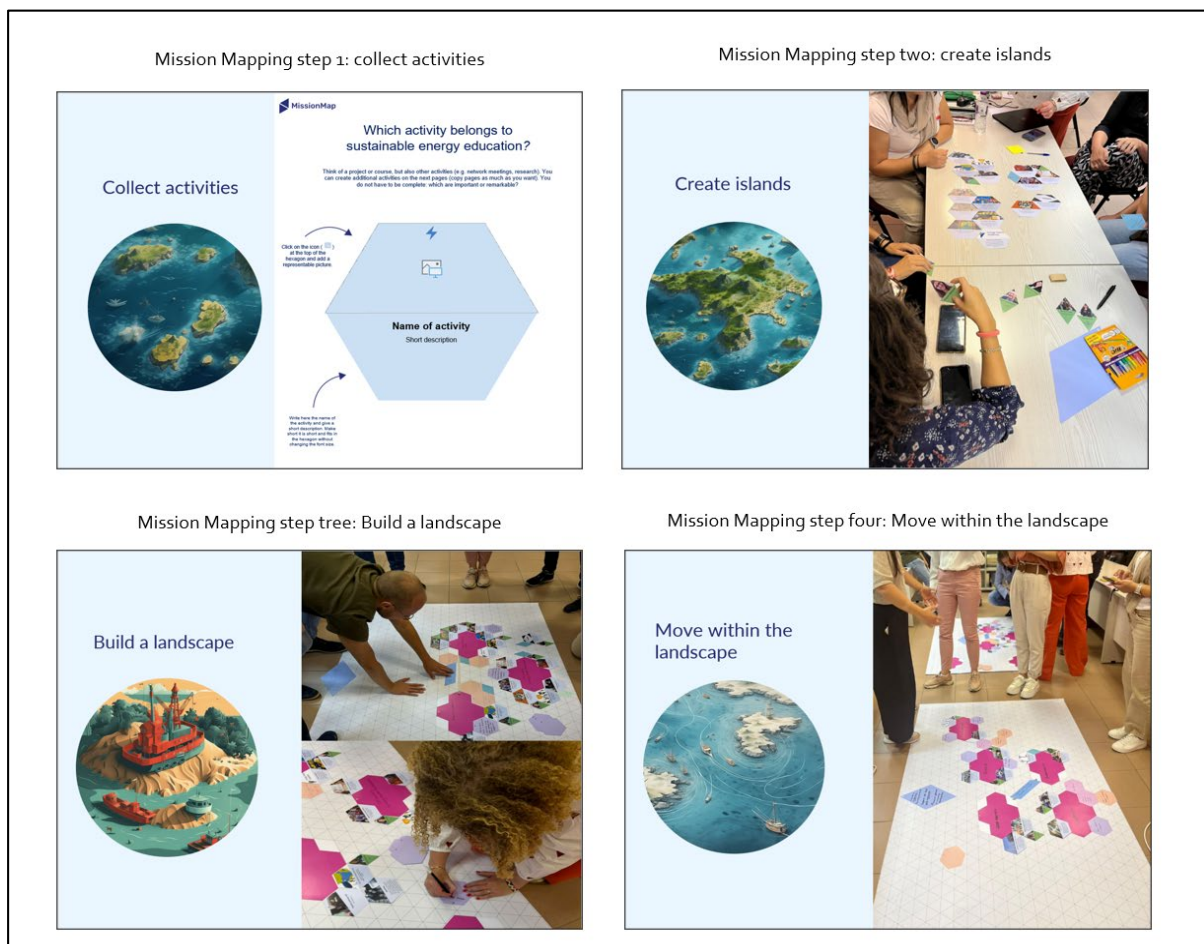
The master workshop, designed as a replicable workshop, was conducted over 2.5 hours in a hybrid format, enabling both in-person and online participation by all project members. The time allocated to each section of the workshop was carefully planned to reflect the importance of its content. The introduction was allotted 5 minutes. Subsequently, the organizing team from UPV scheduled 20 minutes for Part 1, which involved reviewing regional plans and defining the vision for each region. Part 2 was allocated 30 minutes, during

which participants were required to address specific questions based on their regional plans to comprehensively understand their current status.

The most extensive segment, Part 3, lasted 1.5 hours. This segment was facilitated by experts from HU University of Applied Sciences Utrecht, who introduced the Mission Mapping tool. This tool guided participants in formulating a regional learning strategy and translating it into actionable plans. The workshop concluded with a brief 5-minute summary highlighting key takeaways.

Participants mapped the CoVE system during the workshop, focusing on its core entities, including education, industries, research institutions, students, communities, and government bodies. They identified challenges and explored emerging opportunities to enhance sustainable energy education within the CoVE framework through Mission Mapping. The mapping process, illustrated in the accompanying pictures (Fig. 3), clearly represents the strategic landscape and actionable pathways.

**Fig. 3 – SEED project team members applying the Mission Mapping in the master workshop**



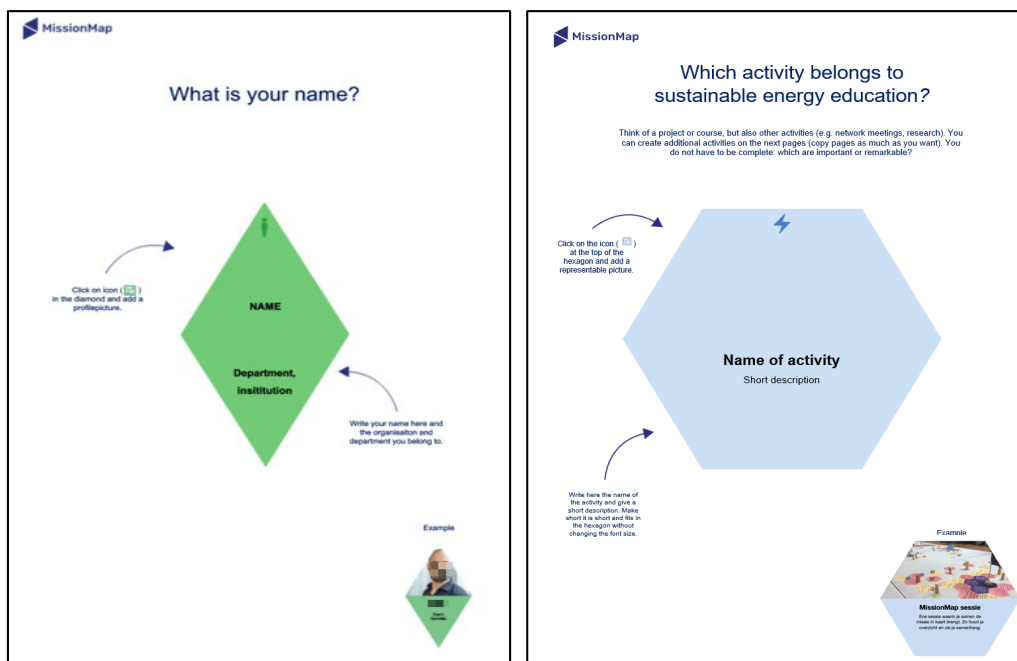
Source: Own elaboration

## 2.5 Regional workshop replication

After attending the master workshop, participants were tasked with replicating the workshop within their respective regions. The participants were encouraged to adapt and apply the tool to facilitate their own region's strategy development. This replication workshop required inviting relevant stakeholders, entities, and contributors who could aid in designing and developing regional CoVE strategies. The objective was to refine and finalise the regional strategy plans collaboratively.

To support this process, participants prepared the necessary materials, as depicted in Fig. 4. These materials were designed to accommodate both digital and physical formats, enabling flexibility for in-person and online participation. This approach ensured accessibility and inclusivity, fostering active engagement from diverse regional stakeholders.

Fig. 4 – Mission Mapping material preparation required for each region



Source: Designed by Kuijper et al. (Under review)

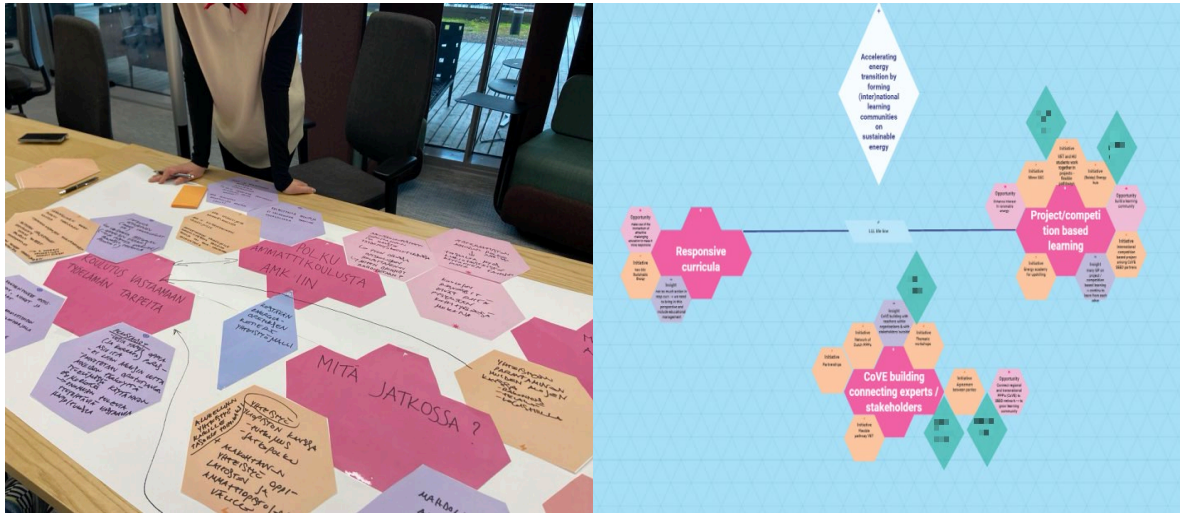
## 3. Results

Following the master and regional workshops, the SEED project successfully formulated transnational and regional learning strategies, action plans, and monitoring frameworks. These were available digitally via Miro for team-project access (Fig. 5). It is an important step forward from the point of view of the SEED project development.

The master workshop had 23 participants (14 in person, 8 online), while regional workshops engaged 66 attendees across five regions. The post-event assessment rated the master

workshop 3.85/4. Participants highlighted its value in developing regional learning strategies, with at least four attendees noting its significant impact on their understanding of the topic.

Fig. 5 – Example of regional Mission Mapping



Source: Own elaboration

#### 4. Conclusions

The workshop achieved an outstanding result, demonstrated by the evaluation score of 3.85 out of 4. This high score is a testament to the workshop's success and impact; participants strongly agreed that the workshop was insightful on the regional learning strategy. Below are key elements we consider that bring us the workshop's success.

Firstly, the workshop's wide use and regional impact are worth highlighting. With the idea of replicating the workshop, the project achieved 66 more participants than one workshop. The workshop's influence was increased significantly. This workshop is about creating the regional learning strategy, which is the essence of the project and is also the beginning and base of all the actions.

Secondly, the content, technique, and technologies highlight the organization's execution. It was the first workshop in a hybrid format (in-person and online participation). In this way, although there are more uncertainties, this format allowed all the regions and all the partners to participate in both the master and replicated workshops. However, the participation of online partners must fulfil two objectives: learning the Mission Mapping tool by studying the material and watching the workshop, then replicating it with regional stakeholders.

Moreover, it is also worth mentioning the organization, the great work, the design, and the workshop execution between partners that allowed the attendees to take full advantage of the workshop. The excellent planning, which resulted from effective communication

between workshop organizers and participants throughout the whole workshop period, reassured us about the workshop's organization.

At the same time, an efficient collaboration between the project partners from UPV and HU University of Applied Sciences Utrecht was conducted to maximize the quality of the workshop. This collaboration, which was more than just a form of 'learning together' but a demonstration of the strength of the partnership, was also a significant factor in the workshop's success.

Finally, this case highlights the crucial role of well-designed workshops in fostering regional strategy creation and development, as does the regional learning community. Workshops can drive significant progress and impact by aligning methods and content with objectives and maintaining high organizational standards.

## **Acknowledgements**

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## **Conflicts of interest**

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