GREEN AND DIGITAL SKILLS DEVELOPMENT FOR EUROPEAN ENGINEERING PHD CANDIDATES

RESULTS GUIDE

Co-funded by
the European Union

INDEX

TRAINING METHODOLOGIES

PROJECT-BASED LEARNING.

Project-Based Learning (PBL) is a learner-centred educational methodology based on three key constructivist principles [1]. First, it recognises that learning is context-specific, meaning that it occurs most effectively when it is embedded in real-world situations. Secondly, students play an active role in their learning process, actively participating in the acquisition of knowledge. Finally, the importance of social interactions and the sharing of knowledge and understanding in achieving educational goals is emphasised.

Therefore, PBL is considered a particular type of Research-based learning, where the educational context is constructed through the exploration of authentic questions and problems linked to real-world situations, leading to meaningful learning experiences [2]. This should not be confused with problem-based learning, as its focus is on solving a particular problem, and it can also deal with other areas of knowledge that are not problems [3]. In this way, a project executed under the PBL methodology focuses not only on learning about something, but also on carrying out a task that solves a practical problem. Thus, PBL promotes more meaningful and applicable learning experiences [4].

From an educational perspective, a project can be defined as a learning strategy that achieves one or more objectives by implementing a series of actions, interactions and resources [5]. Thus, the PBL teaching methodology transforms the elaboration of projects into a didactic strategy within the so-called active methods. Methodologies, where a project is conceived as the search for intelligent solutions to problems or tasks linked to the real world [6].

In this context, many projects focus on concrete and pressing environmental or societal issues. The fundamental purpose of a project is to contribute to the resolution of complex issues that a priori lack simple solutions [7]. In this way, PBL fosters more meaningful and applicable learning experiences, as students not only absorb information, but also actively apply knowledge and skills in practical and relevant situations [8].

KEY PRINCIPLES

Context specificity:

PBL is based on the principle that learning is most effective when it is placed in real-world contexts. The connection between theory and practice motivates students by showing them the direct relevance of what they are learning.

Active Participation:

Engineering doctoral students play a central role in their learning process in PBL. They act as active agents in exploring, investigating and applying concepts to solve practical problems.

Social Interactions:

Collaboration among students is essential in PBL. Social interactions and knowledge sharing not only strengthen understanding of topics but also cultivate social and communication skills.

Practical Implementation

The implementation of PBL methodology should consist of the following steps:

1) Project selection: teachers and students collaborate in choosing challenging and relevant projects. These may address current issues, such as environmental sustainability, social issues, or technological innovations.
2) Planning and development: a detailed plan is established that includes objectives, roles of the engineering doctoral students, resources needed, and a timeline. During development, students actively apply learned concepts to solve concrete problems.
3) Evaluation and presentation: evaluation is not limited to the knowledge acquired; it also encompasses presentation, communication, and teamwork skills. The results of the project are presented to the educational community (other students, other disciplines, etc.), providing an opportunity to share learning and experiences.

Benefits and Applicability

In the university environment, Project-Based Learning offers several applications and advantages that transform the educational experience:

Motivation and Relevance:

PBL increases the motivation of engineering doctoral students by providing them with projects that have direct and practical applications in their field of study. Connecting to real-world problems and situations gives them a broader and more relevant perspective.

Integrated Skills Development:

In the university context, PBL goes beyond merely transmitting theoretical knowledge. It facilitates the development of essential skills such as critical thinking, problem-solving and collaboration, preparing students for future professional challenges.

Preparation for the World of Work:

By tackling projects that simulate real-world challenges, the PBL enables engineering doctoral students to address complex and dynamic situations, replicating the demands of the professional world. When entering the job market, this gives them an advantage with applicable skills and practical experience.

Interdisciplinarity:

The PBL methodology facilitates the integration of various disciplines, promoting an interdisciplinary approach to problem-solving. This reflects the reality of many professional environments requiring collaboration between specialisations.

Active Participation:

Compared to traditional teaching methods, PBL encourages more active participation from university students. Taking a central role in the planning and execution of projects promotes autonomy and engagement in the educational process.

Comprehensive assessment:

Assessment in PBL goes beyond conventional tests. It assesses not only the knowledge acquired but also research, presentation, teamwork, and problem-solving skills, providing a comprehensive evaluation of the student's performance.

Encouraging Creativity:

When faced with complex problems, undergraduate engineering doctoral students must apply creativity to find innovative solutions. This ability to think creatively becomes a valuable skill in their career paths.

DEPLOYMENT RESOURCES

The successful implementation of Project-Based Learning (PBL) in the university environment requires access to valuable resources that support both educators and students in planning, executing, and evaluating projects. Here are some resources that you may find helpful:

CONCLUSIONS

Project-Based Learning (PBL) is presented as a particularly valuable educational methodology in the university context, standing out for its ability to establish meaningful connections between theoretical knowledge and practical applications in the real world. By engaging students in projects that reflect authentic challenges, PBL not only conveys academic information but also promotes the development of practical and applicable skills. This approach goes beyond simply transmitting knowledge, empowering engineering PhD students to become active and decisive learners, which is essential to effectively prepare them for the dynamic and complex challenges of contemporary life and work.

The successful implementation of PBL in university teaching requires careful planning that includes the precise definition of educational objectives, the appropriate selection of projects and the allocation of proper resources. By adopting a student-centred approach, university educators can foster autonomy and responsibility in learning, creating an environment conducive to the holistic development of engineering doctoral students. At its core, PBL stands as an essential bridge between academic theory and practical application, forging not only a deep understanding of concepts but also skills necessary for success in an ever-evolving professional and educational environment.

CHALLENGE-BASED LEARNING

Challenge-Based Learning (CBL) is an innovative educational methodology that seeks to bridge the gap between academic theory and its practical application, focusing on the active participation of students in real and relevant problematic situations related to their environment [9]. This approach is based on the fundamental premise that students learn most effectively when they are actively engaged in open-ended learning experiences, as opposed to passively participating in structured activities [10].

The CBL is inspired by the Experiential Learning model and is presented as a holistic and integrative approach that combines experience, cognition, and behaviour [11]. Its main objective is to establish a dynamic interaction between academic study and its practical application, promoting meaningful and lasting learning. By defining concrete challenges and facilitating the implementation of solutions, CBL drives active problem-solving and the development of key skills [12].

This approach, originally introduced by Apple in the context of K-12 education and later adapted for higher education, differs in that it offers general concepts rather than specific problems to students [13]. It aims to capitalise on students' interest in conferring practical meaning on their education by fostering essential skills such as collaborative and multidisciplinary work [14]. In addition, the CBL is characterised by its interdisciplinary nature, encouraging projects that not only engage students but also connect with the community at large [15]. The combination of allowing students to choose their challenges and linking them to community interaction significantly increases their investment and commitment to productive outcomes. At its core, Challenge-Based Learning is presented as a dynamic approach that not only transforms learning dynamics but also cultivates essential skills for success in academia and careers [16].

In contrast to Project-Based Learning (PBL), CBL has notable differences. While PBL encompasses broad and complex projects that cross various areas of knowledge, CBL focuses specifically on identifying and solving specific challenges linked to real-world situations. This distinction provides the CBL with a more precise orientation towards resolving specific problems, encouraging students to be creative and autonomous, as they play an active role in defining and addressing the proposed challenges [17].

KEY PRINCIPLES

Identifying Significant Challenges:

The CBL focuses on identifying authentic and relevant challenges linked to real-world situations that stimulate the curiosity and interest of doctoral engineering students.

Active Student Participation:

The active participation of students in the definition, analysis and resolution of the proposed challenges is encouraged, promoting more autonomous and meaningful learning.

Interdisciplinary Approach:

The CBL seeks to transcend disciplinary barriers, encouraging the integration of knowledge from various areas to address challenges holistically.

PRACTICAL IMPLEMENTATION

Implementing Challenge-Based Learning (CBL) is structured into several stages, from the initial idea to the validation of the project. The deployment flow is detailed below:

1. General Idea: The CBL begins with a broad and engaging general idea relevant to students and society as a whole. This idea, like biodiversity, health, war, sustainability, democracy, or resilience, has global significance.
2. Essential Question: From the general idea, various questions are generated that lead to the design of a critical question. This question reflects the interest of engineering doctoral students and the community's needs, directing the focus towards more manageable aspects of the concept.
3. Challenge: arises from the essential question, and a challenge/challenge is articulated in a way that involves students in creating a specific solution. This solution must be translated into concrete and meaningful actions, framed to address the general idea and essential questions through local initiatives.
4. Questions, Activities, and Resources Guide: Students generate questions, activities, and guiding resources as part of the process. These represent the knowledge needed to successfully develop a solution, providing a roadmap for the learning process. They identify lessons, simulations, activities, and content resources to lay the foundation for innovative, insightful, and realistic solutions.
5. Solution: each challenge posed is broad enough to allow for various solutions. The resulting solution must be thought out, concrete, clearly articulated, and feasible to implement in the local community.
6. Implementation: PhD engineering students test their implementation's effectiveness in an authentic environment. The scope of this action may vary, but even the least effort to execute the plan in a real-world setting is crucial. The challenge process guides implementation, and both the process and the product are evaluated by the teacher through formal and informal evaluations.
7. Validation: Students evaluate the success of their solution using qualitative and quantitative methods, such as surveys, interviews, and videos. The active participation of the teacher and experts in the discipline is essential at this stage.
8. Reflection and Dialogue: deep reflection on one's learning and the relationships between content, concepts, and experience is encouraged. Engineering doctoral students interact with the community and each other, enriching their understanding through reflection and continuous dialogue.

BENEFITS AND APPLICABILITY

CBL offers a wide range of benefits and applications that enrich the educational experience and prepare engineering doctoral students to face real-world challenges:

Connection to the Real World:

CBL stands out for its ability to directly connect academic learning and real-world situations. By addressing concrete and relevant challenges, students experience meaningful and applicable learning, visualising the direct relevance of their studies in real environments.

Key Skill Development:

This pedagogical approach encourages the comprehensive development of essential skills for the 21st century. Engineering PhD students not only gain academic knowledge but also cultivate skills such as critical thinking, problem-solving, creativity, collaboration, and effective communication.

Motivation and Commitment:

The challenging and meaningful nature of the challenges proposed in the CBL increases student motivation and engagement. By working on "projects" that have a real impact, engineering PhD students feel more connected to their learning process, promoting active and sustained engagement.

Preparation for the World of Work:

CBL prepares students to face situations like those they will encounter in the workplace. By addressing complex and multifaceted problems, students develop the ability to face challenges from the professional environment, improving their adaptability and problem-solving skills in real contexts.

Development of Social Awareness:

The challenges proposed in the CBL are often linked to social and community problems. This fosters the development of social awareness and empathy in students as they work to find solutions that benefit the community.

Flexibility and Adaptability:

Since challenges can address a variety of topics, CBL is highly adaptable to different areas of knowledge. This flexibility allows it to be implemented in various educational contexts and disciplines.

Autonomous Learning:

CBL promotes autonomous learning by allowing engineering PhD students to lead their research and problem-solving processes. This autonomy strengthens the ability of engineering doctoral students to manage their knowledge and acquire research and self-direction skills.

Promotion of Innovation:

When facing specific challenges, students are driven to seek innovative solutions. CBL encourages creative thinking and the pursuit of novel approaches to problem-solving, thereby cultivating a culture of innovation and research among students.

CONCLUSIONS

In the university environment, Challenge-Based Learning is a pedagogical strategy offering substantial advantages. This approach goes beyond research and proposing solutions,

involving direct interaction with the "real world", ranging from collaboration with people and organisations to using tools from the professional environment. By promoting the development of generic competences, the ABR also distinguishes itself by cultivating essential values such as responsibility, involvement, and commitment, which are crucial aspects for engineering doctoral students seeking relevant solutions.

The diversity and breadth of generic competences are palpably integrated into this approach, providing university students with an enriching educational experience. The effectiveness of the proposed solutions not only generates positive stimuli but also instills a sense of satisfaction derived from the realisation of work with direct applicability in real contexts, thus contributing to students' growth and integral development.

Finally, concrete benefits for engineering doctoral students include a deeper understanding of the topics, the acquisition of skills to diagnose and define problems before proposing solutions, and the stimulation of creativity. The active participation of students, both in identifying problems and formulating solutions, significantly strengthens the connection between academic knowledge and the reality surrounding them, providing a more meaningful and applicable educational experience.

RESEARCH-BASED LEARNING

Research-Based Learning (RBL) is an educational methodology that allows students to participate in research processes, applying methods to validate hypotheses, address problems, or answer questions posed [18]. This approach is characterised by accompanying and comprehensively supervising the entire research process, allowing students to actively enter the generation of knowledge.

Within the framework of Higher Education, where it seeks to train students to generate knowledge, apply skills, and continue learning throughout their professional careers, the RBL emerges as a fundamental tool. The development of essential competences for academic, professional, and personal life becomes a central objective, and to achieve this, students must acquire and apply research methods [19].

This pedagogical model finds coherence in contemporary didactics, which is based on the idea that students build knowledge from practical experiences, autonomous work, collaborative learning, and discovery [20]. These elements are essential for achieving significant learning and promoting the development of knowledge and attitudes necessary for innovation in various fields, including scientific, technological, humanistic, and social.

The RBL also highlights the importance of the teacher as the main researcher, exercising a crucial role by serving as an example, providing guidance, and supervising the research process [21]. By bringing research closer to the educational environment and turning students into researchers, an enriched learning environment is promoted, which not only conveys theoretical knowledge but also fosters the ability to generate new knowledge in an active and participatory manner [22].

In contrast to the PBL methodology, which focuses on the realisation of broader and more complex projects that cover various areas of knowledge, the RBL focuses specifically on research. While a project seeks the practical application of knowledge to solve a problem, the RBL emphasises the generation of new knowledge through deeper and more specific research processes [18]. On the other hand, the CBL methodology is distinguished by its definition of concrete challenges and the search for active solutions, which are linked to real-world situations. Unlike the RBL methodology, which focuses on research as the main process.

In summary, the RBL methodology stands out for its focus on research and knowledge generation, unlike PBL and CBL methodologies, which focus on the practical application of knowledge to solve problems or address specific challenges.

KEY PRINCIPLES

Active Immersion in Research:

The RBL is based on the active participation of students in research processes. This principle recognises that the generation of knowledge goes beyond the mere absorption of information and encourages students to immerse themselves in inquiry, formulating

questions, designing research and contributing directly to advancing knowledge in their area of interest.

Cultivating Curiosity and Meaningful Questions:

The RBL is designed to foster students' intrinsic curiosity. It promotes the formulation of meaningful questions that stimulate reflection and in-depth exploration. This principle recognises that learning is enhanced when students can direct their research, addressing questions that arouse their interest and intrinsic motivation.

Promotion of Teacher Guidance as a Facilitating Guide:

Requires a teaching guide to act as a facilitator and mentor. Educators play a key role in formulating research questions, teaching methods, and techniques of research, and providing support throughout the research process. This mentor-student relationship not only facilitates learning but also shapes the attitude and ethics of the researcher.

PRACTICAL IMPLEMENTATION

Implementing the RBL involves a careful design that encourages the active participation of engineering doctoral students in research processes. Here are the key steps to carry out this methodology effectively in a university environment:

1. Selection of Significant Research Topics: The process begins with choosing research topics that are relevant and motivating for students. It seeks to awaken their interest and curiosity, allowing them to explore areas that connect with their academic and professional aspirations.
2. Formulation of Research Questions: Engineering doctoral students should be guided in formulating meaningful research questions. These questions should be clear, specific, and addressable, allowing for a practical approach to data collection and analysis.
3. Development of Methodological Skills: essential to carry out effective research, encompassing the teaching of data collection methods, analysis techniques and the interpretation of results. In this phase, engineering doctoral students develop practical skills and competences that are essential for their academic and professional growth.
4. Teaching Accompaniment and Mentoring: teachers should act as facilitators and mentors, providing expert guidance. In addition to instructing research methods, educators play a crucial role in providing emotional and motivational support, guiding students through challenging times, and celebrating their achievements.
5. Presentation and Communication of Results: Effective communication of research results should be emphasised. Engineering doctoral students learn to present their findings clearly and persuasively, developing oral and written communication skills essential in the academic and professional fields.
6. Continuous Assessment and Constructive Feedback: essential for measuring student progress. Constructive feedback mechanisms are implemented, allowing educators to identify areas for improvement and offer suggestions for improving research skills.

BENEFITS AND APPLICABILITY

Research-Based Learning (RBL) emerges as an educational methodology that goes beyond the mere transmission of knowledge, placing engineering PhD students in the active role of researchers. This approach not only boosts the development of research skills but also generates a series of benefits that strengthen students' academic and professional preparation. Next, the key aspects that make the RBL a valuable pedagogical tool in the university environment are explored.

Development of Integral Competences:

The RBL contributes to the comprehensive development of engineering doctoral students by combining the acquisition of knowledge with the strengthening of critical and analytical skills. The ability to design, carry out, and analyse research improves the preparation of doctoral engineering students to face academic and professional challenges.

Intrinsic Motivation:

The research process intrinsic to RBL fosters student motivation. By allowing students to choose research questions that are relevant and meaningful to them, authentic interest and deeper engagement with learning are promoted.

Advanced Communication Skills:

RBL promotes the development of advanced communication skills. Students not only learn to clearly express their research questions but also hone the ability to effectively present and communicate their findings, both orally and in writing.

Development of Critical Thinking:

The challenging nature of the research process stimulates critical thinking. Students face complex problems, learn to analyse information critically, and develop the ability to formulate evidence-based conclusions.

Transdisciplinary Applicability:

Although RBL is especially effective in disciplines where research is common, its methodological approach is transdisciplinary. It can be applied in various areas of knowledge, allowing its implementation in a variety of academic contexts.

Contribution to Knowledge:

RBL not only benefits students but also contributes to the advancement of knowledge in various disciplines. Student-led research can offer new perspectives, data, and approaches that enrich the academic field.

Development of Academic Autonomy:

By allowing students to formulate their own research questions and lead their own projects, the RBL fosters academic autonomy. This active, student-led approach fosters the development of an autonomous and continuous learning mindset.

CONCLUSIONS

Research-Based Learning (RBL) stands as a valuable tool within the university environment. It goes beyond the transmission of knowledge, empowering and equipping engineering PhD students with crucial skills for their academic development and professional future. By focusing on active research, RBL opens a unique door to transcend disciplinary barriers, immersing students in critical thinking and problem-solving from diverse perspectives.

This methodology not only provides information but also stands as an essential ally for the development of comprehensive competences in engineering doctoral students. By providing research, analysis, and synthesis skills, the RBL prepares them to meet academic and professional challenges with confidence. By fostering curiosity and autonomy, this approach cultivates professionals who are capable of actively contributing to existing knowledge and adapting to an ever-changing world.

In short, the RBL not only transforms the dynamics of university education but also lays the groundwork for training researchers and critical thinkers who will leave a lasting impact on society. Thus, its impact and influence will endure over time by equipping students to take an active role in expanding knowledge, preparing them to assume their role as committed agents in the development of knowledge.

SERIOUS GAMES

At the dynamic crossroads between education and gamification, "Serious Games" stand as a powerful tool that fuses the fun inherent in games with specific pedagogical objectives [23]. These games not only share the fundamental mission of educating but also adopt and enhance gamification dynamics and strategies to achieve specific educational goals [24].

Gamification involves the application of game elements and mechanics in non-game contexts, with the aim of enhancing participation, motivation, and information retention [25]. Serious Games take this premise a step further by integrating these gamification principles into educational experiences that are not only instructive but also entertaining and immersive [26]. In this way, they are characterised by integrating playful elements and game mechanics into an educational framework, with the aim of facilitating the acquisition of knowledge, skills, and attitudes. In addition, the topics addressed by Serious Games are broad and can range from specific academic disciplines to essential soft skills in the workplace, such as leadership, problem-solving, and effective communication [27].

The basis of Serious Games is the conviction that learning can be more effective when it is incorporated in an active and participatory way [28]. Through interactivity and immersion, students can face simulated challenges that mimic real-world situations, allowing them to apply and consolidate their knowledge in a practical way. This practical and experiential approach contributes to a deeper and more lasting understanding of the concepts taught.

There are multiple inherent benefits of Serious Games in the university environment. Not only do they foster student engagement and motivation, but they also provide a platform for the development of cognitive and socio-emotional skills [29]. Immediate feedback, another key component, allows students to learn from their mistakes instantaneously, promoting a cycle of continuous improvement [30].

In addition, these games facilitate the connection between theory and practice by allowing students to experience complex and realistic situations [31]. This practical connection can be especially valuable in disciplines where the practical application of knowledge is crucial, such as engineering, medicine, or business management.

Finally, in this context of educational innovation, it is crucial to recognise the versatility of Serious Games and consider the possibility of combining them with other teaching methodologies that enhance active and meaningful learning. Integrating Serious Games with approaches such as Project-Based Learning, Challenge-Based Learning, and Research-Based Learning can generate valuable synergies. For example, by combining Serious Games with Project-Based Learning, students can apply the knowledge they gain to real-world projects, thereby strengthening their understanding and practical skills. The intersection with Challenge-Based Learning introduces specific challenges that require creative solutions, promoting collaborative problem-solving. Likewise, the connection to Research-Based Learning invites students to explore and deepen their understanding of play-related topics, fostering a broader understanding and active inquiry. Together, these methodologies can enrich the educational experience, providing students with diverse approaches that complement each other for comprehensive learning applicable in the university environment [32].

KEY PRINCIPLES

Interactivity and Active Participation:

The essence of Serious Games lies in the interactivity and active participation of players. These games require participants to be fully engaged, make decisions that affect the plot and apply knowledge in simulated situations.

Clear Challenge and Objectives:

Serious Games must present clear challenges and specific objectives. The game's structure should stimulate problem-solving and goal achievement, thereby encouraging the development of both practical and cognitive skills.

Continuous feedback:

Providing constant feedback is essential. Serious Games should offer immediate feedback on players' actions, facilitating the correction of errors, reinforcing positive learning, and motivating continuous improvement.

PRACTICAL IMPLEMENTATION

The successful implementation of serious games involves considering various aspects, from game design to their effective integration into educational environments. Here are some key points for the practical implementation of these games:

- Educational Goal-Centred Design: Serious Games development should begin with a clear definition of educational goals. Every game element, from the plot to the mechanics, must be designed coherently to ensure pedagogical effectiveness.
- Integration into the Curriculum: Serious Games should not be considered separate entities, but tools integrated into the curriculum. Educators should identify how the game aligns with the subject matter themes and objectives and plan its implementation consistently in course development.
- Clear Roles for Participants: Defining clear roles for students and educators is crucial. Engineering PhD students must understand their responsibilities within the game, while educators must actively guide and facilitate the learning process.
- Accessibility: Ensuring the accessibility of the game is essential. Additionally, the necessary technological infrastructure, including devices, software, and connectivity, must be in place to ensure seamless participation by students.
- Evaluation of Results: Implementing effective evaluation mechanisms is crucial. Educators must measure not only performance within the game but also the transfer of knowledge and skills acquired to academic and practical contexts.
- Flexibility and Adaptability: Serious Games should be designed with flexibility to accommodate different learning styles and skill levels. Additionally, they must allow for real-time adjustments based on student needs and progress.
- Iteration and Continuous Improvement: After the initial implementation, it is crucial to gather feedback and data to iterate and improve the game design. This continuous feedback contributes to the evolution and continued effectiveness of Serious Games.

BENEFITS AND APPLICABILITY

Serious Games offer significant benefits that go beyond the simple transmission of knowledge, especially in the university environment. Their applicability spans various disciplines, making them valuable tools to enrich the learning experience. Here are some of its key advantages in this context:

Improved Engagement and Motivation:

Serious Games capture the attention of engineering PhD students by offering an immersive and fun learning experience. The gamification of education enhances intrinsic motivation, resulting in increased engagement with educational content and goals.

Development of Practical and Cognitive Skills:

By facing simulated challenges within the games, engineering PhD students develop practical and cognitive skills applicable in real-world situations. These skills may include decision-making, problem-solving, critical thinking, and communication skills.

Knowledge Transfer:

Serious Games facilitate the effective transfer of theoretical knowledge into practice. Participants apply what they have learned in realistic situations, which strengthens understanding and retention of concepts.

Promotion of Teamwork:

Some serious games incorporate elements of collaboration and teamwork, encouraging effective communication and teamwork among students. These soft skills are essential in both academic and professional settings.

Immediate Feedback:

The constant feedback provided by the games allows engineering PhD students to learn from their mistakes immediately. Not only does this reinforce positive learning, but it also creates a cycle of continuous improvement.

Personalisation of Learning:

The ability to tailor the Serious Games to the individual progress of engineering PhD students allows for a personalised learning experience. Each student can tackle challenges that match their skill level, thereby optimizing the effectiveness of their learning.

CONCLUSIONS

Serious Games represent an innovative and effective pedagogical tool that redefines the way learning is approached in university education. The fusion of fun and play with specific educational objectives allows for an immersive and meaningful approach to the teaching and learning process.

The ability to provide immersive, personalized, and meaningful experiences makes Serious Games a valuable addition to the suite of educational methods. Its impact extends beyond simply passing on knowledge, as it cultivates practical skills essential for success in academia and careers.

The immersive nature of serious games facilitates the assimilation of knowledge and cultivates critical skills, such as analytical thinking, decision-making, collaboration, and problem-solving. In addition, their ability to adapt to diverse learning styles and offer personalised educational experiences makes them effective allies in motivating engineering doctoral students and maintaining high levels of participation.

Ultimately, the integration of Serious Games into university education aims to prepare engineering PhD students for the complex challenges of the academic and professional world. By offering both theoretical understanding and practical skills, Serious Games stand out as a comprehensive tool that contributes to the holistic development of students, enabling them to excel in an increasingly demanding and dynamic environment.

TRAINING PROGRAMME

Based on the teaching methodologies described above (Project-based Learning, Challenge-based Learning, Research-based Learning, and Serious Games) and on the green and digital competence framework of the TECSKILL project, the training programme was designed.

Firstly, a structured programme was proposed based on the two main competence fields, i.e., the different training sessions were proposed based on the different competences collected within the green and digital competence frameworks. In this way, 22 sessions were proposed within the green competence framework, with between 5 and 8 sessions per competence (Valuing sustainability, Supporting fairness, Promoting nature, Systems thinking, Critical thinking, Problem framing, Futures literacy, Adaptability, Exploratory thinking, Political agency, Collective action and Individual initiative), and 29 within the digital competence framework, with between 9 and 14 sessions for each competence block (Information and data literacy, Communication and collaboration, Digital content creation, Safety and Problem Solving), which in turn grouped between 3 and 6 competences to complete the total of 21 competences. This first draft was developed thanks to the experience of the different teachers of the partner entities in this type of training. Figures 1 and 2 illustrate the structuring of competences in this initial draft.

DIGITAL COMPETENCE TRAINING DRAFT					
GROUP OF COMPETENCE	Number of competences	Possible training session (PBL, CBL y Serious Game methodology)	GROUP OF COMPETENCE	Number of competences	Possible training session (PBL, CBL y Serious Game methodology)
Information and data literacy	3	1-Challenge: advanced search and filtering in ScienceDirect, WOS etc. Definition of keywords. 2-Practical workshop: elaboration of a state of the art. Management and organization of information (develop the state of the art of the scientific congress to be elaborated). 3-Discussion workshop: How to manage the scientific information overload within a research line or project? 4-Practical workshop: creation and organization of a research database. Collection, evaluation, treatment and filtering of scientific data. 5-Discussion workshop: analysis and interpretation of scientific results. 6-Challenge: identify research where the database is not adequate for the scientific objective. 7-Practical workshop: adequate graphical representation of scientific data and information. Flow charts, graphs, graphical abstract. 8-Discussion workshop: understanding scientific diagrams, graphs, etc. 9-Practical workshop: management and organization of information within research projects. 18-Practical workshop: data measurement with sensors.	Safety	4	11-Practical workshop: how to interact with and manage scientific social networks. 14-Practical workshop: information flow, planning and sharing of responsibilities in virtual research projects. 19-Discussion workshop: copyrights and intellectual property of research results. 20-Challenge: patent-industrial protection of a prototype or research result. 21-Practical workshop: creation of an intellectual property contract for a research project. 24-Discussion workshop: frauds and suspicious mail in university environments. 25-Personal work organization with Kanban. Limitation of working hours and effectiveness. 26-Practical workshop: use of digital technologies to reduce environmental impact (for example, José proposed the measurement of CO2 in different environments). **Note: the environmental protection competence 4.4 is also worked with the green competences workshops.
Communication and collaboration	6	7-Practical workshop: proper graphical representation of scientific data and information. Flow charts, graphs, graphical abstract. 9-Practical workshop: management and organization of information within research projects. 10-Practical workshop: organization of an online and face-to-face coordination meeting of a research project. 11-Practical workshop: how to interact with and manage scientific social networks. 12-Challenge: how to elaborate a research abstract in a proper way. 13-Practical workshop: elaboration of a corporate entity for a research project. 14-Practical workshop: information flow, planning and distribution of responsibilities in research projects in a virtual manner. 15-Challenge: creation of a Kanban board for research.	Problem solving	4	4-Practical workshop: creation and organization of a research database. Collection, evaluation, processing and filtering of scientific data. 7-Practical workshop: adequate graphical representation of scientific data and information. Flowcharts, graphs, graphical abstract. 9-Practical workshop: management and organization of information within research projects. 18-Practical workshop: data measurement with sensors. 23-Practical workshop: simulation/modeling of complex research problems (modeling of climate, solar radiation, etc.). 26-Practical workshop: use of digital technologies to reduce environmental impact (e.g., José proposed CO2 measurement in different environments). 27-Practical workshop/challenge: any simulation or management of digital technology in research (here could enter any software management to solve research problems such as those proposed by Roberto and João. It would be the most important of the group of competences) 28-Discussion workshop: How and when to use translation technologies? Deepl., Google Translate, ChatGPT, Microsoft word etc) 29-Challenge: personal assessment of digital skills gaps.
Digital content creation	4	7-Practical workshop: proper graphical representation of scientific data and information. Flow charts, graphs, graphical abstract. 8-Discussion workshop: understanding scientific diagrams, graphs, etc. 11-Practical workshop: how to interact with and manage scientific social networks. 13-Practical workshop: elaboration of a corporate entity for a research project. 15-Challenge: creation of a poster and a paper for a scientific congress (do it for the congress you have to attend). 16-Practical workshop: computer graphics and renderings of prototypes and equipment used in research projects. 17-Challenge: look for a diagram in a scientific article and represent it in a more accurate graphic format. 18-Practical workshop: data measurement with sensors. 19-Discussion workshop: copyright and intellectual property of research results. 20-Challenge: patent-industrial protection of a prototype or research result. 21-Practical workshop: creation of an intellectual property contract for research projects. 22-Challenge: solving a problem through the development of a model/algorithm/programming (Arduino, Excel etc.). 23-Practical workshop: simulation/modeling of complex research problems (climate modeling, solar radiation, etc.). 4-Practical workshop: creation and organization of research database. Collection, evaluation, processing and filtering of scientific data.			

Figure 1. Training Programme– Digital skills.

GREEN COMPETENCE TRAINING DRAFT			
Competence	Possible training session (PBL, CBL y Serious Game methodology)	Competence	Possible training session (PBL, CBL y Serious Game methodology)
Valuing sustainability	1 -Discussion workshop: Presentation of current good sustainable practices in research projects. 2 -Challenge to identify the activities in a research project that affect the environment the most. Propose changes/improvements for those critical activities. 3 -Practical workshop: Green Project Management: How to manage a project in a sustainable way? 4 -Challenge to evaluate 4 research projects from a sustainable point of view. Each group exposes and defends its assessment publicly. 14 -Practical workshop: direction and management of sustainable research projects: definition of sustainable problems or challenges, formulation of scope, constraints, requirements, stakeholders, time, cost, risks, etc.	Futures literacy	1 - Discussion workshop: Presentation of current good sustainable practices in research projects. 6 - Challenge to propose new research projects to improve current challenges from the perspective of sustainability for future generations. Assess different research projects 7 - Challenge to develop a working method/propose tips for future research projects to be sustainable. 15 -Challenge to propose future European, national and regional lines of action in terms of research and sustainability. 16 -Workshop discussion: What are the sustainable trends in the research lines of the PhD students?
Supporting fairness	1 -Discussion workshop: Presentation of current good sustainable practices in research projects. 3 -Green Project Management Workshop: How to manage a project in a sustainable way? 5 -Discussion workshop: Presentation of new ideas to implement sustainability in their own research projects/projects. 6 -Challenge to propose new research projects to improve current challenges from sustainability for future generations. Value different research projects 7 -Challenge to develop a working method/propose tips for future research projects to be sustainable. 22 -Challenge to propose different recycling strategies in research projects in order to improve their sustainability.	Adaptability	2 - Challenge to identify the activities of a research project that most affect the environment. Propose changes/improvements for those critical activities. 6 - Challenge to propose new research projects to improve current challenges from the perspective of sustainability for future generations. Evaluate different research projects 14 -Practical workshop: direction and management of sustainable research projects: definition of sustainable problems or challenges, formulation of the scope, restrictions, requirements, stakeholders, time, cost, risks, etc. 16 -Discussion workshop: What are the sustainable trends in the research lines of the doctoral students? 17 -Discussion workshop: Propose different sustainable solutions to current research problems or challenges. 18 -Challenge to propose solutions based on circular economy in research projects.
Promoting nature	2 -Challenge to identify the activities of a research project that most affect the environment. Propose changes/improvements for those critical activities. 8 -Practical workshop: product/service life cycle assessment. Quantify environmental impacts 9 -Challenge to propose improvements in a research project to reduce the use of natural resources. 10 -Challenge to quantify CO2 emissions within a research project. 11 -Practical workshop: eco-design of a prototype/patent for a research project 14 -Practical workshop: management of sustainable research projects: definition of sustainable problems or challenges, formulation of the scope, constraints, requirements, stakeholders, time, cost, risks, etc. 18 -Challenge of proposing solutions based on circular economy in research projects	Exploratory thinking	1 - Discussion workshop: Presentation of current good sustainable practices in research projects. 2 - Challenge to identify the activities in a research project that affect the environment the most. Propose changes/improvements for those critical activities. 3 - Green Project Management Workshop: How to manage a project in a sustainable way? 5 - Discussion workshop: presentation of new ideas to implement sustainability in your own research lines/projects. 6 - Challenge to propose new research projects to improve current challenges from sustainability for future generations. Assess different research projects 11 -Practical workshop: of the eco-design of a prototype/patent for research projects. 17 - Discussion workshop: Propose different sustainable solutions to current research problems or challenges. 18 -Challenge to propose solutions based on the circular economy in research projects.
Systems thinking	2 -Challenge to identify the activities of a research project that most affect the environment. Propose changes/improvements for those critical activities. 8 -Practical workshop: product/service life cycle assessment. Quantify environmental impacts 12 - Discussion workshop: What are the phases or processes that most affect the environmental impact of a given product? 13 - Challenge of selecting an optimal material/product for our research project, based on multiple criteria (economic, technical, environmental). 14 - Workshop direction and management of sustainable research projects: definition of sustainable problems or challenges, formulation of scope, constraints, requirements, stakeholders, time, cost, risks, etc.	Political agency	14 -Practical workshop: direction and management of sustainable research projects: definition of sustainable problems or challenges, formulation of scope, constraints, requirements, stakeholders, time, cost, risks, etc. 15 -Challenge to set the future European, national and regional lines of action in terms of research and sustainability. 16 -Workshop discussion: What are the sustainable trends in the research lines of the PhD students? 17 -Workshop discussion: Propose different sustainable solutions to current research problems or challenges. 19 -Challenge to elaborate a political/economic action plan to foster sustainable public and private research and development projects.
Critical Thinking	2 -Challenge to identify the activities of a research project that most affect the environment. Propose changes/improvements for those critical activities. 4 -Challenge to evaluate 4 research projects from a sustainable point of view. Each group exposes and defends its assessment publicly. 5 -Discussion workshop: presentation of new ideas to implement sustainability in their own research lines/projects. 9 -Challenge to propose improvements in a research project to reduce the use of natural resources. 11 -Practical workshop: eco-designing a prototype/patent for research projects 14 -Workshop on management of sustainable research projects: definition of sustainable problems or challenges, formulation of scope, constraints, requirements, stakeholders, time, cost, risks etc. 22 -Challenge to propose different recycling strategies in research projects in order to improve their sustainability.	Collective action	5 - Discussion workshop: presentation of new ideas to implement sustainability in their own lines/projects of research. 6 - Challenge to propose new research projects to improve current challenges from sustainability for future generations. Assess different research projects 14 - Workshop direction and management of sustainable research projects: definition of sustainable problems or challenges, formulation of the scope, restrictions, requirements, stakeholders, time, cost, risks, etc. 18 -Challenge to propose solutions based on the circular economy in research projects. 19 -Challenge to elaborate a political/economic action plan to promote sustainable public and private research and development projects. 20 -Challenge to find the main drawbacks so that companies or institutions can collaborate to carry out sustainable research projects.
Problem framing	2 -Challenge to identify the activities of a research project that most affect the environment. Propose changes/improvements for those critical activities. 6 -Challenge to propose new research projects to improve current challenges from the perspective of sustainability for future generations. Evaluate different research projects 7 -Challenge to develop a working method/propose tips for future research projects to be sustainable. 14 - Practical workshop: direction and management of sustainable research projects: definition of sustainable problems or challenges, formulation of scope, constraints, requirements, stakeholders, time, cost, risks etc. 22 - Challenge of proposing different recycling strategies in research projects in order to improve their sustainability. 18 -Challenge to propose solutions based on the circular economy in research projects.	Individual initiative	1 -Discussion workshop: Presentation of current good sustainable practices in research projects. 2 - Workshop: Presentation of current good sustainable practices in research projects. 4 -Challenge to evaluate 4 research projects from a sustainable point of view. Each group presents and defends its assessment publicly. 5 -Discussion workshop: Presentation of new ideas to implement sustainability in their own research lines/projects. 16 -Discussion workshop: What are the sustainable trends in the research lines of the doctoral students? 17 -Discussion workshop: Propose different sustainable solutions to current research problems or challenges. 21 -Challenge of knowing how to align the objectives of one's own project or research line with European sustainability objectives

Figure 2. Training Programme – Green Skills.

Additionally, Annex includes a table that illustrates the first draft of the complete training programme.

After several iterations in different face-to-face and virtual meetings of the consortium, a new approach to the training programme was proposed. In this case, four training sub-programmes were proposed, located in different partner institutions, in which all the teachers and students on the programme would participate. These sub-programmes would cover different training sessions (related to the sessions proposed in the first draft), both the green competence framework and the digital framework, grouping a total of 40 sessions evenly distributed, i.e., 10 sessions per sub-programme. These sessions would also be distributed over a period of two weeks, giving 5 sessions per week. Figures 3, 4, 5, and 6 illustrate each of the proposed training sub-programmes.

		Badajoz June 2024			
WEEK1	Day 1	**SPAIN** Professor **Justo García / Jaime González** Title: **Self-assessment of green and digital competencies. First steps to develop a sustainable research project**	**SPAIN** Professor **Gonzalo Sánchez** Title: **Developing new sustainable ideas - WORKSHOP**	Day 1	WEEK2
	Day 2	**SPAIN** Professor **Jaime González Domínguez** Title: **First steps to develop a sustainable research project**	**SWEDEN** Professor **João Santos Gomes** Title: **Sustainability research project - energy**	Day 2	
	Day 3	**ITALY** Professor **Federico Solari** Title: **Simulation in digital twin development**	**SWEDEN** Professor **Per Ängskog** Title: **Intelligent digital Data Acquisition and sensor calibration**	Day 3	
	Day 4	**SPAIN** Professor **Gonzalo Sánchez** Title: **Design thinking methodology for the development of innovative sustainable ideas for research projects.**	**ITALY** Professor Tebaldi **Letizia** Title: **Advanced search, filtering and data management**	Day 4	
	Day 5	**PORTUGAL** Professor **Tlemçani Mouhaydine** Title: **Signals and systems. Design mathematical models for dynamix systems.**	**PORTUGAL** Professor **Janeiro Fernando** Title: **Digital and Analog signals - LABVIEW**	Day 5	

Figure 3. Training Subprogramme- University of Extremadura.

		Parma January 2025			
WEEK1	Day 1	**ITALY** Professor **Milanese Daniel** Title: **Selecting an optimal material/product for our research project, based on multiple criteria (economic, technical, environmental).**	**ITALY** Professor **Vignali Giuseppe** Title: **Sustainability and Life Cycle Assessment**	Day 1	WEEK2
	Day 2	**ITALY** Professor **Sciancalepore Corrado** Title: **Recycling strategies in research projects in order to improve their sustainability**	**ITALY** Professor **Marco Mambrioni** Title: **Data measurement with sensors and problem solving trough programming in Arduino**	Day 2	
	Day 3	**SWEDEN** Professor **Daniel Rönnow** Title: **Machine Learning for digitalization of non-linear systems**	**SPAIN** Professor **Jaime González / Gonzalo Sánchez** Title: **Communication and First steps to develop a sustainable research project**	Day 3	
	Day 4	**PORTUGAL** Professor **Grilo Frederico** Title: **Low-cost digital processors, low cost sensors and actuators for prototype concept validation.**	**SWEDEN** Professor **José Chilo** Title: **Intelligent digital Data Acquisition and sensor calibration**	Day 4	
	Day 5	**SPAIN** Professor **Lourdes Moreno / Justo García** Title: **Inductrial property of a research and Change management**	**PORTUGAL** Professor **Figueiredo Joao** Title: **Develop automated solutions with increased complexity through the development of a model / algorithm / PLC-programming**	Day 5	

Figure 4. Training Subprogramme – University of Parma.

		Evora September 2024			
WEEK1	Day 1	**PORTUGAL** Professor **Figueiredo Joao** Title: **Supervisory control and data acquisition with SCADA system**	**SPAIN** Professor **Gonzalo Sánchez / Manuel Botejara** Title: **Digital research project management with KANBAN and digital multivariable analysis**	Day 1	WEEK2
	Day 2	**PORTUGAL** Professor **Figueiredo Joao** Title: **Workshop - Control and data adquisition with SCADA system**	**PORTUGAL** Professor **Grilo Frederico** Title: **Develop low-cost automated wired and wireless prototype solutions with Arduino hardware (Arduino programming)**	Day 2	
	Day 3	**ITALY** Professor **Cavazza Antonella** Title: **Innovative solutions based on circular economy in research projects**	**ITALY** Professor **Volpi Andrea** Title: **Data measurement with sensors and problem solving trough programming in Arduino**	Day 3	
	Day 4	**SWEDEN** Professor **Niclas Björsell** Title: Intelligent digitized in research projects	**SWEDEN** Professor **Robin von Haartman** Title: **Sustainable logistics**	Day 4	
	Day 5	**SPAIN** Professor **Gonzalo Sánchez / Jaime González Domínguez** Title: **Schedule and cost of sustainable research projects**	**PORTUGAL** Professor **Tlemçani Mouhaydine** Title: **Represent and solve mathematical models, data analysis and data visualization using MATLAB (MatLab programming).**	Day 5	

Figure 5. Training Subprogramme – University of Évora.

		Gävle			
		June 2025			
WEEK1	Day 1	**SWEDEN** Professor **Oscar Bautista Gonzalez** Title: **Digital models to simulate and predict behaviours in research projects**	**SWEDEN** Professor **Ola Norrman Eriksson** Title: **Environmental assessment of technology with a focus on life cycle analysis (LCA) in construction, energy and transport**	Day 1	WEEK2
	Day 2	**SWEDEN** Professor **Amir Hosseinzadeh** Title: **Principles of sustainability with state-of-the-art digital control methodologies**	**SWEDEN** Professor **Lea Fobbe** Title: **Circular economy to minimize environmental impact**	Day 2	
	Day 3	**ITALY** Professor **TEBALDI Letizia** **Title: Workshop - create and state of art and research poster**	**ITALY** Professor **CAVAZZA Antonella** Title: **Eco-designing a prototype/patent for research projects**	Day 3	
	Day 4	**PORTUGAL** Professor **Janeiro Fernando** Title: **Develop virtual instrumentation solutions for data acqusition and process supervisory control using NI-LabView (LabView programming)**	**PORTUGAL** Professor **Figueiredo Joao** Title: **Develop automated solutions with increased complexity through the development of a model / algorithm / PLC-programming**	Day 4	
	Day 5	**SPAIN** Professor **Gonzalo Sánchez** Title: **Work Flow of a sustainable research project**	**SPAIN** Professor **Jaime González Domínguez / Lourdes Moreno / Justo García** Title: **Workshop - Intellectual and industrial protection and self evaluation**	Day 5	

Figure 6. Training Subprogram – University of Gävle.

In addition, Annex includes the complete and detailed training programme, providing a calendar of the contents to be taught during the training.

TEACHERS INVOLVED

In the context of a collaborative project that involves multiple partner institutions, the participation of teachers with extensive professional experience and expertise in green and digital conceptual frameworks is essential. These teachers bring specialized knowledge that is crucial for developing competences in areas related to sustainability, technology, and innovation. Table 1 lists the different participating teachers by partner institution.

Table 1. Teachers involved in green and digital competence training

	University of Extremadura	*University of Parma*	*University of Evora*	*University of Gävle*
Teachers	Justo García	Andrea Volpi	Joao Figueiredo	Ola Norrman Eriksson
	Jaime González	Letizia Tebaldi	Mouhaydine Tlemçani	Robin von Haartman
	Lourdes Moreno	Roberto Montanari	Fernando Janeiro	Niclas Björsell
	Gonzalo Sánchez-Barroso	Daniel Milanese	Frederico Grilo	Daniel Rönnow
	Manuel Botejara Antúnez	Antonella Cavazza		Per Ängskog
		Giusseppe Vignali		Oscar Bautista
		Corrado Scianlopere		Amir Hosseinzadeh
		Federico Solari		Lea Fobbe
		Marco Mambrioni		José Chilo

The collaboration between the partner institutions and their respective professors will facilitate the creation of an interdisciplinary knowledge ecosystem, where engineering doctoral students can learn and apply concepts related to sustainability and digitalization in an integrated manner. This will not only prepare PhD students for the world's current challenges but also equip them with the necessary tools to be leaders in the transition to a more sustainable and technologically advanced society.

LEARNING OBJECTIVES

Clear learning objectives have been established to develop digital and green competences among doctoral engineering students in Europe. This methodology is based on the documents prepared by the European Commission on competences

DIGITAL COMPETENCES

In an increasingly digitalized world, it is essential that future professionals be equipped with the skills to use emerging technologies safely, efficiently, and critically. TECSKILL aims to provide participants with the tools and knowledge necessary to navigate the current and future digital environment.

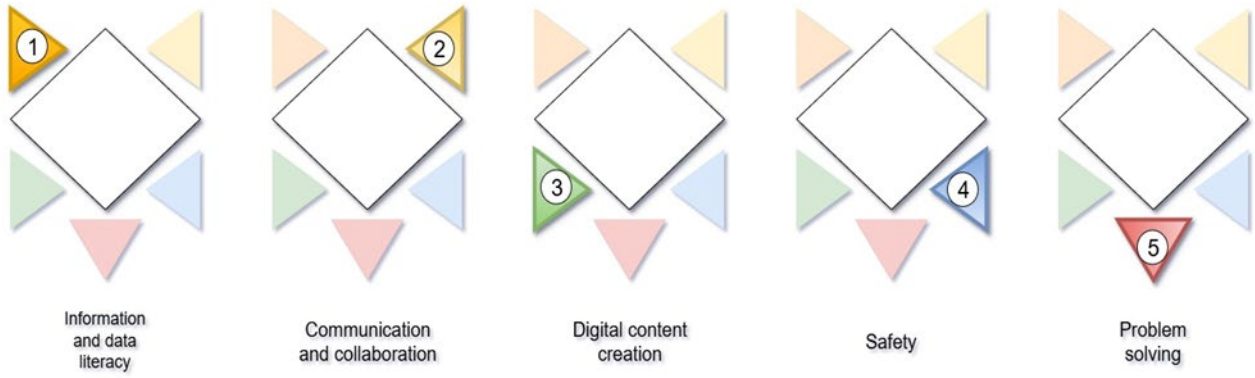


Figure 7. Image from DigComp 2.2 "The Digital Competence Framework for Citizens".

GREEN COMPETENCES

It is essential for future professionals to understand the principles and practices needed to promote sustainable development within their fields of work. Through this project, doctoral students will develop a critical and proactive approach to sustainability, integrating environmental considerations into their professional activities and thus contributing to building a more sustainable future

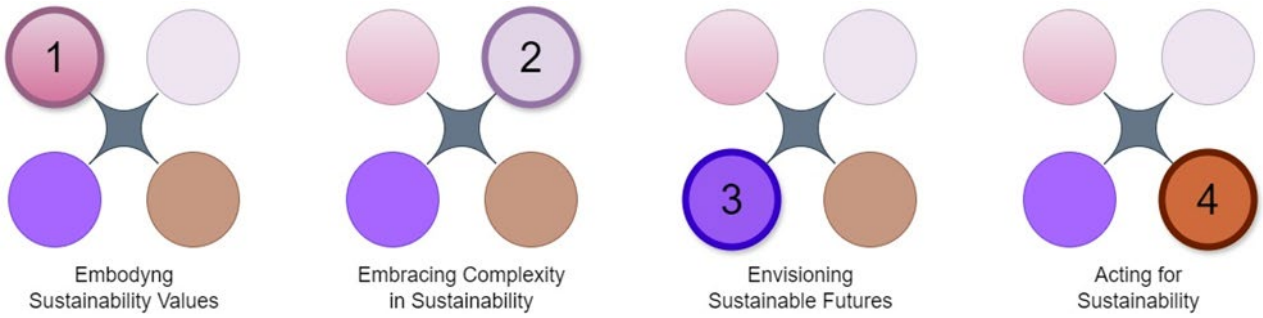


Figure 8. Image based on DigComp 2.2 "The Digital Competence Framework for Citizens".

DEVELOPMENT OF THE METHODOLOGY

DEVELOPMENT PROCESS

During the development of the competence assessment methodology for the TECSKILL project, various options were explored to ensure an effective and accurate approach that would enable meaningful measurement of students' progress and competence acquisition. Several methodologies were considered, including point-in-time, project-based, and progression-level assessments.

Point-in-time assessments, which focus on individual tests and exams, were discarded because they are limited in their ability to assess complex competences and practical skills. These assessments tend to measure only superficial knowledge and do not adequately reflect the student's ability to apply it in real-world contexts.

Project-based assessments, although offering a better opportunity to evaluate practical competences and problem-solving skills, can be difficult to standardize and may vary significantly in terms of complexity and scope. Moreover, they may require considerable time and resources for both project creation and evaluation.

A performance-indicator-based assessment methodology was developed for each competence. These indicators would be defined as either competent or not competent. However, this approach presented the challenge of being an evaluation with few nuances and being difficult to monitor

3	Identify and create diagrams to effectively represent research findings	Apto	☐	Motivo:

Figure 9. Performance Indicator DC10_3 in the Performance Indicator–Based Assessment Methodology

Finally, a progression-level assessment methodology was chosen for its ability to provide a comprehensive, continuous evaluation of competence development over time. This methodology allows for assessing students' progress across the different performance indicators of each competence, from an initial level to an advanced level, through a series of clearly defined stages.

PROGRESSION LEVELS

Progression levels were considered the best option because they offer the following benefits:

1. **Flexibility:** They allow adaptation to individual student needs and learning pace, fostering a personalized and student-centered approach.
2. **Clarity**: Progression levels establish clear and measurable criteria for competence assessment, providing transparent guidance on what is expected of students at each stage.
3. **Continuous** monitoring: By providing ongoing assessment over time, progression levels enable students and educators to track progress and make adjustments as needed to improve performance.
4. **Motivation:** Progression levels offer achievable, stepwise goals that can motivate students as they advance in their competence development.

As explained in detail in the competence deliverable, for each competence, a series of knowledge indicators will be specified to evaluate whether the doctoral student is correctly developing the competence. These knowledge indicators will have four progression levels (A, B, C, D), with level A being the lowest and D the highest. These levels will serve as the basis for student assessment. For each competence, a minimum progression level to be achieved during the training will be established. These levels were defined and validated with the participation of an expert committee, whose involvement ensured the coherence, relevance, and reliability of the established assessment system.

The following image provides an example of a knowledge indicator, specifically DC10_3. Competence DC10, “Development of digital multimedia content for research purposes,” involves creating scientific digital content to enhance communication, dissemination, and transfer of engineering research results.

3	Identify and create diagrams to effectively represent research findings	A	Generates digital diagrams with a formal aesthetic that correctly communicate his ideas.
		B	Designs diagrams using the latest software on the market and effectively convey his ideas.
		C	Effortlessly represents research data using the software tools needed
		D	Researches new software for creating diagrams and updates its skills on existing ones

Knowledge Indicator

Progression levels

Figure 10. knowledge indicator and progression level

This knowledge indicator assesses doctoral students’ ability to present their research results effectively and graphically. To carry out this assessment, we have four progression levels to measure the student’s capability in this competence aspect.

All knowledge indicators, along with their respective progression levels associated with each competence, are detailed in the Appendix.

MONITORING

Monitoring is an essential component of the TECSKILL learning and teaching methodology, as it enables continuous, systematic assessment of doctoral students' progress in developing digital and green competences. This process aims not only to measure individual advancements but also to identify areas for improvement and adjust pedagogical strategies when necessary.

In practice, monitoring was implemented through two surveys administered to the doctoral students: one at the beginning of the project and another at its conclusion. In both surveys, participants assessed, for each performance indicator in each competence, the level of progress they believed they had achieved. These surveys were created using Google Forms and distributed to students via email and a dedicated WhatsApp group. Their content is in the Appendix.

This approach allowed for a comparative view of competence development throughout the training process, providing valuable information for the overall evaluation of the TECSKILL project's impact.

COMPETENCES ASSESSMENT METHOD

Once the competence assessment methodology—based on performance indicators and progression levels—was developed, along with the monitoring methodology, which involves administering two surveys to doctoral students to evaluate the knowledge acquired throughout the training process, the evaluation method was defined to determine whether each doctoral student has correctly acquired the knowledge corresponding to each competence.

To achieve this, an expert committee was convened to establish the conditions under which a doctoral student meets the criteria for the competence to be considered acquired. These conditions are as follows:

- Minimum average competence level: Each competence is composed of several knowledge indicators, assessed on a four-level progression scale. The first condition for considering a competence as acquired is that its average progression level is equal to or greater than 2, corresponding to the “clarity” level.
- Mastery of most indicators: The second condition establishes that students must reach a progression level B in 75% of the knowledge indicators. This measure complements the first condition, ensuring that the doctoral student has mastered the majority of the competence's components.

EVALUATION OF THE TEACHING METHODOLOGY

PURPOSE

The purpose of a teaching evaluation methodology stems from the need to establish a protocol to analyse the performance of the teaching approach designed in Activity A2.1. The aim is to assess participants' satisfaction (both students and trainers) and to define appropriate strategies for an effective transfer of knowledge.

Having a structured method for evaluating teaching will make it possible to identify nonconformities and opportunities for improvement within the teaching process itself and, consequently, to design and implement concrete actions aimed at continuous improvement and teaching excellence.

The premise of this teaching evaluation method lies in verifying the proper incorporation and treatment of green and digital competences in doctoral teaching activities. In addition, it will ensure the correct application of Challenge-Based Learning (CBL) and the Serious Game philosophy. Furthermore, it will allow for the assessment of knowledge transfer from the instructor's perspective.

TYPES OF EVALUATION

The following three types of evaluation are proposed, to be carried out both before the training activity (*ex-ante*) and after it (*ex-post*):

- Self-evaluation: conducted by the instructor, assessing their own work.
- Co-evaluation (peer evaluation): conducted by one instructor on the work of another.
- External evaluation: conducted by an expert panel on the instructors.

EVALUATION PROCESS

The **initial (*ex-ante*) evaluation** will be carried out prior to the start of the training activity. It will verify the following indicators:

- Green competences incorporated.

  This indicator will reflect the number of competences integrated into the methodology.

  The acceptance criterion is the inclusion and development of all 12 green competences (100%) within the teaching design.

- Digital competences incorporated.

  This indicator will reflect the number of digital competences integrated into the methodology.

The acceptance criterion is the inclusion and development of all 21 digital competences (100%) within the teaching design.

The **final (*ex-post*) evaluation** will be conducted during and after the implementation of the training activity. It will verify the following indicators:

- Adequate incorporation of Challenge-Based Learning (CBL) and Serious Game.
  This indicator reflects whether CBL and Serious Game methodologies were correctly implemented.

  The response will be dichotomous: inadequate incorporation or adequate incorporation. The acceptance criterion is that at least 80% of the teaching activities are considered adequately implemented.

- Satisfaction with the teaching methodology.
  This indicator assesses whether the teaching methodology succeeded in creating an active and practical environment for competence development.

  Responses are categorised as low satisfaction, medium satisfaction, or high satisfaction. The acceptance criterion is achieving at least 90% high satisfaction.

- Assessment of evaluation methods.
  This indicator measures the adequacy of the evaluation methods used.

  Responses are categorised as poor adequacy, fair adequacy, or good adequacy. The acceptance criterion is obtaining 90% rated as good adequacy.

- Applicability of the methodology.
  This indicator assesses the extent to which the teaching methodology and learning materials can be replicated, transferred, or adapted to other educational or professional contexts.

  Acceptance criterion: at least 85% of participants and instructors reporting high applicability of the methodology to future contexts.

EVALUATION METHODOLOGY

SELF-EVALUATION

The self-evaluation will be carried out by each instructor responsible for a specific part of the course content. The instructor will evaluate their own work in two stages.

On the one hand, they will apply the *ex-ante* evaluation to ensure that the content to be delivered aligns with the identified needs for competence development among the PhD engineering students.

On the other hand, they will apply the *ex-post* evaluation to reflect on their teaching performance and on the impact of their instructional approach on the competence acquisition of the engineering PhD students. It is worth noting the prior experience of the instructors in this type of teaching–learning context, which implies an assumed capacity for constructive self-criticism.

CO-EVALUATION

The co-evaluation will be conducted by fellow instructors participating in the training activity. this co-evaluation will be carried out *ex-post*, using the information gathered by the peer instructor during classroom visits or observations of the teaching sessions.

The feedback to the evaluated instructor, based on the information collected and the colleague's perspective, will be conveyed through a semi-structured conversation aimed at identifying both positive aspects and areas for improvement. Based on this dialogue, specific improvement actions will be designed to refine the teaching–learning methodology.

EXTERNAL EVALUATION

The external evaluation will be carried out through a multi-perspective approach involving three complementary groups of evaluators: experts, students, and instructors themselves. External experts will provide an independent and objective assessment of the teaching methodology, focusing on its innovation, applicability, and alignment with green and digital competences. PhD students, as direct participants in the training, will evaluate the perceived quality, relevance, and impact of the learning process on their competence development. Finally, instructors will contribute by reflecting on their own teaching practices and outcomes, ensuring that the evaluation incorporates both external validation and internal self-assessment for continuous improvement.

The external evaluation will be conducted by a panel of experts with extensive experience in developing innovative teaching methodologies for competence-based learning processes. The applicability index will be rated on three levels: low applicability, medium applicability, and high applicability. The acceptance criterion is that 95% of the expert panel's evaluations should consider that the teaching methodology demonstrates high applicability to PhD programmes across different engineering disciplines.

EVALUATION TEMPLATES

SELF-EVALUATION AND CO-EVALUATION

Below is the content of the *ex-ante* evaluation template, applicable to both self-evaluation and co-evaluation processes for:

- Course Desing:

Question	Yes	No	Observations
Does the course have a student-centered approach focused on the development of practical skills?			
Have the challenges or problems that students will address during the course been clearly identified?			
Are the course objectives aligned with specific and measurable competences?			
Have gamification elements been incorporated to increase student motivation and engagement?			
Are the proposed challenges realistic and relevant to real-world contexts?			

- Teaching Methodology:

Question	Yes	No	Observations
Is collaboration and teamwork among students encouraged?			
Is technology used effectively to enhance the learning experience?			
Do students have the opportunity to apply theoretical knowledge in practical and challenging situations?			
Is assessment carried out formatively, providing continuous feedback for competence development?			
Is critical thinking and problem-solving promoted throughout the course?			

- Materials and Resources:

Question	Yes	No	Observations
Are the learning materials accessible and designed to facilitate understanding of the proposed challenges?			
Are different types of media (videos, simulations, case studies) used to enrich the learning experience?			

Are the provided resources up-to-date and reflective of current realities in the field of study?			

EXTERNAL EVALUATION: EXPERTS

Below is the content of the *ex-post* evaluation template, applicable to external evaluation processes by experts. Annex shows the response collection form.

- Applicability and satisfaction:

Question	Low	Medium	High
Indicate the level of applicability of the teaching methodology developed in this project			
Indicate satisfaction with the teaching methodology proposed in this project			
The teaching methodologies described above have been adequately incorporated into the workshops proposed			
Indicates the level of adequacy of the evaluation method proposed in the project			

- Indicate the level of satisfaction with Green competence adapted for PhD students:

Green competence	Low	Medium	High
GC1 – Valuing sustainability			
GC2 – Supporting fairness			
GC3 – Promoting nature			
GC4 – Systems thinking			
GC5 – Critical thinking			
GC6 – Problem framing			
GC7 – Futures literacy			
GC8 – Adaptability			
GC9 – Exploratory thinking			
GC10 – Political agency			

GC11 – Collective action			
GC12 – Individual initiative			

- Indicate the level of satisfaction with Digital competence adapted for PhD students:

Digital competence	Low	Medium	High
DC1 – Searching and Filtering Data, Information, and Digital Content			
DC2 – Evaluating Data, Information, and Digital Content			
DC3 – Data Information, and Digital Content Management			
DC4 – Interacting through Digital Technologies			
DC5 – Sharing through Digital Technologies			
DC6 – Engaging Citizenship through Digital Technologies			
DC7 – Collaborating through Digital Technologies			
DC8 – Netiquette			
DC9 – Managing Digital Identity			
DC10 – Development of digital multimedia content for research purposes			
DC11 – Digital Content Integration and Reelaboration			
DC12 – Copyright and Intellectual Property Licensing			
DC13 – Programming			
DC14 – Protecting Devices			
DC15 – Protecting Personal Data and Privacy			
DC16 – Protecting health and Well-Being			
DC17 – Protecting the Environment			
DC18 – Troubleshooting technical problems			
DC19 – Identification of technological needs and responses			

DC20 – Creative use of digital technology			
DC21 – Identifying gaps in digital skills			

EXTERNAL EVALUATION: INSTRUCTORS

This survey aims to collect feedback from instructors involved in the TECSKILL transnational training programme. Instructor's reflections on the design, implementation, and outcomes of the teaching methodology are essential to evaluate its effectiveness and identify areas for enhancement. By sharing instructor's experience, they will contribute to the continuous improvement of the training model, ensuring its alignment with green and digital competence frameworks and its applicability across different academic contexts. Annex shows the response collection form.

Questions	Options		
How many training sessions have you delivered within the TECSKILL project?	1-2	3-4	> 5
During these sessions, did you focus on Digital competence, Green competence, or both?	DigComp	GreenComp	Both
How satisfied are you with the teaching methodology proposed in the project?	Low	Medium	High
In your opinion, is this methodology appropriate for training PhD students in engineering?	Low	Medium	High
Did you use project-based learning (PBL) as the main strategy in your classes?	Yes	No	-
Did you propose real or simulated challenge (CBL) in the classes to stimulate critical thinking and creativity?	Yes	No	-
Did you implement Research-Based Learning (RBL) allowing students to explore and formulate hypotheses and analyze data?	Yes	No	-
Did you use gamification during the training sessions?	Yes	No	-
Did you facilitate the active role of the student as the protagonist of their learning?	Yes	No	-

Did you feel comfortable applying these methodologies for engineering PhD students?	Yes	No	-
Lessons learned:	Observations		

EXTERNAL EVALUATION: STUDENTS

This survey is designed to gather feedback from PhD students participating in the TECSKILL transnational training programme. Students' responses will help assess the quality, relevance, and effectiveness of the teaching methodology, particularly in promoting green and digital competences. The information collected will contribute to improving future training activities and ensuring that the learning experience remains practical, engaging, and aligned with your professional and research needs. Annex shows the response collection form.

Questions	Options			
How many TECSKILL project trainings have you participated in?	1	2	3	4
Please, rate your level of satisfaction (low, medium, high) on the following questions regarding TECSKILL training				
The activities of the training programmes were well-organized.	Low	Medium	High	
I found the content of the training sessions to be practical and applicable.	Low	Medium	High	
The methodology used during training is suitable for engineering PhD students.	Low	Medium	High	
Support was readily available whenever I encountered difficulties.	Low	Medium	High	
During the training programmes, the collaboration among participants was encourage.	Low	Medium	High	
I gained valuable insights from interacting with other participants.	Low	Medium	High	
I appreciated the opportunity to visit different countries and explore their cultures.	Low	Medium	High	
I had the chance to bond and engage with other participants during extracurricular activities.	Low	Medium	High	

Thanks to the activities carried out during the training programmes, I can better evaluate sustainability issues.	Low	Medium	High
I am more skilled in using digital tools for data analysis and research.	Low	Medium	High
The activities carried out during the training programmes were relevant to my academic and professional goals.	Low	Medium	High
The training programmes I attended met my expectations.	Low	Medium	High
Should other editions of TECSKILL Erasmus+ project be organized in the future, I would recommend other PhD students to attend.	Low	Medium	High
I would participate in a similar project in the future if given the chance.	Low	Medium	High

PROCESS FOR COLLECTING ANSWERS

DESIGN OF SURVEYS

The first step in collecting feedback begins with the careful design of the survey, tailored to the specific goals of each evaluation phase. For the *ex-ante* evaluation, questions focus on students' prior knowledge, expectations, and learning preferences, while the *ex-post* survey targets outcomes such as perceived knowledge gain, engagement, and satisfaction with the teaching methodology.

IMPLEMENTATION IN A PLATFORM

Once the survey is designed, it is implemented using an online forms platform such as Microsoft Forms. The form should include a clear introduction explaining its purpose, estimated completion time, and confidentiality assurances. Required fields ensure that key data is collected consistently, while optional open-ended questions allow for richer feedback. Validation rules can help minimize incomplete or inconsistent responses.

Specifically, the link for the external expert evaluation is the following and also a preview is provided in Figure 1:

https://forms.office.com/e/Wuz7zZ37kz

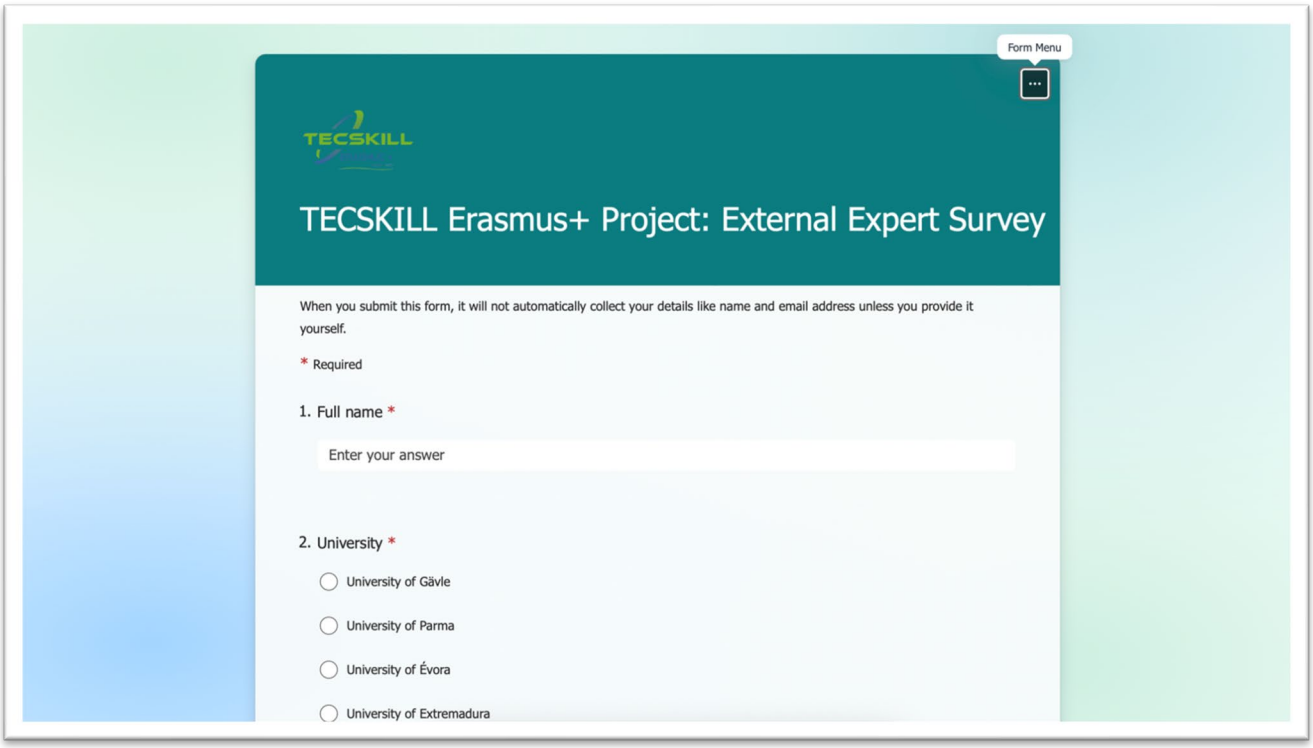


Figure 11. Screenshot of the external evaluation survey.

FACILITATE PARTICIPATION

To facilitate participation, a short explanatory video is created and shared alongside the survey. This video briefly outlines the objectives of the evaluation, demonstrates how to fill out the form, and emphasizes the importance of honest and thoughtful responses. The video also provides instructions on deadlines and where to seek support if students encounter difficulties. The survey and video are distributed through multiple channels, such as the course LMS, email, or group messaging platforms, ensuring accessibility for all external experts.

Figure 12. Explanatory video of the project and the work expected by external evaluators.

In addition to the explanatory video, external evaluators were also provided with key project documentation to understand the context in which they will carry out their evaluation. Thus, in order to understand the degree of practical applicability of the methodology developed, they were also sent the report on the methodology developed for TECSKILL and the adapted Green and Digital Competence Framework, as shown in Figure 3.

Figure 13. Input documentation for the assessment by external experts.

SUPPORT MECHANISMS

During the response period, support mechanisms are made available. Trainers and external experts are encouraged to ask questions via a dedicated discussion forum or email contact, and brief step-by-step guidance can be provided to clarify any uncertainties. In addition, periodic reminders are sent to external experts to encourage completion before the deadline. The response rate is monitored in real time through the forms' analytics dashboard, allowing prompt intervention if participation is lower than expected.

RESPONSES ANALYSIS

Finally, after the deadline, all responses are collected and exported for analysis. Data is compiled, summarized, and interpreted to identify patterns, insights, and areas for improvement. For transparency and motivation, key aggregated results can be shared with trainers and external experts, showing how their feedback contributes to refining the teaching methodology.

All of this analysis of the responses, as well as the evaluation of the assessors' opinions as a whole, will be presented in report R4.6.

REPORT'S AIM

This report aims to incorporate different resources (digital, computational, etc.) into engineering doctoral programs, with a dual focus on training and promoting green and digital competences. In turn, this purpose is articulated through a series of specific objectives.:

- **Innovation in teaching and learning methodology**: To implement innovative pedagogical approaches supported by ICT (Information and Communication Technologies) in order to create dynamic and participatory learning environments. This includes the use of gamification and project-based learning, which can increase student engagement and motivation..
- **Access to cutting-edge research resources**: Facilitate access to global scientific databases, specialized journals, and open-access publishing platforms, allowing doctoral students to stay up to date with the latest advances in their field and to disseminate their own research.
- **Development of competences for managing large datasets (Big Data)**: Train students in advanced data analysis techniques, machine learning, and data science, which are essential for contemporary engineering research and for evidence-based decision-making in complex contexts.
- **Promote autonomous and adaptive learning**: Use digital and computational resources to offer doctoral students a flexible learning environment that adapts to their individual needs and learning pace, while fostering autonomy and self-motivation.
- **Foster a deep and applied understanding of global environmental challenges**: Prepare doctoral students to contribute innovative and sustainable solutions to issues such as climate change, resource management, and sustainability. This requires not only advanced technical knowledge but also strong ecological awareness and social responsibility.
- **Develop advanced digital skills**: Ensure that doctoral students master emerging digital tools and technologies, which are fundamental for data analysis, modelling and simulation, project management, and remote collaboration. This mastery is essential for research and development in engineering, as well as for innovation in virtually any field.

RESOURCES REQUIRED FOR GREEN COMPETENCE TRAINING

There are multiple benefits associated with the use of auxiliary or support resources in the training of engineering doctoral students in Green Competences. These resources not only strengthen self-directed learning and promote a mindset oriented toward continuous research and innovation—skills that are essential in the field of sustainable engineering—but also enrich the doctoral students' educational experience from both a technical and academic perspective, preparing them comprehensively to face future challenges.

Among the resources used for training in Green Competences, the following stand out:

GREEN PROJECT MANAGEMENT (GPM)

- **Resource Description:**

Green Project Management (GPM) is a project management methodology that integrates sustainability practices. This approach is based on the premise that projects should not only meet their objectives in terms of time, cost, and scope, but also minimize—or positively contribute to—the environmental, social, and economic context. GPM encourages project managers to consider the full life cycle of the products or services they develop, assessing and mitigating their environmental impact from conception through end-of-life. It also promotes efficient resource use, waste reduction, and the incorporation of renewable energy and sustainable materials into project design.

- **Advantages/Benefits:**
  - It fosters environmental responsibility in project management.
  - It enhances corporate image and increases acceptance among environmentally conscious stakeholders.
  - It improves resource efficiency and reduces long-term costs.
- **Suitability for the TECSKILL project:**

The Green Project Management (GPM) methodology is essential to the TECSKILL project because it equips doctoral students with key skills in sustainable project management, which are vital for developing green competences in engineering. By integrating sustainable practices into project management, GPM prepares engineering PhD candidates to lead initiatives that balance technical and economic requirements with the minimization of environmental and social impacts. This training not only addresses current global challenges—such as climate change and the need for greener economies—but also ensures that doctoral students can contribute meaningfully to innovative and sustainable solutions. In summary, GPM is a cornerstone of TECSKILL, enabling the formation of engineering leaders committed to sustainable development.

SIMAPRO SOFTWARE

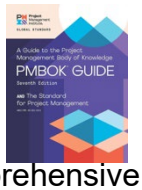
- **Resource Description:**

SimaPro is an advanced software tool designed for Life Cycle Assessment (LCA), enabling users to evaluate the sustainability of products or services throughout their entire life cycle, from raw material extraction to final disposal. The software provides a solid foundation for making informed decisions regarding design, production, and resource use, aiming to minimize negative environmental impacts. Additionally, SimaPro grants access to a wide range of international databases (Ecoinvent, ELCD, Agri-footprint, etc.) containing information on the environmental impacts of thousands of materials and processes, facilitating comprehensive analyses and comparisons across different design and production options. It is an indispensable tool for professionals and organizations committed to sustainable engineering and the development of eco-efficient products.

- **Advantages/Benefits:**
  - Facilitates the identification of critical stages in the life cycle where environmental impacts can be reduced.
  - Promotes the design and development of more sustainable products.
  - Enables the comparison of design alternatives from an environmental perspective.
- **Suitability for the TECSKILL project:**

The integration of SimaPro within the TECSKILL project framework is crucial, as it provides doctoral students with advanced skills in sustainability assessment through life cycle analysis, a fundamental aspect of green competence training. This software enables them to approach engineering projects from a holistic perspective, evaluating environmental impacts across all phases, from conception to project closure. By becoming proficient with this tool, doctoral students gain a solid foundation to lead the design and implementation of solutions that are not only innovative but also sustainable and environmentally responsible. SimaPro aligns perfectly with TECSKILL's objectives, preparing engineering doctoral students to tackle and address 21st-century environmental challenges through the adoption of practices that promote comprehensive sustainability in engineering.

PMBOK GUIDE



- **Resource Description:**

A Guide to the Project Management Body of Knowledge (PMBOK) is a comprehensive guide that provides a reference framework for project management, developed by the Project Management Institute (PMI). This resource is considered the industry standard for best practices in project management, offering a common terminology and a set of guidelines covering all phases of a project's life cycle. From initiation and planning to execution, monitoring, controlling, and closure, PMBOK details the processes and practices necessary to achieve successful project management. It includes knowledge areas such as integration, scope, time, cost, quality, human resources, communications, risk, procurement, and stakeholder management. By adopting PMBOK principles and practices, professionals can

significantly improve project efficiency and effectiveness, ensuring high-quality outcomes that meet or exceed stakeholder expectations. Although it does not focus exclusively on sustainability, its principles can be applied to projects with green objectives.

- **Advantages/Benefits:**
  - Provides a common reference framework for project management.
  - Enhances efficiency and effectiveness in project execution.
  - Compatible with sustainability practices when integrated with other green methodologies.
- **Suitability for the TECSKILL project:**

The PMBOK guide is particularly relevant for the TECSKILL project, as it equips engineering doctoral students with a structured and proven framework for effective project management. By incorporating PMBOK principles and practices into their training, doctoral students not only gain essential project management knowledge but also learn to apply this knowledge in developing sustainable engineering projects. This prepares them to lead complex projects, ensuring they are delivered within the planned scope, time, cost, and quality while considering environmental impacts and promoting sustainability. In summary, PMBOK complements the technical and green competences that TECSKILL aims to develop, preparing doctoral students to tackle the multidisciplinary challenges of modern engineering.

AUTODESK INVENTOR PROFESSIONAL

- **Resource Description:**

Inventor is a powerful computer-aided design (CAD) and building information modeling (BIM) software developed by Autodesk. This tool provides a comprehensive set of advanced features for 3D modeling, product simulation, and design visualization and documentation. Inventor enables users to create precise and detailed digital models of mechanical products, which can be used to validate design performance and functionality before physical manufacturing, thereby reducing the time and costs associated with physical prototypes. With capabilities for integrating data from multiple sources and collaborating on complex projects, Inventor facilitates teamwork and enhances both the efficiency and sustainability of the design process.

- **Advantages/Benefits:**
  - Facilitates the design of innovative and efficient products.
  - Reduces time and costs associated with developing physical prototypes.
  - Allows design adjustments to minimize environmental impacts.
- **Suitability for the TECSKILL project:**

Inventor is highly relevant for the TECSKILL project as it provides doctoral students with advanced tools to innovate and excel in mechanical design and engineering. By mastering

this software, students can undertake complex design projects, optimize products for sustainability, and assess the environmental impact of their designs through precise simulations. This equips them with essential practical and technical skills for modern engineering, where efficiency, innovation, and sustainability are key. Training in Inventor thus aligns doctoral students with current labor market expectations and prepares them to contribute effectively to the creation of innovative and sustainable engineering solutions.

CES EDUPACK

- **Resource Description:**

CES Edupack is an advanced educational tool specifically designed to support teaching and learning in materials science and engineering. Developed by Granta Design, this software provides an extensive database of materials and processes, enabling students and professionals to explore, select, and apply the most suitable materials for various design and engineering applications. CES Edupack facilitates understanding of material properties, their applications, and the environmental impact of their use, promoting informed and sustainable decision-making in product design. The tool includes educational modules, case studies, and practical exercises designed to complement classroom teaching in science and engineering, making materials learning a more interactive and enriching experience.

- **Advantages/Benefits:**
  - Provides access to detailed information on the sustainability of different materials.
  - Supports informed decision-making for sustainable design.
  - Promotes understanding of the relationship between materials, manufacturing processes, and sustainability.
- **Suitability for the TECSKILL project:**

CES Edupack aligns perfectly with the objectives of the TECSKILL project by enhancing doctoral students' training in engineering with a deep understanding of material and process selection from a sustainability perspective. By integrating this resource into their education, students gain essential technical knowledge about materials while also developing sensitivity to sustainable design and environmental responsibility. This tool enables them to critically evaluate the sustainability implications of their design decisions, preparing them to lead the way toward greener and more environmentally responsible engineering practices. In this way, CES Edupack equips engineering doctoral students with the skills and knowledge needed to address the challenges of a world increasingly focused on sustainability and emission reduction.

SUSTAINBLE DEVELOPMENT GOALS

- **Resource Description:**

The Sustainable Development Goals (SDGs) are a global initiative promoted by the United Nations, consisting of 17 interconnected goals designed to serve as a "roadmap" toward a more sustainable and equitable world by 2030. The SDGs cover a wide range of topics, from

eradicating poverty and hunger to climate action, quality education, gender equality, clean water, and healthcare, among others. This framework not only provides clear objectives for sustainable development but also offers specific indicators to measure progress. By integrating the SDGs into education and research, academic institutions and doctoral students can make significant contributions to these global efforts, aligning their projects and studies with the goals established by the international community.

- **Advantages/Benefits:**
  - Provides a global framework to guide projects toward sustainability.
  - Encourages innovation and research in key areas for sustainable development.
  - Promotes interdisciplinary and international collaboration in sustainable projects.
- **Suitability for the TECSKILL project:**

Integrating the Sustainable Development Goals into the TECSKILL project strengthens the commitment of doctoral engineering training to sustainable development and social responsibility. By aligning research and training objectives with the SDGs, TECSKILL not only prepares doctoral students to contribute to sustainable solutions on a global scale but also provides them with a deep understanding of contemporary challenges and the significance of their work within the broader context of global efforts for a sustainable future. This alignment ensures that TECSKILL graduates are well-equipped to lead by example in promoting sustainability within their fields, fostering a positive and lasting impact on society and the environment.

OPENLCA SOFTWARE

- **Resource Description:**

OpenLCA is an open-source software platform developed for life cycle assessment (LCA), sustainability evaluation, and environmental modeling of products, processes, and services. It is one of the most versatile tools in the field of sustainable engineering, allowing the use of multiple databases such as Ecoinvent, Agribalyse, or ELCD. OpenLCA enables modeling of complex systems, impact calculation using recognized methods (ReCiPe, CML, ILCD, among others), and the creation of detailed reports that facilitate sustainable decision-making. Its open and modular nature makes it an essential tool for both teaching and applied sustainability research.

- **Advantages/Benefits:**
  - Enables comprehensive life cycle analyses with access to international databases.
  - Supports customization of environmental assessment methodologies.
  - Promotes transparency and reproducibility in sustainability studies.
- **Suitability for the TECSKILL project:**

OpenLCA aligns perfectly with the objectives of TECSKILL by providing doctoral students with advanced skills in environmental assessment and sustainability. Its application in the life cycle analysis of products and processes allows future engineering researchers to develop a practical understanding of the environmental and economic impacts of technical decisions. This tool helps train engineers with a holistic perspective, capable of designing sustainable solutions based on quantitative data, thereby strengthening the green competences promoted by TECSKILL.

ANSYS ENGINEERING SIMULATION SOFTWARE

- **Resource Description:**

Ansys is a leading multiphysics simulation software in engineering, enabling structural, thermal, fluid, and electromagnetic analyses. Its ability to model the behavior of materials and systems under real conditions allows for design optimization, reduction of physical prototypes, and minimization of the environmental impact of industrial processes. Ansys integrates advanced simulation modules, such as Fluent, Mechanical, and Computational Fluid Dynamics, which facilitate detailed studies of energy performance and the efficiency of materials and structures.

- **Advantages/Benefits:**
  - Allows analysis of complex system behavior before physical fabrication.
  - Optimizes designs to improve energy efficiency and sustainability.
  - Reduces development costs and time through precise simulations.
- **Suitability for the TECSKILL project:**

Ansys is highly relevant for TECSKILL, as it equips doctoral students with skills in advanced simulation and system optimization, essential for developing sustainable engineering solutions. Its use promotes critical analysis of energy efficiency and environmental impact of designs, integrating sustainability from the earliest stages of development. This enables doctoral students to balance technical performance, cost, and sustainability, strengthening their training in green competences.

MICROSOFT POWER BI

- **Resource Description:**

Power BI is a business intelligence tool developed by Microsoft that enables the transformation of complex data into interactive visualizations and dynamic dashboards. It facilitates the collection, analysis, and presentation of data from multiple sources, helping to identify patterns, trends, and performance indicators. In sustainable engineering, Power BI is used to analyze environmental, energy, and production data, supporting evidence-based decision-making and promoting resource efficiency.

- **Advantages/Benefits:**
  - Facilitates the analysis and visualization of large volumes of data.

- Allows the creation of interactive dashboards integrating sustainability metrics.
- Enhances evidence-based decision-making using environmental and operational indicators.

- **Suitability for the TECSKILL project:**

Power BI is a valuable resource for TECSKILL, as it enables engineering doctoral students to develop skills in data management and analysis applied to sustainability. Its use supports the visual interpretation of results from environmental or energy-related studies, fostering effective communication of technical data and evidence-based reasoning. Integrating Power BI into doctoral training strengthens both digital and green competencies, promoting more transparent and sustainability-oriented research.

PYTHON PROGRAMMING LANGUAGE

- **Resource Description:**

Python is an open-source programming language widely used in engineering, data analysis, numerical modeling, and automation. Its clear syntax, flexibility, and extensive libraries (such as NumPy, Pandas, SciPy, Matplotlib, or PyLCA) make it a powerful tool for environmental data processing, system simulation, and life cycle analysis. Additionally, it is a key platform for implementing artificial intelligence and machine learning algorithms applied to energy optimization and industrial sustainability.

- **Advantages/Benefits:**
  - Enables automation of complex analyses and simulations.
  - Facilitates integration with other scientific and sustainability tools.
  - Promotes reproducibility and transparency in technical studies.

- **Suitability for the TECSKILL project:**

Python contributes decisively to TECSKILL's objectives by developing both digital and green competences in doctoral students through computational data analysis and environmental modeling. Its flexibility allows tackling complex engineering problems with a sustainable, efficiency-oriented approach, supporting the adoption of data-driven methodologies for decision-making. Thus, Python becomes a strategic resource for advanced training in sustainable engineering.

R LANGUAGE FOR STATISTICAL COMPUTING

- **Resource Description:**

R is a programming language specialized in statistical analysis and data visualization. Its environment enables everything from descriptive analyses to advanced modeling, and it is applied in sustainability studies, circular economy, and environmental management. R offers packages such as "openLCA-r," "ggplot2," and "dplyr," which facilitate data manipulation and the creation of high-level visualizations. It is an essential tool for scientific research,

particularly when a quantitative and reproducible interpretation of environmental and sustainability results is required.

- **Advantages/Benefits:**
  - Enables advanced statistical analysis and environmental data visualization.
  - Supported by a large scientific community and open repositories.
  - Facilitates integration with life cycle analysis and sustainability tools.
- **Suitability for the TECSKILL project:**

R is a key resource for developing green and digital competences within TECSKILL. Its application in environmental research allows doctoral students to conduct robust statistical analyses, interpret sustainability results, and communicate findings through professional visualizations. Mastery of R promotes data-driven decision-making and the application of reproducible methodologies, fundamental pillars in doctoral training for sustainable engineering.

RESOURCES REQUIRED FOR DIGITAL COMPETENCE TRAINING

The advantages offered by digital and technological resources in the training of engineering doctoral students are countless, particularly in the development of Digital Competences. These tools, ranging from specialized software to global research repositories, not only promote autonomous learning and foster a continuous spirit of research and innovation, but also enhance remote collaboration. By enabling joint work across geographic boundaries, they significantly enrich the educational experience of doctoral students from a technical and academic perspective. This approach prepares students comprehensively for future challenges, equipping them with the essential skills and knowledge for their professional performance.

- Among the resources used for Digital Competence training, the following stand out:

JIRA (SOFTWARE)

- **Resource Description:**

Jira is a widely recognized project management platform known for its effectiveness in task coordination and bug tracking. Its flexible structure allows it to adapt to various working methodologies, including agile frameworks such as Scrum and Kanban, making it particularly valuable for teams seeking to enhance efficiency and productivity. Jira offers an intuitive interface that facilitates project planning, task assignment, progress tracking, and deadline management. Additionally, its ability to integrate with a wide range of development and collaboration tools expands its functionality, enabling users to centralize project management and team communication on a single platform.

- **Advantages/Benefits:**
  - Facilitates remote team collaboration and agile project management.
  - Allows detailed tracking of tasks and their progress.
  - Improves team communication through a system of comments and notifications.
- **Suitability for the TECSKILL project:**

Jira stands out as an ideal resource for the TECSKILL project due to its focus on enhancing engineering project management through agile methodologies. This platform enables doctoral students to organize, monitor, and adapt effectively in research and development projects, fostering a collaborative and efficient environment. Integrating Jira promotes the development of key digital competences, preparing engineering PhD students to tackle dynamic challenges with innovative solutions. By centralizing communication and providing clear visibility of project progress, Jira improves collaboration and time management, which are crucial for success in highly digitalized professional environments.

MICROSOFT SHAREPOINT

- **Resource Description:**

SharePoint is a collaboration and content management platform developed by Microsoft that allows teams to share documents, data, and resources, facilitating collaboration and information management. SharePoint stands out for its ability to support real-time collaboration, enabling users to work together on documents, lists, and applications regardless of their geographical location. With features such as version control, customizable workflows, and personalization options, SharePoint is a valuable tool for optimizing work processes and improving operational efficiency.

- **Advantages/Benefits:**
  - Centralizes documentation and resources in a single location.
  - Facilitates real-time collaboration and teamwork.
  - Offers extensive customization options to meet project needs.
- **Suitability for the TECSKILL project:**

SharePoint is well-suited for the TECSKILL project due to its ability to provide a comprehensive and versatile solution that supports both information management and efficient collaboration among doctoral students and faculty. This platform aligns perfectly with TECSKILL objectives by offering a secure, centralized environment where participants can store, share, and manage documents related to their research projects, as well as collaborate on them in real time. Integrating SharePoint promotes effective knowledge organization and smooth communication within teams, which are crucial elements for advancing complex engineering projects.

EXCEL SPREADSHEET PROGRAM

- **Resource Description:**

Microsoft Excel is an advanced spreadsheet application and one of the most widely used programs worldwide for data analysis, financial management, and project planning. It offers a broad set of tools that allow users to create and edit detailed spreadsheets where large amounts of data can be organized, analyzed, and stored. One of Excel's most powerful features is its ability to perform complex calculations and data analysis through advanced formulas and functions, supporting data-driven decision-making. Additionally, it enables data visualization through charts and pivot tables, allowing users to interpret and present information clearly and effectively.

- **Advantages/Benefits:**
  - Enables detailed data analysis using advanced functions and visualization tools.
  - Facilitates information management and the execution of complex calculations.
  - Is widely known and used, facilitating its integration across diverse environments.
- **Suitability for the TECSKILL project:**

Excel is essential for the TECSKILL project due to its versatility in data analysis and management, which is fundamental in advanced engineering education. It allows doctoral students to work with large datasets, develop key analytical skills, and present results professionally—crucial for scientific publication and effective communication of research. Furthermore, its integration with Microsoft tools and cloud platforms supports real-time collaboration, enabling joint work on data analysis within research projects. As a widely recognized tool in professional environments, Excel prepares doctoral students to face technical challenges while strengthening their digital competences in engineering.

XMIND SOFTWARE

- **Resource Description:**

XMind is a mind-mapping and brainstorming software that facilitates the visual organization of ideas, project planning, and problem solving. It offers a variety of predefined structures, including tree diagrams, fishbone diagrams, and flow maps, which can be used for a wide range of applications—from project management to strategic planning and process analysis. Additionally, its ability to integrate multimedia, such as images and links, and to share mind maps in multiple formats enhances collaboration and communication within teams.

- **Advantages/Benefits:**
  - Encourages creativity and simplifies the organization of complex ideas in a visual way.
  - Facilitates project planning and task structuring.
  - Improves communication of ideas and concepts within teams.
- **Suitability for the TECSKILL project:**

XMind is a suitable resource for the TECSKILL project, as it promotes critical thinking and effective planning in engineering research while enhancing project visualization and collaboration. Its ability to organize complex ideas and support structured thinking is essential for research planning, project design, and knowledge management—key elements in advanced engineering training.

DRAW.IO SOFTWARE

- **Resource Description:**

Draw.io is a free and open-source online tool for creating diagrams and charts. Its intuitive interface and wide range of features make Draw.io a popular choice for students and professionals interested in visualizing information clearly and efficiently. This tool allows users to create various types of diagrams, such as flowcharts, network diagrams, UML models (Unified Modeling Language), organizational charts, and mind maps, facilitating the visual representation of complex processes, systems, and structures. In addition, Draw.io integrates seamlessly with multiple work environments and tools, including content

management systems and collaboration platforms, enhancing workflow efficiency and team productivity.

- **Advantages/Benefits:**
  - Provides an easy-to-use platform for creating professional diagrams.
  - Facilitates the visualization of processes, structures, and systems.
  - Enables real-time collaboration in the creation and editing of diagrams.
- **Suitability for the TECSKILL project:**

Draw.io aligns perfectly with the objectives of the TECSKILL project by offering a versatile and accessible platform for developing diagrams, which is essential for visualizing concepts and processes in engineering. Its ability to support the creation of flowcharts, network diagrams, UML models, and more allows engineering doctoral students to structure and present their ideas clearly and effectively—an essential skill in scientific and technical communication. Furthermore, its seamless integration with cloud storage platforms promotes real-time collaboration among project participants, enabling dynamic information exchange and feedback that enriches the learning process and project development.

GRAPHPAD PRISM

- **Resource Description:**

GraphPad Prism is an advanced software for statistics, data analysis, and scientific graphics, widely used in biomedical research and other scientific fields to analyze, transform, and present data clearly and efficiently. This program combines precise, high-quality scientific graphing tools with robust statistical analyses, making it a comprehensive solution for researchers seeking to analyze complex datasets and effectively communicate their results.

- **Advantages/Benefits:**
  - It offers specialized tools for statistical analysis and graphical data representation.
  - It is intuitive and easy to use, reducing the learning curve.
  - It improves accuracy and clarity in the presentation of research results.
- **Suitability for the TECSKILL project:**

GraphPad is relevant for TECSKILL by providing PhD students with a powerful tool for data analysis and presentation in engineering research, supporting evidence-based decision-making and the effective communication of findings.

MICROSOFT TEAMS

- **Resource Description:**

Microsoft Teams is a comprehensive collaboration and communication platform developed by Microsoft, designed to facilitate teamwork and enhance productivity in both educational and professional environments. It combines chat, video conferencing, calls, and document collaboration in a single workspace. Teams allows users to create and organize teams or working groups, assign tasks, share files, and co-edit documents in real time, leveraging its integration with Microsoft Office 365 applications. It also offers advanced features such as digital whiteboards, meeting planning and scheduling, and the ability to integrate external apps and services. This tool is designed to adapt to different types of teams and projects, providing customizable solutions that improve communication and project management, enabling a collaborative work environment accessible from any device.

- **Advantages/Benefits:**
  - Facilitates real-time communication and collaboration, removing geographical barriers.
  - Integrates Office 365 tools, allowing users to work with documents, presentations, and spreadsheets within the same platform.
  - Offers features for video conferences and virtual meetings, increasing efficiency in project coordination.
- **Suitability for the TECSKILL project:**

Microsoft Teams is ideal for TECSKILL, as it promotes effective collaboration between PhD students and supervisors by enabling smooth communication and efficient management of shared documents and resources. It facilitates virtual meetings and workshops, essential for distance training and collaborative work in research projects, while integrating productivity tools and third-party applications that enrich the learning environment and support adaptation to diverse needs and working styles. The platform becomes a virtual space where interaction and the exchange of ideas flow freely, strengthening the development of digital and collaborative competences that are crucial in academic and professional contexts.

MENDELEY

- **Resource Description:**

Mendeley is a reference management tool and academic social network that enables users to organize, share, and discover research and bibliographic sources. It offers tools for document management, citation and bibliography creation, and supports collaboration and information exchange among researchers.

- **Advantages/Benefits:**
  - Helps organize and quickly access bibliographic materials and research documents.

- Facilitates inserting citations and creating bibliographies in documents, saving time during writing.
- Allows users to discover the latest research and connect with other researchers in their field.

- **Suitability for the TECSKILL project:**

Mendeley is highly suitable for TECSKILL, as it improves efficiency in managing bibliographic references and encourages scientific collaboration. It is a key tool for doctoral students to keep their research literature organized and to access the latest publications in their field of study.

ARDUINO PLATFORM

- **Resource Description:**

Arduino is an open-source hardware and software platform designed to make electronics easy to use in multidisciplinary projects. It consists of a circuit board with a microcontroller and a development environment (IDE) that allows users to write programs for the board. It is widely used in prototyping by designers and educators who are beginning to explore programming and electronics, thanks to its simplicity and its potential for creating interactive and automated projects.

- **Advantages/Benefits:**
  - Facilitates the learning and implementation of electronic and programming concepts in engineering projects.
  - Its active community and extensive online resources provide strong support and numerous project examples.
  - Encourages innovation and experimentation in engineering and technology projects.

- **Suitability for the TECSKILL project:**

Arduino is perfectly suitable for TECSKILL due to its practical and hands-on approach, allowing doctoral students to develop prototypes and engineering projects with a tangible foundation. It offers an accessible platform for integrating technology into their research, stimulating innovation and creativity in the development of sustainable solutions.

RESEARCHGATE

- **Resource Description:**

ResearchGate is a specialized social network designed for scientists and researchers, facilitating collaboration, knowledge exchange, and the discovery of relevant research across academic and scientific fields. The platform allows users to create personal profiles where they can publish details about their research, share full articles, preprints, research data, and

experimental results. It also enables users to follow other researchers, participate in discussions within specialized groups, and ask questions that can be answered by experts worldwide.

- **Advantages/Benefits:**
  - Facilitates collaboration and communication among researchers from different disciplines and regions.
  - Provides access to a vast collection of scientific publications and research data.
  - Offers opportunities to receive peer feedback and increase the visibility of one's own research.
- **Suitability for the TECSKILL project:**

ResearchGate aligns perfectly with the goals of TECSKILL by promoting international collaboration and the exchange of knowledge in the academic sphere. It is an essential tool for doctoral students to expand their professional networks, access relevant scientific resources, and increase the dissemination of their own research, thus contributing to advancing knowledge in the field of engineering.

MATLAB SOFTWARE

- **Resource Description:**

Matlab (Matrix Laboratory) is a programming platform and numerical software environment developed by MathWorks that enables matrix manipulation, graphical representation of functions and data, algorithm implementation, user interface creation, and integration with programs in other languages and hardware devices. It is widely used in engineering, mathematics, and the sciences for research and the development of algorithms, mathematical modeling, and simulation.

- **Advantages/Benefits:**
  - Facilitates the efficient solving of complex mathematical problems and data analysis.
  - Offers an extensive library of predefined functions for numerical, statistical, and graphical computations.
  - Provides a graphical interface that allows intuitive visualization of data and models.
  - Features strong capabilities for algorithm development and system simulation.
  - Supports integration with other languages and hardware, expanding its applications.
- **Suitability for the TECSKILL project:**

The suitability of Matlab for the TECSKILL project is considerable, as this software environment provides a solid foundation for the development of advanced digital competences among engineering doctoral students. As a leading tool in numerical analysis and mathematical modeling, it enables users to efficiently address and solve a wide range of complex engineering problems, which is essential for innovative research and the creation of new technologies. Moreover, its ability to process large volumes of data and perform high-level simulations is crucial for the study and development of projects in areas such as artificial intelligence, control systems, and robotics, among others. This environment also fosters the acquisition of programming and data analysis skills, preparing doctoral students to face the challenges of an increasingly digitized world driven by big data. In this sense, Matlab aligns perfectly with the objectives of TECSKILL by enhancing the doctoral students' profiles with cutting-edge digital competences that are essential for progress and innovation in the field of engineering.

LABVIEW SOFTWARE

- **Resource Description:**

LabView (Laboratory Virtual Instrument Engineering Workbench) by National Instruments is a graphical development platform and environment for designing measurement, testing, control, and automation systems, distinguished by its visual programming approach that uses block diagrams instead of traditional lines of code. This feature makes LabView particularly accessible for engineers and scientists who are not programming specialists, allowing them to quickly create prototypes and complex test systems without becoming coding experts. The platform is widely used in industry and academia for applications requiring data acquisition, instrument control, data analysis, and real-time visualization. Additionally, LabView supports a broad range of hardware, enabling users to integrate various devices and instruments into their projects, facilitating experimentation and the implementation of automated and control systems. Its extensive library of predefined functions accelerates development, allowing researchers and developers to focus on innovation and solving complex problem.

- **Advantages/Benefits:**
  - Enables rapid application development through its graphical approach.
  - Facilitates integration and control of a wide range of hardware.
  - Provides tools for data analysis and report generation.
  - Supports system simulation before physical implementation.
  - Promotes innovation and experimentation through rapid prototyping.
- **Suitability for the TECSKILL project:**

LabView aligns perfectly with the goals of TECSKILL by offering an intuitive and powerful tool for the design and simulation of control and measurement systems, essential in modern engineering. Its graphical approach and hardware support make it an ideal platform for teaching engineering concepts, allowing doctoral students to experiment with designs and

prototypes, thereby enhancing their ability to innovate and solve complex problems in an advanced digital environment.

WEB OF SCIENCE

- **Resource Description:**

Web of Science (WOS) is a renowned scientific research platform that provides access to multiple bibliographic databases. This resource offers extensive coverage of high-quality publications across various disciplines, facilitating the search for articles, citations, journals, and research data. Its intuitive interface and advanced search tools allow users to perform thorough literature reviews and track current research trends.

- **Advantages/Benefits:**
  - Access to a wide range of peer-reviewed publications.
  - Advanced tools for citation analysis and identification of research trends.
  - Ability to track the impact of one's own research and publications.
  - Facilitates systematic literature reviews and meta-analyses.
- **Suitability for the TECSKILL project:**

WOS is particularly suitable for TECSKILL as it provides doctoral students and their supervisors with essential tools for advanced research, enabling access to the latest publications in their fields of study. Using WOS supports the development of digital competences related to information management and the ability to perform bibliometric analyses, key skills for contemporary scientific research. Additionally, it promotes a research culture based on evidence, crucial for the development of innovative and sustainable engineering projects.

SCOPUS

- **Resource Description:**

Like Web of Science, Scopus is a renowned scientific research platform and one of the largest and most prestigious bibliographic abstract and citation databases, covering peer-reviewed scientific literature, including journals, conferences, and patents. It offers robust tools for tracking, analyzing, and visualizing research, allowing users to access a wide range of resources across scientific, technical, medical, and social fields.

- **Advantages/Benefits:**
  - Extensive coverage of international sources.
  - Advanced functionalities for citation analysis and expert identification.
  - Enables easy comparison of scientific output between institutions and countries.

- Tools for tracking the evolution of specific research areas.

- **Suitability for the TECSKILL project:**

Scopus aligns perfectly with the objectives of TECSKILL, as its extensive database and analytical tools enhance the capacity of doctoral students to conduct well-founded and cutting-edge research. It facilitates access to up-to-date and relevant information, essential for formulating innovative research hypotheses and developing advanced technological solutions. Additionally, by fostering critical analysis and evaluation of scientific literature, Scopus significantly contributes to strengthening the digital and analytical competences required in engineering research.

LinkedIn

- **Resource Description:**

LinkedIn is a professional social network that connects individuals and organizations worldwide. It provides a platform for building professional networks, job searching, and sharing knowledge and experiences across a wide range of industries. Additionally, LinkedIn Learning offers access to thousands of online courses and tutorials aimed at developing specific skills, including digital competences, project management, specialized software, and more.

- **Advantages/Benefits:**
  - Facilitates the building and maintenance of a professional network.
  - Provides access to job and collaboration opportunities worldwide.
  - Offers educational resources for developing and improving professional skills.
  - Helps stay updated on industry trends and the labor market.

- **Suitability for the TECSKILL project:**

LinkedIn is particularly suitable for TECSKILL for several reasons. First, it allows doctoral students and academics to build and expand their professional networks, connecting with experts and organizations in the fields of engineering and sustainability. Second, the platform serves as a valuable source of information on the latest trends and labor market demands in areas related to green and digital competencies, which is crucial for guiding doctoral training toward high-demand fields. Additionally, LinkedIn Learning provides resources that can complement the doctoral students' academic training, helping them acquire additional digital skills essential in today's professional environment.

MS Project

- **Resource Description:**

Microsoft Project is a professional project management tool that allows planning, scheduling, resource allocation, and progress tracking of activities. It offers features for creating detailed timelines, managing task dependencies, and monitoring costs and durations. Its intuitive

interface and integration with other Microsoft applications make it a standard for managing complex projects in collaborative environments.

- **Advantages/Benefits:**
  - Facilitates comprehensive project planning and control.
  - Enables efficient management of resources, time, and budgets.
  - Improves team communication through reports and visualizations.
- **Suitability for the TECSKILL project:**

MS Project is well-suited for TECSKILL as it provides doctoral students with a foundation for structured management of research and development projects. Its use promotes the acquisition of digital competences in project planning, monitoring, and control, which are essential skills in modern engineering. Additionally, its integration with collaborative tools strengthens teamwork and task organization within a digital environment.

MIRO

- **Resource Description:**

Miro is an online visual collaboration platform that enables teams to create digital whiteboards for brainstorming, project planning, process mapping, and collaborative design. Its intuitive interface and multiple templates make it an ideal tool for co-creation in educational and research settings. Miro facilitates both synchronous and asynchronous interaction among users, enhancing creativity and the visual organization of ideas.

- **Advantages/Benefits:**
  - Promotes real-time collaboration and visual co-creation.
  - Allows dynamic structuring of ideas and workflows.
  - Integrates multiple tools and presentation formats.
- **Suitability for the TECSKILL project:**

Miro aligns with TECSKILL by fostering creativity, structured thinking, and digital collaboration among doctoral students. Its use facilitates joint planning of research and the development of interdisciplinary projects, strengthening communication and teamwork skills. Additionally, its visual approach enhances the understanding and presentation of complex technical concepts in engineering.

TRELLO

- **Resource Description:**

Trello is a project management tool based on the Kanban method, allowing tasks to be organized through boards, lists, and cards. It is especially useful for agile planning and

tracking collaborative projects, as it facilitates task assignment, progress management, and real-time activity prioritization.

- **Advantages/Benefits:**
  - Enables agile management of projects and tasks.
  - Promotes collaboration and transparency in distributed teams.
  - Allows easy and intuitive visualization of workflow.
- **Suitability for the TECSKILL project:**

Trello is an essential tool for TECSKILL, as it encourages efficient organization of collaborative projects and the development of digital skills in agile management. Its simplicity and adaptability make it ideal for doctoral students who need to coordinate tasks and maintain an overall view of their research progress. Additionally, it strengthens planning, prioritization, and collaborative work skills, which are key aspects of advanced engineering training.

AVIDNOTE

- **Resource Description:**

Avidnote is a digital platform designed for the management and writing of scientific notes, especially aimed at researchers and doctoral students. It allows the organization of observations, summaries, and experimental results in a structured way, integrating search, tagging, and collaboration features. Avidnote also facilitates the drafting of scientific articles and linking with external bibliographic references.

- **Advantages/Benefits:**
  - Enables efficient organization of research notes.
  - Facilitates collaborative writing and traceability of scientific work.
  - Improves productivity and academic information managemen.
- **Suitability for the TECSKILL project:**

Avidnote aligns perfectly with the objectives of TECSKILL by providing a modern tool for digital research management. It promotes the development of digital competences in scientific writing, information organization, and academic collaboration. Its use allows doctoral students to document and structure their projects more efficiently, enhancing the quality and coherence of their scientific output.

REFERENCES

[1] D. Kokotsaki, V. Menzies, A. Wiggins, Project-based learning: A review of the literature, Improv. Sch. 19 (2016) 267–277. https://doi.org/10.1177/1365480216659733.

[2] D. Leat, Enquiry and project-based learning: Students, school and society, Taylor & Francis, 2017.

[3] M.K. Noordin, Problem-Based Learning (PBL) and Project-Based Learning (PjBL) in engineering education : a comparison, Proceedings IETEC'11 Conf. (2011) 1–14.

[4] M.A. Almulla, The Effectiveness of the Project-Based Learning (PBL) Approach as a Way to Engage Students in Learning, SAGE Open. 10 (2020) 215824402093870. https://doi.org/10.1177/2158244020938702.

[5] A. Sharma, H. Dutt, C.N. Venkat Sai, S.M. Naik, Impact of Project-Based Learning Methodology in Engineering, Procedia Comput. Sci. 172 (2020) 922–926. https://doi.org/10.1016/j.procs.2020.05.133.

[6] N. Wijayati, W. Sumarni, S. Supanti, Improving Student Creative Thinking Skills Through Project Based Learning, KnE Soc. Sci. (2019). https://doi.org/10.18502/kss.v3i18.4732.

[7] C.-H. Chen, Y.-C. Yang, Revisiting the effects of project-based learning on students' academic achievement: A meta-analysis investigating moderators, Educ. Res. Rev. 26 (2019) 71–81. https://doi.org/10.1016/j.edurev.2018.11.001.

[8] P. Guo, N. Saab, L.S. Post, W. Admiraal, A review of project-based learning in higher education: Student outcomes and measures, Int. J. Educ. Res. 102 (2020) 101586. https://doi.org/10.1016/j.ijer.2020.101586.

[9] S.E. Gallagher, T. Savage, Challenge-based learning in higher education: an exploratory literature review, Teach. High. Educ. (2020) 1–23. https://doi.org/10.1080/13562517.2020.1863354.

[10] M. Leijon, P. Gudmundsson, P. Staaf, C. Christersson, Challenge-based learning in higher education– A systematic literature review, Innov. Educ. Teach. Int. 59 (2022) 609–618. https://doi.org/10.1080/14703297.2021.1892503.

[11] R.P. Gibert Delgado, M. Rojo Hernández, J.G. Torres Morales, H.B. Mendoza, Aprendizaje Basado En Retos, (2018) 1–11.

[12] M. Portuguez Castro, M.G. Gómez Zermeño, Challenge-Based Learning: Innovative Pedagogy for Sustainability through e-Learning in Higher Education, Sustainability. 12 (2020) 4063. https://doi.org/10.3390/su12104063.

[13] M.M. Agüero Pérez, L.A. López Fraile, J. Pérez Expósito, Challenge Based Learning como modelo de aprendizaje profesionalizante. Caso del programa Universidad Europea con Comunica +A, Vivat Acad. Rev.. Comun. (2019) 1–24. https://doi.org/10.15178/va.2019.149.1-24.

[14] J. Membrillo-Hernández, M. de Jesús Ramírez-Cadena, A. Ramírez-Medrano, R.M.G. García-Castelán, R. García-García, Implementation of the challenge-based learning approach in Academic Engineering Programs, Int. J. Interact. Des. Manuf. 15 (2021) 287–298. https://doi.org/10.1007/s12008-021-00755-3.

[15] Z. Yang, Y. Zhou, J.W.Y. Chung, Q. Tang, L. Jiang, T.K.S. Wong, Challenge-Based Learning nurtures creative thinking: An evaluative study, Nurse Educ. Today. 71 (2018) 40–47. https://doi.org/10.1016/j.nedt.2018.09.004.

[16] A.J.P. Tortosa, J.A.S. Pineda, Challenge-Based Learning: un puente metodológico entre la Educación Superior y el mundo profesional, ARANZADI/CIVITAS, 2021.

[17] L. Johnson, S. Adams, Challenge based learning: The report from the implementation project, The New Media Consortium, 2011.

[18] I. De los Ríos, S. Sastre-Merino, M.D. López, Aprendizaje basado en la investigación, Serv. Innovación Educ. (2020) 2–22. https://innovacioneducativa.upm.es/guias_pdi.

[19] L.E. Santana-Vega, A. Suárez-Perdomo, L. Feliciano-García, El aprendizaje basado en la investigación en el contexto universitario, Rev. Española Pedagog. 78 (2020) 519–538.

[20] F.P. Valderrama, A.G. Méndez, C.M. Castillo, R. Castro, A.T. Salinas, J.D.C. Aburto, L.I. Aguilar, L.C. Castillo, C.Q. Figueroa, K. Hetz, Aprendizaje Basado en Investigación para el fortalecimiento de la Formación Inicial Docente en Pedagogía en Educación Física, Retos Nuevas Tendencias En Educ. Física, Deport. y Recreación. (2023) 589–592.

[21] M.C. Saavedra Serrano, Aprendizaje Cooperativo basado en la Investigación en la Educación Superior, Rev. Docencia Univ. 16 (2018) 235. https://doi.org/10.4995/redu.2018.9305.

[22] G. Penagos-Cruz, Desde los proyectos de aula hacia la investigación formativa: un reto de la docencia en la educación superior, Rastros Rostros. 17 (2015) 111–116.

[23] N. Maugard, Fundamentals of Serious Games, in: 2019: pp. 15–41. https://doi.org/10.1007/978-3-030-29926-2_2.

[24] C. López Raventós, El videojuego como herramienta educativa. Posibilidades y problemáticas acerca de los serious games, Apert. (Guadalajara, Jal.). 8 (2016).

[25] S. Stieglitz, C. Lattemann, S. Robra-Bissantz, R. Zarnekow, T. Brockmann, Gamification, Springer International Publishing, Cham, 2017. https://doi.org/10.1007/978-3-319-45557-0.

[26] G. Baptista, T. Oliveira, Gamification and serious games: A literature meta-analysis and integrative model, Comput. Human Behav. 92 (2019) 306–315. https://doi.org/10.1016/j.chb.2018.11.030.

[27] M.R.F. Sánchez, M.C.S. Daza, J.V. Berrocoso, Serious Games para la adquisición de competencias profesionales para el desarrollo social y comunitario, Prism. Soc. Rev. Investig. Soc. (2020) 141–160.

[28] W. Westera, Why and how serious games can become far more effective: Accommodating productive learning experiences, learner motivation and the monitoring of learning gains, J. Educ. Technol. Soc. 22 (2019) 59–69.

[29] A. Abd-alrazaq, M. Alajlani, D. Alhuwail, C.T. Toro, A. Giannicchi, A. Ahmed, A. Makhlouf, M. Househ, The Effectiveness and Safety of Serious Games for Improving Cognitive Abilities Among Elderly People With Cognitive Impairment: Systematic Review and Meta-Analysis, JMIR Serious Games. 10 (2022) e34592. https://doi.org/10.2196/34592.

[30] D. Checa, A. Bustillo, A review of immersive virtual reality serious games to enhance learning and training, Multimed. Tools Appl. 79 (2020) 5501–5527. https://doi.org/10.1007/s11042-019-08348-9.

[31] K. Larson, Serious Games and Gamification in the Corporate Training Environment: a Literature Review, TechTrends. 64 (2020) 319–328. https://doi.org/10.1007/s11528-019-00446-7.

[32] J. Cuevas-Ortuno, J.C. Huegel, Serious Games or Challenge-based Learning - A comparative analysis of learning models in the teaching of lean manufacturing, in: 2020 IEEE Glob. Eng. Educ. Conf., IEEE, 2020: pp. 1542–1549. https://doi.org/10.1109/EDUCON45650.2020.9125393.

ANEXXES

DRAFT GREEN COMPETENCE TRAINING PROGRAMME

GREEN COMPETENCE TRAINING DRAFT							
Competence	Possible training session (PBL, CBL y Serious Game methodology)	Competence	Possible training session (PBL, CBL y Serious Game methodology)	Competence	Possible training session (PBL, CBL y Serious Game methodology)	Competence	Possible training session (PBL, CBL y Serious Game methodology)
Valuing sustainability	1 -Discussion workshop: Presentation of current good sustainable practices in research projects. 2 -Challenge to identify the activities in a research project that affect the environment the most. Propose changes/improvements for those critical activities. 3 -Practical workshop: Green Project Management: How to manage a project in a sustainable way? 4 -Challenge to evaluate 4 research projects from a sustainable point of view. Each group exposes and defends its assessment publicly. 14 -Practical workshop: direction and management of sustainable research projects: definition of sustainable problems or challenges, formulation of scope, constraints, requirements, stakeholders, time, cost, risks, etc.	Futures literacy	1 - Discussion workshop: Presentation of current good sustainable practices in research projects. 6 - Challenge to propose new research projects to improve current challenges from the perspective of sustainability for future generations. Assess different research projects 7 - Challenge to develop a working method/propose tips for future research projects to be sustainable. 15 -Challenge to propose future European, national and regional lines of action in terms of research and sustainability. 16 -Workshop disussion: What are the sustainable trends in the research lines of the PhD students?	Systems thinking	2 - Challenge to identify the activities of a research project that most affect the environment. Propose changes/improvements for those critical activities. 8 -Practical workshop: product/service life cycle assessment. Quantify environmental impacts 12 -Discussion workshop: What are the phases or processes that most affect the environmental impact of a given product? 13 -Challenge of selecting an optimal material/product for our research project, based on multiple criteria (economic, technical, environmental). 14 -Workshop direction and management of sustainable research projects: definition of sustainable problems or challenges, formulation of scope, constraints, requirements, stakeholders, time, cost, risks, etc.	Political agency	14 -Practical workshop: direction and management of sustainable research projects: definition of sustainable problems or challenges, formulation of scope, constraints, requirements, stakeholders, time, cost, risks, etc. 15 -Challenge to set the future European, national and regional lines of action in terms of research and sustainability. 16 -Workshop disussion: What are the sustainable trends in the research lines of the PhD students? 17 -Workshop disussion: Propose different sustainable solutions to current research problems or challenges. 19 -Challenge to elaborate a political/economic action plan to foster sustainable public and private research and development projects.
Supporting fairness	1 -Discussion workshop: Presentation of current good sustainable practices in research projects. 3 -Green Project Management Workshop: How to manage a project in a sustainable way? 5 -Discussion workshop: Presentation of new ideas to implement sustainability in their own research projects/projects. 6 -Challenge to propose new research projects to improve current challenges from sustainability for future generations. Value different research projects 7 -Challenge to develop a working method/propose tips for future research projects to be sustainable. 22 -Challenge to propose different recycling strategies in research projects in order to improve their sustainability.	Adaptability	2 - Challenge to identify the activities of a research project that most affect the environment. Propose changes/improvements for those critical activities. 6 - Challenge to propose new research projects to improve current challenges from the perspective of sustainability for future generations. Evaluate different research projects 14 -Practical workshop: direction and management of sustainable research projects: definition of sustainable problems or challenges, formulation of the scope, restrictions, requirements, stakeholders, time, cost, risks, etc. 16 -Discussion workshop: What are the sustainable trends in the research lines of the doctoral students? 17 -Discussion workshop: Propose different sustainable solutions to current research problems or challenges. 18 -Challenge to propose solutions based on circular economy in research projects.	Critical Thinking	2 - Challenge to identify the activities of a research project that most affect the environment. Propose changes/improvements for those critical activities. 4 - Challenge to evaluate 4 research projects from a sustainable point of view. Each group exposes and defends its assessment publicly. 5 -Discussion workshop: presentation of new ideas to implement sustainability in their own research lines/projects. 9 -Challenge to propose improvements in a research project to reduce the use of natural resources. 11 -Practical workshop: eco-designing a prototype/patent for research projects 14 -Workshop on management of sustainable research projects: definition of sustainable problems or challenges, formulation of scope, constraints, requirements, stakeholders, time, cost, risks etc. 22 -Challenge to propose different recycling strategies in research projects in order to improve their sustainability.	Collective action	5 - Discussion workshop: presentation of new ideas to implement sustainability in their own lines/projects of research. 6 - Challenge to propose new research projects to improve current challenges from sustainability for future generations. Assess different research projects 14 - Workshop direction and management of sustainable research projects: definition of sustainable problems or challenges, formulation of the scope, restrictions, requirements, stakeholders, time, cost, risks, etc. 18 - Challenge to propose solutions based on the circular economy in research projects. 19 - Challenge to elaborate a political/economic action plan to promote sustainable public and private research and development projects. 20 - Challenge to find the main drawbacks so that companies or institutions can collaborate to carry out sustainable research projects.
Promoting nature	2 -Challenge to identify the activities of a research project that most affect the environment. Propose changes/improvements for those critical activities. 8 -Practical workshop: product/service life cycle assessment. Quantify environmental impacts 9 -Challenge to propose improvements in a research project to reduce the use of natural resources. 10 -Challenge to quantify CO2 emissions within a research project. 11 -Practical workshop: eco-design of a prototype/patent for a research project 14 -Practical workshop: management of sustainable research projects: definition of sustainable problems or challenges, formulation of the scope, constraints, requirements, stakeholders, time, cost, risks, etc. 18 -Challenge of proposing solutions based on circular economy in research projects	Exploratory thinking	1 - Discussion workshop: Presentation of current good sustainable practices in research projects. 2 - Challenge to identify the activities in a research project that affect the environment the most. Propose changes/improvements for those critical activities. 3 - Green Project Management Workshop: How to manage a project in a sustainable way? 5 - Discussion workshop: presentation of new ideas to implement sustainability in your own research lines/projects. 6 - Challenge to propose new research projects to improve current challenges from sustainability for future generations. Assess different research projects 11 -Practical workshop: of the eco-design of a prototype/patent for research projects. 17 -Discussion workshop: Propose different sustainable solutions to current research problems or challenges. 18 -Challenge to propose solutions based on the circular economy in research projects. 22 -Challenge to propose different recycling strategies in research projects in order to improve their sustainability.	Problem framing	2 - Challenge to identify the activities of a research project that most affect the environment. Propose changes/improvements for those critical activities. 6 - Challenge to propose new research projects to improve current challenges from the perspective of sustainability for future generations. Evaluate different research projects 7 - Challenge to develop a working method/propose tips for future research projects to be sustainable. 14 -Practical workshop: direction and management of sustainable research projects: definition of sustainable problems or challenges, formulation of scope, constraints, requirements, stakeholders, time, cost, risks etc. 22 -Challenge of proposing different recycling strategies in research projects in order to improve their sustainability. 18 -Challenge to propose solutions based on the circular economy in research projects.	Individual initiative	1 - Discussion workshop: Presentation of current good sustainable practices in research projects. 2 - Workshop: Presentation of current good sustainable practices in research projects. 4 - Challenge to evaluate 4 research projects from a sustainable point of view. Each group presents and defends its assessment publicly. 5 - Discussion workshop: Presentation of new ideas to implement sustainability in their own research lines/projects. 16 - Discussion workshop: What are the sustainable trends in the research lines of the doctoral students? 17 - Discussion workshop: Propose different sustainable solutions to current research problems or challenges. 21 - Challenge of knowing how to align the objectives of one's own project or research line with European sustainability objectives

DRAFT DIGITAL COMPETENCE TRAININGPROGRAMME

DIGITAL COMPETENCE TRAINING DRAFT					
GROUP OF COMPETENCE	Number of competences	Possible training session (PBL, CBL y Serious Game methodology)	GROUP OF COMPETENCE	Number of competences	Possible training session (PBL, CBL y Serious Game methodology)
Information and data literacy	3	1- Challenge: advanced search and filtering in Science Direct, WOS etc. Definition of keywords. 2- Practical workshop: elaboration of a state of the art. Management and organization of information (develop the state of the art of the scientific congress to be elaborated). 3 - Discussion workshop: How to manage the scientific information overload within a research line or project? 4 - Practical workshop: creation and organization of a research database. Collection, evaluation, treatment and filtering of scientific data. 5 - Discussion workshop: analysis and interpretation of scientific results. 6 - Challenge: identify research where the database is not adequate for the scientific objective. 7 - Practical workshop: adequate graphical representation of scientific data and information. Flow charts, graphs, graphical abstract. 8 - Discussion workshop: understanding scientific diagrams, graphs, etc. 9 - Practical workshop: management and organization of information within research projects. 18 - Practical workshop: data measurement with sensors.	Safety	4	11 - Practical workshop: how to interact with and manage scientific social networks. 14 - Practical workshop: information flow, planning and sharing of responsibilities in virtual research projects. 19 - Discussion workshop: copyrights and intellectual property of research results. 20 - Challenge: patent-industrial protection of a prototype or research result. 21 - Practical workshop: creation of an intellectual property contract for a research project. 24 - Discussion workshop: frauds and suspicious mails in university environments. 25 - Personal work organization with Kanban. Limitation of working hours and effectiveness. 26 - Practical workshop: use of digital technologies to reduce environmental impact (for example, José proposed the measurement of CO2 in different environments). **Note: the environmental protection competence 4.4 is also worked with the green competences workshops.
Communication and collaboration	6	7 - Practical workshop: proper graphical representation of scientific data and information. Flow charts, graphs, graphical abstract. 9 - Practical workshop: management and organization of information within research projects. 10 - Practical workshop: organization of an online and face-to-face coordination meeting of a research project. 11 - Practical workshop: how to interact with and manage scientific social networks. 12 - Challenge: how to elaborate a research abstract in a proper way. 13 - Practical workshop: elaboration of a corporate entity for a research project. 14 - Practical workshop: information flow, planning and distribution of responsibilities in research projects in a virtual manner. 15 - Challenge: creation of a Kanban board for research.	Problem solving	4	4 - Practical workshop: creation and organization of a research database. Collection, evaluation, processing and filtering of scientific data. 7 - Practical workshop: adequate graphical representation of scientific data and information. Flowcharts, graphs, graphical abstract. 9 - Practical workshop: management and organization of information within research projects. 18 - Practical workshop: data measurement with sensors. 23 - Practical workshop: simulation/modeling of complex research problems (modeling of climate, solar radiation, etc.). 26 - Practical workshop: use of digital technologies to reduce environmental impact (e.g., José proposed CO2 measurement in different environments). 27 - Practical workshop/challenge: any simulation or management of digital technology in research (Here could enter any software management to solve research problems such as those proposed by Roberto and João. It would be the most important of the group of competences) 28 - Discussion workshop: How and when to use translation technologies? Deepl., Google Translate, ChatGPT, Microsoft word etc) 29 - Challenge: personal assessment of digital skills gaps.
Digital content creation	4	7 - Practical workshop: proper graphical representation of scientific data and information. Flow charts, graphs, graphical abstract. 8 - Discussion workshop: understanding scientific diagrams, graphs, etc. 11 - Practical workshop: how to interact with and manage scientific social networks. 13 - Practical workshop: elaboration of a corporate entity for a research project. 15 - Challenge: creation of a poster and a paper for a scientific congress (do it for the congress you have to attend). 16 - Practical workshop: computer graphics and renderings of prototypes and equipment used in research projects. 17 - Challenge: look for a diagram in a scientific article and represent it in a more accurate graphic format. 18 - Practical workshop: data measurement with sensors. 19 - Discussion workshop: copyright and intellectual property of research results. 20 - Challenge: patent-industrial protection of a prototype or research result. 21 - Practical workshop: creation of an intellectual property contract for research projects. 22 - Challenge: solving a problem through the development of a model/algorithm/programming (Arduino, Excel etc.). 23 - Practical workshop: simulation/modeling of complex research problems (climate modeling, solar radiation, etc.). 4 - Practical workshop: creation and organization of research database. Collection, evaluation, processing and filtering of scientific data.			

TRAINING PROGRAMME

		16/06/2024 - 29/06/24 Badajoz June 2024	08/09/24 - 21/09/24 Evora September 2024	19/01/2025 - 01/02/2025 Parma January 2025	01/06/25 - 14/06/25 Gävle June 2025
WEEK1	Day 1	**SPAIN** Professor **Justo García / Jaime González** Title: **Self-assessment of green and digital competencies. First steps to develop a sustainable research project**	**PORTUGAL** Professor **Figueiredo Joao** Title: **Supervisory control and data acquisition with SCADA system**	**ITALY** Professor **Milanese Daniel** Title: **Selecting an optimal material/product for our research project, based on multiple criteria (economic, technical, environmental).**	**SWEDEN** Professor **Oscar Bautista Gonzalez** Title: **Digital models to simulate and predict behaviours in research projects**
	Day 2	**SPAIN** Professor **Jaime González Domínguez** Title: **First steps to develop a sustainable research project**	**PORTUGAL** Professor **Figueiredo Joao** Title: **Workshop - Control and data adquisition with SCADA system**	**ITALY** Professor **Sciancalepore Corrado** Title: **Recycling strategies in research projects in order to improve their sustainability**	**SWEDEN** Professor **Amir Hosseinzadeh** Title: **Principles of sustainability with state-of-the-art digital control methodologies**
	Day 3	**ITALY** Professor **Federico Solari** Title: **Simulation in digital twin development**	**ITALY** Professor **Cavazza Antonella** Title: **Innovative solutions based on circular economy in research projects**	**SWEDEN** Professor **Daniel Rönnow** Title: **Machine Learning for digitalization of non-linear systems**	**ITALY** Professor **Tebaldi Letizia** **Title: Workshop - create and state of art and research poster**
	Day 4	**SPAIN** Professor **Gonzalo Sánchez** Title: **Design thinking methodology for the development of innovative sustainable ideas for research projects.**	**SWEDEN** Professor **Niclas Björsell** Title: **Intelligent digitized in research projects**	**PORTUGAL** Professor **Grilo Frederico** Title: **Low-cost digital processors, low cost sensors and actuators for prototype concept validation.**	**PORTUGAL** Professor **Janeiro Fernando** Title: **Develop virtual instrumentation solutions for data acqusition and process supervisory control using NI-LabView (LabView programming)**
	Day 5	**PORTUGAL** Professor **Tlemçani Mouhaydine** Title: **Signals and systems. Design mathematical models for dynamix systems.**	**SPAIN** Professor **Gonzalo Sánchez / Jaime González Domínguez** Title: **Schedule and cost of sustainable research projects**	**SPAIN** Professor **Lourdes Moreno / Justo García** Title: **Inductrial property of a research and Change management**	**SPAIN** Professor **Gonzalo Sánchez** Title: **Work Flow of a sustainable research project**
WEEK2	Day 1	**SPAIN** Professor **Gonzalo Sánchez** Title: **Developing new sustainable ideas - WORKSHOP**	**SPAIN** Professor **Gonzalo Sánchez / Manuel Botejara** Title: **Digital research project management with KANBAN and digital multivariable analysis**	**ITALY** Professor **Vignali Giuseppe** Title: **Sustainability and Life Cycle Assessment**	**SWEDEN** Professor **Ola Norrman Eriksson** Title: **Environmental assessment of technology with a focus on life cycle analysis (LCA) in construction, energy and transport**
	Day 2	**SWEDEN** Professor **João Santos Gomes** Title: **Sustainability research project - energy**	**PORTUGAL** Professor **Grilo Frederico** Title: **Develop low-cost automated wired and wireless prototype solutions with Arduino hardware (Arduino programming)**	**ITALY** Professor **Marco Mambrioni** Title: **Data measurement with sensors and problem solving trough programming in Arduino**	**SWEDEN** Professor **Lea Fobbe** Title: **Circular economy to minimize environmental impact**
	Day 3	**SWEDEN** Professor **Per Ängskog** Title: **Intelligent digital Data Acquisition and sensor calibration**	**ITALY** Professor **VOLPI Andrea** Title: **Data measurement with sensors and problem solving trough programming in Arduino**	**SPAIN** Professor **Jaime González / Gonzalo Sñnchez** Title: **Communication and First steps to develop a sustainable research project**	**ITALY** Professor **CAVAZZA Antonella** Title: **Eco-designing a prototype/patent for research projects**
	Day 4	**ITALY** Professor **Tebaldi Letizia** Title: **Advanced search, filtering and data management**	**SWEDEN** Professor **Robin von Haartman** Title: **Sustainable logistics**	**SWEEDEN** Professor **José Chilo** Title: **Intelligent digital Data Acquisition and sensor calibration**	**PORTUGAL** Professor **Figueiredo Joao** Title: **Develop automated solutions with increased complexity through the development of a model / algorithm / PLC-programming**
	Day 5	**PORTUGAL** Professor **Janeiro Fernando** Title: **Digital and Analog signals - LABVIEW**	**PORTUGAL** Professor **Tlemçani Mouhaydine** Title: **Represent and solve mathematical models, data analysis and data visualization using MATLAB (MatLab programming).**	**PORTUGAL** Professor **Figueiredo Joao** Title: **Develop automated solutions with increased complexity through the development of a model / algorithm / PLC-programming**	**SPAIN** Professor **Jaime González Domínguez / Lourdes Moreno / Justo García** Title: **Workshop - Intellectual and industrial protection and self evaluation**

PHD STUDENTS SURVEY

DC1. Searching and Filtering Data, Information and Digital Content

Definition
Ability to adapt, customize search strategies and effectively select information, ensuring that relevant and high quality information is obtained in line with research needs.

Goal
Develop and implement an efficient and customized search strategy, incorporating information filtering, to comprehensively identify and compile the scientific literature.

4. Adjust search strategies according to the specific needs of the research *

- ◯ 1. Is able to adjust search strategies according to the specific needs of the research.
- ◯ 2. Can perform independent searches in advanced databases, distinguishing between Open Access and Non-Open Access.
- ◯ 3. Can perform advanced database searching, using DOI and authors' names as an efficient method to locate and access publications.
- ◯ 4. Expert in autonomous searches in databases such as WOS and ScienceDirect. Shows ability to teach these skills.

5. Modify and adapt data filtering methods according to the specific requirements of an research *

- ◯ 1. Ability to apply data filtering strategies, although it shows shortcomings to execute them efficiently
- ◯ 2. Displays solid knowledge of keyword usage to optimize information filtering
- ◯ 3. Has a proven ability in data filtering by applying expert Boolean search with "AND", "OR" and "NOT" operators to refine queries with precision.
- ◯ 4. Expert in data flow analysis with the ability to efficiently apply advanced Boolean search and keyword usage

6. To make the doctoral student aware of the complexities of information searches *

- ◯ 1. Recognizes limitations in content accessibility
- ◯ 2. Recognizes the importance of minimizing information overload and shows ability to avoid distractions in searches
- ◯ 3. Performs a detailed analysis of the advantages and disadvantages of using artificial intelligence-based search engines.
- ◯ 4. Fully understands the complexity of information search and develops advanced strategies to overcome limitations in content accessibility.

7. Establish strategies to search for research-related project calls for proposals *

- ◯ 1. Identifies projects carried out in their area of study
- ◯ 2. Filters projects using criteria such as method, field of application or location
- ◯ 3. Uses more complex filters, such as date of realization, novelty or economic impact
- ◯ 4. Expert in the pursuit of projects related to the area of research, with the ability to teach such skills

8. Conduct effective searches for research calls for proposals *

- ◯ 1. Uses conventional search engines to find research calls
- ◯ 2. Use specialized search engines such as Pivot-RP to search for specific calls
- ◯ 3. Use specialized databases and customizable alerts to receive notifications of new calls, such as Horizon 2020 or Research Professional
- ◯ 4. Apply advanced trend analysis techniques to identify emerging calls, using tools such as Dimmensions or GrantForward.

DC2. Evaluating Data, Information and Digital Content

Definition
Critical and systematic analysis of digital datasets, information and relevant content to determine the quality, relevance and reliability of the research information collected.

Goal
Improve the ability to discern the validity and usefulness of digital resources in relation to research objectives.

9. To discern the quality of digital resources, identifying aspects such as accuracy, reliability and timeliness of the data and information evaluated. *

- ◯ 1. The PhD student possesses the ability to perform basic assessments of the reliability of digital information sources.
- ◯ 2. Recognizes specific limitations in the information assessed, indicating an intermediate understanding of factors affecting quality.
- ◯ 3. Has an advanced understanding of the validity of the data collection methods used.
- ◯ 4. Autonomously and expertly evaluates the quality and reliability of the information.

10. Understand the different means of recognizing malicious information *

- ◯ 1. Basic understanding of the potential sources of malicious information
- ◯ 2. Identifies the various software typically employed in plagiarism detection research
- ◯ 3. Specifically familiar with copyright legislation and knows methods such as cross-validation of data or peer review.
- ◯ 4. Effectively applies advanced strategies and techniques to recognize malicious information, demonstrating an expert level of critical content evaluation.

11. Understand the information presented in digital engineering research content *

- ◯ 1. Identifies basic elements in flowcharts and graphs, recognizing symbols commonly used in their area of research.
- ◯ 2. Analyzes complex graphs and flowcharts in scientific articles, identifying causal relationships and dependencies between variables
- ◯ 3. Synthesizes information from graphs and diagrams to gain an overall understanding and evaluates the effectiveness of Graphical Abstracts in conveying key concepts
- ◯ 4. Critically evaluates the effectiveness of visual presentation in digital content, providing advanced insights on how to improve clarity and visual communication

12. Identify the adequacy of the representation of digital content *

- ◯ 1. Identifies the need for visual representations through graphics or images
- ◯ 2. Evaluates consistency between visual representations and textual content
- ◯ 3. Evaluates the appropriateness of the type of graphic chosen with the content it represents
- ◯ 4. Perfectly assesses whether the type and number of graphical representations is optimal for conveying information

13. Evaluate the suitability of databases used in scientific publications. *

- ◯ 1. Recognizes the source of data used in a paper
- ◯ 2. Understands the relationship of the database to the research objective.
- ◯ 3. Evaluates the appropriateness of the type of graphic chosen with the content it represents relation to its scope, quality and relevance to the purpose ofthe research.
- ◯ 4. Critically examines the limitations of the database, identifying potential biases or shortcomings that could influence the research findings

DC3. Data, Information and Digital Content Management

Definition
Efficiently organize, store and manage data and digital information generated during research projects

Goal
To advance the efficiency of information management through innovative solutions that optimize the handling of digital data in research projects.

14. Acquire skills to design and implement systems that optimize the organization and retrieval of bibliographic information in research projects. *

- ◯ 1. Basic knowledge of academic systems such as Mendeley and Zotero to organize bibliographic references in research projects.
- ◯ 2. Sets up a customized database integrated with tools such as Zotero and Mendeley for efficient management of bibliographic information and associated documents
- ◯ 3. Optimizes a data management system that incorporates advanced features of Mendeley, as well as tools such as EndNote, facilitating online collaboration and document synchronization in collaborative research projects.
- ◯ 4. Leads the development of a data management environment integrating analytical tools to extract key information from references and documents in research projects.

15. Manage standards that promote interoperability and quality in digital data management. *

- ◯ 1. Possesses basic knowledge of existing bibliographic standards, such as APA, IEEE or ISO, used in engineering research.
- ◯ 2. Rigorously applies recognized bibliographic standards to ensure correct citation and referencing in research projects.
- ◯ 3. Applies FAIR principles to ensure transparency and accessibility of data in research projects.
- ◯ 4. Expert in the implementation of specialized regulations for data management in engineering research, promoting the integrity and reproducibility of results.

16. Organize the information presented by other authors related to the same research topic. *

- ◯ 1. Identifies and summarizes key information from previous studies on a research topic
- ◯ 2. Organizes state-of-the-art information into a document, highlighting trends, methods, and gaps in research
- ◯ 3. Effectively manages information overload by applying advanced organization techniques such as concept maps or comparison matrices.
- ◯ 4. Develops innovative strategies to organize and manage large amounts of information, applying data mining and automated analysis techniques.

17. Create a digital information management system for research projects. *

- ◯ 1. Uses basic digital tools to organize and store information related to a research project, such as Google Drive
- ◯ 2. Implements more advanced digital information management systems, such as Trello or Asana, to coordinate tasks and documentation in a project.
- ◯ 3. Designs and customizes an information management system using more complex platforms such as SharePoint, customizing workflows
- ◯ 4. Adapts customized digital information management systems for complex research projects

18. Optimal organization of information *

- ◯ 1. Creates simple folders to organize documents related to a research project, using descriptive file names
- ◯ 2. Applies a more elaborate folder structure and uses consistent naming conventions to facilitate document identification
- ◯ 3. Designs a folder structure adapted to the specific needs of the project, considering the interrelation of documents and facilitating quick searches
- ◯ 4. Develops a customized information organization system that incorporates knowledge management principles, with workflow automation and advanced metadata approaches.

19. Manage databases of the research projects. *

- ◯ 1. Uses basic tools such as spreadsheets to record and organize manually collected data, keeping a simple structure
- ◯ 2. Implements simple relational databases using software such as Microsoft Access or MySQL to organize data from a variety of sources
- ◯ 3. Uses more advanced database management systems, such as PostgreSQL or MongoDB, to handle large datasets and ensure integrity and security
- ◯ 4. Designs and implements a customized data management system, considering performance optimization, scalability and interoperability with other analytics tools

DC4. Interacting through Digital Technologies

Definition
Develop knowledge, skills and interaction attitude in research projects through various digital technologies.

Goal
Use and critically integrate digital technologies in the communication of engineering research projects.

20. Manage various digital technologies to facilitate the interaction of the doctoral student in digital environments. *

- ◯ 1. Demonstrates familiarity with various digital technologies to facilitate the doctoral student's interaction with digital media, but does not have a deep understanding of their maximum performance
- ◯ 2. Develops knowledge and skills that enable them to interact with new digital technologies
- ◯ 3. Dominate digital technologies to facilitate the interaction of the doctoral student in digital environments.
- ◯ 4. Leading the implementation of new innovative ways to facilitate doctoral student interaction in digital environments.

21. Use digital internal communication technologies for the management of research projects. *

- ◯ 1. He/She is fluent in identifying different internal communication tools for research project management, but his knowledge of the different applications is limited.
- ◯ 2. He/she is proficient in the advanced functions of digital technologies for the management of internal communications (moderating online sessions, internal communication flow, etc.).
- ◯ 3. Integrating digital tools into cross-cutting aspects of research project management to optimise internal communication
- ◯ 4. Can improve and optimise the application of digital tools, making innovations, applying emerging digital technologies to improve internal communication for research project management.

22. Understand the platforms for communicating scientific and technical results obtained during research. *

- ◯ 1. Compares the purpose and prestige of different digital platforms for disseminating scientific results of research conducted
- ◯ 2. Ability to develop strategies for selecting digital platforms to disseminate research results
- ◯ 3. Identifies new innovative ways of disseminating scientific research results
- ◯ 4. Adapt the results presented to digital platforms for the communication of the results.

23. Understand the platforms for communicating scientific and technical results obtained during research. *

- ◯ 1. Use social media to increase the dissemination of research project milestones.
- ◯ 2. Regularly contributes to discussions in social networks related to the thematic area of your research project.
- ◯ 3. Attract followers through their interaction with digital content
- ◯ 4. Attract researcher interest through social networking groups in own research social networks (ResearchGate).

DC5. Sharing through Digital Technologies

Definition
Encourage advanced information sharing and state-of-the-art digital content to establish effective sharing during engineering research projects.

Goal
Develop skills and capacities to share digital content effectively through advanced technology. Promote transparency of research results.

24. Implement the project's corporate identity in scientific communications during research through digital tools *

- ◯ 1. Uses digital technologies to adhere colours, logos and other visual elements in accordance with the corporate identity of the research project.
- ◯ 2. Use of digital technologies to coherently implement the corporate identity of the research project in various digital tools such as presentations and social networks.
- ◯ 3. Identifies digital tools with which to innovate in the creative implementation of visual elements that enhance the corporate identity of the project.
- ◯ 4. Investigate how to incorporate the project's corporate identity into the dissemination of project results.

25. Knowing the digital technologies for sharing information within research projects through their corporate identity *

- ◯ 1. Understand the essential elements of corporate identity and how they are applied in digital tools.
- ◯ 2. Rational use of common digital tools for sharing information in research projects, incorporating corporate identity
- ◯ 3. Explores and uses emerging digital technologies (such as AI) to share information, while maintaining a strong integration with the project's corporate identity.
- ◯ 4. Participate in the development of new digital technologies to convey the corporate identity of a research project.

26. Implementing digital technologies to share scientific-technical information generated during research *

- ◯ 1. Demonstrates basic understanding of the functions and features of these platforms in terms of information sharing
- ◯ 2. Customise the presentation of scientific and technical information for different contexts using digital technologies (text editors, drawio...).
- ◯ 3. It integrates cutting-edge digital technologies to share scientific and technical information.
- ◯ 4. Increases knowledge by disseminating their experience in scientific and technical research work (Linkedin)

27. Organise meetings within a research project to share scientific information through digital technologies. *

- ◯ 1. It ensures the effective participation of partners and the clear transmission of scientific information through the application of digital technologies.
- ◯ 2. Efficiently manages advanced functions of digital platforms to enhance the participants' experience.
- ◯ 3. Tailors digital meetings according to gies according to the specific needs of the research
- ◯ 4. Investigates new digital tools to improve the efficiency/organisation of meetings within a research project.

DC6. Engaging Citizenship Through Digital Technologies

Definition
Employ digital technologies appropriately in the context of research projects to enhance community interaction, address societal challenges and contribute to sustainable development.

Goal
Effectively apply digital technologies in research projects to strengthen community interaction, address social challenges and contribute to sustainable development through research in engineering projects.

28. Apply digital technologies to assess the needs of citizens and strengthen the research object of the projects. *

- ◯ 1. Adequately identifies relevant digital platforms and tools to capture the needs of society
- ◯ 2. Apply digital technologies in a proficient way to collect data and strengthen the management of research projects
- ◯ 3. It introduces innovative practices in the application of digital technologies to assess citizens' needs.
- ◯ 4. Researches new digital technologies to achieve greater data size to capture the needs of the public

29. Understand various public and private platforms for managing and soliciting engineering research projects. *

- ◯ 1. Identifies and understands the functioning of digital platforms for the management and application of research projects
- ◯ 2. Learn about the advanced functions of various digital platforms optimising the research project management and application process.
- ◯ 3. Customise the use of project management platforms according to the specific needs of the research projects (Jira).
- ◯ 4. It leads initiatives for the incorporation of new platforms or the development of customised solutions to optimise the management of engineering research projects.

30. Use digital tools to involve citizens in research projects, either in the development of the database or to ensure the applicability of research results. *

- ◯ 1. Identifies and uses digital tools to communicate research project information to the public
- ◯ 2. Develop more advanced strategies to engage citizens through digital tools.
- ◯ 3. Establishes feedback biases through the use of digital technologies to strengthen the applicability of results
- ◯ 4. Collaborate with other institutions to share experiences and promote continuous improvement in citizen participation in research projects.

31. To adequately represent, through digital technologies, the scientific information generated so that it is accessible to the public. *

- ◯ 1. Uses digital technologies to represent scientific information (excel, graphpad...).
- ◯ 2. Adapt complex visual representations to make them understandable for citizens (Power BI).
- ◯ 3. Uses digital technologies to represent visual information in an attractive way through code development (Python, Matlab...).
- ◯ 4. Investigates visual data compression strategies through the application of digital technologies.

DC7. Collaborating Through Digital Technologies

Definition
Advanced management of digital technologies in collaborative processes of integrated data and/or resource creation in research projects.

Goal
Dominate the strategic selection of digital technologies for knowledge co-creation and collaboration within engineering research.

32. Know digital technologies that optimise collaboration between stakeholders and/or research project team members. *

- ◯ 1. Knows the functionality of various technologies and how it could be adapted to research projects (SharePoint, Microsoft Teams).
- ◯ 2. Efficient use of collaborative digital technologies
- ◯ 3. Innovate in the use of digital technologies through the use of new functionalities useful for collaboration (Miro).
- ◯ 4. Continuously integrates new digital technologies to optimise collaboration between stakeholders and/or project team members.

33. Develop effective strategies to facilitate smooth collaboration of scientific information during a project using digital tools. *

- ◯ 1. Learn about different strategies that facilitate effective collaboration through the application of digital technologies.
- ◯ 2. It implements more advanced digital tools to optimise research project communication and collaboration.
- ◯ 3. Design strategies to suit different contexts and types of projects
- ◯ 4. Introduces specific innovative features of digital technologies to enhance collaboration during research projects

34. Use digital tools, in a collaborative context, to assign responsibilities within an engineering research project. *

- ◯ 1. Knows different ways of establishing accountability (RACI matrix) through digital tools (e.g. JIRA).
- ◯ 2. Can integrate the particular scenario of his or her research project into the functionalities offered by digital responsibility management tools.
- ◯ 3. Develops personalised strategies within the team to allocate responsibilities in innovative ways
- ◯ 4. Introduces innovations in accountability practices to maximise efficiency

35. Using specific digital tools to plan and share tasks effectively in the framework of an engineering research project. *

- ◯ 1. Efficiently use digital tools for planning and task allocation in a research project such as Kanban or Miro.
- ◯ 2. Effectively integrates digital tools (Kanban, Miro...) for particular scenarios specific to research projects.
- ◯ 3. Critica la eficacia de las estrategias utilizadas para compartir tareas con las herramientas digitales empleadas
- ◯ 4. Critique the effectiveness of the strategies used to share tasks with the digital tools employed.

36. Co-create, through digital technologies, digital resources that enhance collaboration within an engineering research project. *

- ◯ 1. Participate in co-creation activities using digital technologies.
- ◯ 2. Design digital resources with advanced functionalities that enhance collaboration, such as real-time collaborative editing tools.
- ◯ 3. Customises digital resources to suit the specific needs of the research project.
- ◯ 4. Introduces significant innovations in digital co-creation that transform project collaboration.

37. Know and implement digital technologies that enable the co-creation of digital resources within engineering research projects. *

- ◯ 1. Demonstrates familiarity with at least two digital platforms designed for the co-creation of resources in research projects.
- ◯ 2. Uses advanced tools to manage and organise the process of co-creation of digital resources.
- ◯ 3. Facilitates the equitable and meaningful participation of all collaborators during co-creation sessions.
- ◯ 4. Leads the implementation of innovative practices in digital co-creation, contributing to the development of new approaches and technologies.

DC8. Netiquette

Definition
To increase researchers' knowledge related to the way they behave in the use of digital technologies and their interaction to meet the needs of specific audiences.

Goal
To develop skills in understanding norms of behaviour in the use of technologies, as well as specific knowledge in the use of technologies and interaction in digital environments.

38. Knowing the rules of behaviour in scientific digital environments, communicating effectively according to the target audience. *

- ◯ 1. Identifies variables that relate to the well-being of the working group and the use of digital technology in the research project.
- ◯ 2. Uses digital platforms in an ethical and respectful manner in accordance with established standards.
- ◯ 3. Leads innovative problem-solving strategies in the use of digital technologies
- ◯ 4. Contributes to the establishment of ethical standards and practices in the digital communication of research projects

39. Manage conflicts between members of the working group through the application of digital technologies. *

- ◯ 1. Ability to identify digital technologies that manage conflicts in the context of research projects (ODR systems).
- ◯ 2. Demonstrates understanding in the application of these digital conflict management technologies in the framework of research projects
- ◯ 3. Customise certain functions in the application of digital technologies for research working groups.
- ◯ 4. Controls the resolution of conflicts through the creation of forums on digital platforms, thus helping to share risk management plans.

40. Create digital resources adapted to different contexts, culture or generation for the dissemination of the results or knowledge generated during the PhD student's research. *

- ◯ 1. Understands how these characteristics can influence the dissemination of the digital resource created.
- ◯ 2. Develops digital resources tailored to the specific needs of the target population
- ◯ 3. Identifies areas for improvement through the addition of elements that provide feedback from specific audiences
- ◯ 4. Demonstrates ability to anticipate potential conflicts in managing the creation of digital content

41. Be able to interact/adapt the rules of conduct in the use of digital information and communication technologies. *

- ◯ 1. Understands the importance of these standards in the context of digital conduct
- ◯ 2. Demonstrates the ability to interpret and adapt standards to specific research contexts
- ◯ 3. Develops norms adapted to the use of digital technologies in research projects
- ◯ 4. Has experience in developing norms of conduct for using digital technologies efficiently

DC9. Managing Digital Identity

Definition
Manage digital contents of your doctoral thesis to disseminate via social networks the information generated in Project Engineering of your doctoral thesis.

Goal
Achieve a wider dissemination of the achievements and knowledge gained in your doctoral thesis through social networks.

42. Understand the importance of effectively managing digital identity in digital environments, embracing its specific relevance within the field of research. *

- ◯ 1. Demonstrates basic understanding of how digital identity management affects online presence in the field of research
- ◯ 2. Uses various digital platforms to manage basic aspects such as connecting between profiles
- ◯ 3. Uses his/her digital identity to disseminate a digital personality
- ◯ 4. Protects their digital identity through personal identifiers, enforces regulations

43. Establish a digital identity, such as the use of identifiers like ORCiD, for the management of scientific and technical documentation. *

- ◯ 1. Correctly link scientific output to identifiers such as ORCiD
- ◯ 2. Customise ORCiD profile to highlight scientific contributions and achievements
- ◯ 3. Ability to manage digital identity with identifiers other than ORCiD
- ◯ 4. Seamlessly uses all types of identifiers typical of scientific databases (Scopus, Publons, WOS...)

44. Integrates the digital identity in a way that allows you to establish connections with the various scientific profiles related to your research *

- ◯ 1. Connect your digital identity with relevant scientific profiles
- ◯ 2. Shape your digital identity into relevant scientific profiles in ways that connect you with experts in your research area.
- ◯ 3. Collaborates with other researchers due to the similarity of your digital identity, contributing to knowledge generation
- ◯ 4. Your digital identity is recognised as a reference in your field, generating an impact on global collaboration.

45. Effectively manages the digital identity and digital environments ensuring up-to-date management *

- ◯ 1. Regularly updates information on their digital profiles (e.g. ORCID, ResearchGate).
- ◯ 2. Participates in training courses or events to keep up to date with the latest digital trends in their field
- ◯ 3. Uses digital tools to identify trends in research and digital change
- ◯ 4. Leads initiatives to improve digital identity management at institutional level

DC10. Development of digital multimedia content for research purposes.

Definition
Creation of scientific digital content to improve communication, dissemination and transfer of engineering research information.

Goal
Effective use of digital tools to achieve efficient communication of information generated during doctoral student research.

46. Create synthetic graphical resources of the research results *

- ◯ 1. Summarizes your research adequately, although some relevant information is lost.
- ◯ 2. reates graphs that accurately represent your research, making it more understandable
- ◯ 3. Improves the quality of his scientific article thanks to the quality of his multimedia content
- ◯ 4. Develops highly innovative multimedia resources that significantly enhance the presentation and understanding of the research findings

47. Employing digital tools for the creation of scientific posters for an engineering research conference *

- ◯ 1. Generates digital content independently and inefficiently
- ◯ 2. Is fluent in a wide range of software.
- ◯ 3. Create complex multimedia content seamlessly and semi-automated
- ◯ 4. Knows the advanced options of all the softwarethat uses in work

48. Identify and create diagrams to effectively represent research findings *

- ◯ 1. Generates digital diagrams with a formal aesthetic that correctly communicate his ideas.
- ◯ 2. Designs diagrams using the latest software on the market and effectively convey his ideas.
- ◯ 3. Effortlessly represents research data using the software tools needed
- ◯ 4. Researches new software for creating diagrams and updates its skills on existing ones

49. Use information technologies to create digital content to improve the management of research projects. *

- ◯ 1. Creates digital content when it is completely necessary according to project requirements
- ◯ 2. Creates digital content comfortably and is aware that it enriches his work
- ◯ 3. Finds the most effective way to communicate regardless of the type of digital format.
- ◯ 4. Is an expert in digital communication and helps other colleagues to improve their multimedia content.

DC11. Digital Content Integration and Reelaboration

Definition
Modify, refine, improve and integrate information and content into an existing body of knowledge to create new, original and relevant content.

Goal
To develop the ability to rework scientific digital content for the creation of new scientific

50. Re-elaboration of Proprietary Scientific Multimedia Contents *

- 1. Makes superficial adjustments to existing multimedia content, with a basic understanding of the subject matter
- 2. Modifies specific elements of digital content, improving clarity
- 3. Effectively combines and rearranges existing multimedia content to create an original product
- 4. Fuses advanced design skills and scientific knowledge to create completely new and meaningful multimedia content.

51. Re-elaborate Scientific Multimedia Content from other Authors *

- 1. Examines, interprets and reworks content from other authors to suit their research
- 2. Is able to create original content from other authors' publications.
- 3. Provides new scientific information and knowledge from the research of other scientists
- 4. Integrates and synthesizes multimedia content from various authors to generate comprehensive and innovative resources that contribute significantly to advancing the field and fostering interdisciplinary collaboration.

52. Tailoring Digital Content for Specific Audiences *

- 1. Customizes digital content to specific audiences, significantly improving relevance and understanding
- 2. Tailors advanced digital content for diverse audiences, ensuring optimal comprehension and meaningful relevance
- 3. Develops highly personalized content and uses innovative strategies and advanced resources to achieve effective communication.
- 4. Demonstrates a deep understanding of the specific needs of diverse audiences. Implements advanced and creative strategies that elevate the user experience.

53. Modifying scientific digital resources with AI digital technologies *

- 1. Shows a basic understanding of how these tools can contribute to content enhancement
- 2. Uses artificial intelligence tools to make simple modifications to scientific digital assets
- 3. Demonstrates advanced skills in the strategic application of artificial intelligence for the reworking of scientific content.s
- 4. Carries out comprehensive digital content management, generating innovative material that contributes significantly to the advancement of the field.

DC12. Copyright and Intellectual Property Licensing

Definition
Request and manage data, information, and digital content with copyrights and intellectual property licenses.

Goal
Develop the skills and knowledge necessary to understand, manage and ethically and effectively apply copyright and intellectual property licenses in the context of research projects.

54. Identifies databases and scientific information that can be legally viewed and downloaded *

- ◯ 1. Knows databases of legal scientific articles and recognizes the importance of legality in the access to scientific information.
- ◯ 2. Demonstrates superior knowledge of license types and their application in research projects
- ◯ 3. Applies advanced strategies for the legal protection of copyrights in research projects.
- ◯ 4. Offers comprehensive legal advice on copyright and intellectual property rights.

55. Know how to use and share the research results of other researchers in a legal manner. *

- ◯ 1. Understands the ethical implications of sharing results from other researchers.
- ◯ 2. Shares research results of others while respecting licenses and copyrights.
- ◯ 3. Demonstrates a thorough understanding of contractual and legal implications, tailored to the academic environment
- ◯ 4. Demonstrates superior proficiency in the application of regulations and licensing, contributing to the active promotion of legal practices in the scientific field

56. Is able to check the novelty of your patent or intellectual property through the appropriate databases. *

- ◯ 1. Understands basic concepts related to novelty in the context of intellectual property.
- ◯ 2. Uses databases to verify novelty of patents and intellectual property in a basic way.
- ◯ 3. Performs complete and accurate novelty verification, demonstrating advanced skills.
- ◯ 4. Provides leadership in the implementation of advanced standards to ensure novelty in patents and intellectual property.

57. Develop, with support, the necessary documentation to register the rights to the results of an engineering research project. *

- ◯ 1. Understands basic concepts related to patent registration documentation
- ◯ 2. Develops documentation for the registration of intellectual property rights with the support of
- ◯ 3. Creates complete and accurate documentation for the registration of intellectual property rights.
- ◯ 4. Advises peers on intellectual property registration and documentation development

DC13. Programming

Definition
Solve problems that arise during engineering research projects, through models, algorithms or programming with digital technologies.

Goal
Develop programming skills for effective process automation, analysis of experimental data and creation of customized computational tools.

58. To know different digital programming tools to improve the creation of databases. *

- ◯ 1. Uses simple spreadsheet scripts to automate repetitive tasks in data analysis
- ◯ 2. Develops simple scripts to process and clean data sets in common formats such as CSV or Excel.
- ◯ 3. Creates basic programs in Python or R to perform more complex data analysis, such as visualizations or descriptive statistics.
- ◯ 4. Uses artificial intelligences to automate specific processes in research projects

59. Use digital technologies for the development of codes that personalize the processing and filtering of scientific data. *

- ◯ 1. Uses scripts to perform basic analysis of experimental data
- ◯ 2. Develops scripts that implement more advanced statistical techniques such as regression methods.
- ◯ 3. Applies machine learning algorithms to perform predictive or classificatory analysis.
- ◯ 4. Leads the implementation of new data analysis techniques that contribute to research innovation

60. Simulate or model complex problems within the PhD student's research using digital tools. *

- ◯ 1. Recognizes the usefulness of simulation in research and identifies some digital tools for this purpose.
- ◯ 2. Shows basic understanding of how simulations/models inform research
- ◯ 3. Apply advanced digital tools for simulation with a strategic approach.
- ◯ 4. Uses Artifical Intelligence as a tool to speed up the development of simulations.

61. Solve problems through algorithm development or programming with digital tools. *

- ◯ 1. Identifies basic programming concepts and recognizes the importance of programming in research
- ◯ 2. Develops basic algorithms and programs to solve specific problems
- ◯ 3. Uses advanced programming to solve complex research problems
- ◯ 4. Contributes innovative approaches to problem solving through programming.

DC14. Protecting Devices

Definition
Know, design and execute security and privacy measures/protocols for the protection of information and digital devices, understanding the risks and potential threats in the field of engineering research.

Goal
Critical evaluation in terms of security and adoption of risk prevention, eradication and/or mitigation measures in digital research environments.

62. Identify malicious scientific emails/messages in digital research environments. *

- ◯ 1. Know the severity of malicious scientific emails/messages in digital research environments.
- ◯ 2. Explains to other researchers the severity of malicious emails/messages in digital research environments.
- ◯ 3. Identifies malicious emails/messages in digital research environments.
- ◯ 4. Explains to other researchers how to properly identify malicious emails/messages.

63. Managing passwords for scientific digital environments. *

- ◯ 1. Is aware that proper password management in scientific environments is critical.
- ◯ 2. Establish secure passwords in scientific digital environments.
- ◯ 3. Develop security protocols/codes for setting passwords in different digital environments.
- ◯ 4. Research new digital tools for password management of digital environments used in research.

64. Establish security measures in digital environments for accessing and editing engineering research project information. *

- ◯ 1. Knows the importance of setting access and editing measures in the digital environments used to share research information.
- ◯ 2. Implement standard security measures for accessing and editing research project information in digital environments.
- ◯ 3. Establishes protocols and/or solid action measures for the correct access and edition of information in digital environments of research projects.
- ◯ 4. Contact the university's ICT service to effectively manage new ways of managing access and editing environments in digital environments used to share research information.

65. Evaluate the massive request for malicious information and collaboration in digital research environments. *

- ◯ 1. Manages information request and collaboration emails in digital research environments.
- ◯ 2. Knows the origins or main sources of suspicious information requests and collaboration in digital research environments.
- ◯ 3. Evaluates requests for information and collaboration coming through digital research environments.
- ◯ 4. Is able to implement automatic information filtering in digital environments to eliminate malicious information request emails.

66. Protect research results through patents or intellectual property. *

- ◯ 1. Know the difference between patent and intellectual property.
- ◯ 2. Identify through digital platforms whether your potential research result has been patented or protected.
- ◯ 3. Identifies and uses the platforms for the protection of research results.
- ◯ 4. Use digital tools for the protection of research results generated during the PhD student's research career.

DC15. Protecting Personal Data and Privacy

Definition
Understand how to implement protocols for the protection of personal information and privacy from potential risks in digital research environments.

Goal
Effective protection of privacy and personal data and privacy within research projects against potential digital risks and threats.

67. Information privacy management within research projects through digital tools. *

- ◯ 1. Identify critical information that must be properly privacy managed through digital tools
- ◯ 2. Classify documents and information generated in research projects according to their level of privacy.
- ◯ 3. Implement privacy protocols for documents/information generated in research projects through digital technologies.
- ◯ 4. Explain the privacy protocols to the members of the research team of the project.

68. Protect the personal information and privacy of research project stakeholders through digital technologies. *

- ◯ 1. Knows the importance of properly managing the privacy of stakeholders in research projects
- ◯ 2. Identifies the stakeholders with the most sensitive and critical information.
- ◯ 3. Protects the personal information and privacy of stakeholders in the digital environment used in the project.
- ◯ 4. Researches new digital tools to securely protect stakeholders' personal information and privacy.

69. Establish access and editing of personal information in digital environments used in research projects. *

- ◯ 1. Gives access to the digital environment to the members of the research project.
- ◯ 2. Defines personal information that cannot be shared through digital tools.
- ◯ 3. Controls access to personal information within digital environments in research projects.
- ◯ 4. Controls editing of personal information within digital environments in research projects.

70. Develop confidentiality agreements with the different public and private partners of research projects for the protection of information shared in digital environments. *

- ◯ 1. Understands the need for data protection and intuits the levels of confidentiality of data processed in digital environments.
- ◯ 2. Establishes oral agreements with partners and/or entities in the treatment of information generated and shared in digital environments.
- ◯ 3. Develops, with digital tools, confidentiality agreements with partners and/or entities in the treatment of information generated and shared in digital environments.
- ◯ 4. Researches new digital tools for the generation of confidentiality agreements for the privacy of research projects.

DC16. Protecting Health and Well-Being

Definition
Ability to identify and mitigate health risks, both physical and mental, derived from the use of digital technologies in research.

Goal
Development of skills and/or technical abilities in identifying and evaluating problems in the use of digital technologies and designing and implementing solutions that protect personal integrity and support the inherent dangers of digital environments.

71. Identify what are the main issues within a research project on the impact of digital technologies on health and well-being. *

- ◯ 1. Identifies research activities that, through the use of digital technologies, have the greatest potential to affect health and well-being.
- ◯ 2. Identifies the management activities that, through the use of digital technologies, have the greatest potential to affect health and well-being.
- ◯ 3. Determines the people who will be affected by the use of digital technologies in research projects.
- ◯ 4. Explains to other project members the problems generated in health and well-being due to activities that employ digital technologies in research projects.

72. To propose strategies to improve health and well-being and reduce the impact of digital technologies. *

- ◯ 1. Knows the importance of mitigating the problems generated in health and well-being by the use of digital technologies in research.
- ◯ 2. Knows strategies to improve health and well-being and reduce the impact of the use of digital technologies in research.
- ◯ 3. Implements strategies to improve health and well-being and reduce the impact of the use of digital technologies in research.
- ◯ 4. Researches new strategies with digital tools to improve health and wellness and reduce the impact of the use of digital technologies in research.

73. Employ digital technologies to manage workload among research team members, minimizing the impact of the use of digital technologies on health and well-being. *

- ◯ 1. Knows the importance of properly managing the workload of research team members to improve health and well-being.
- ◯ 2. Knows digital tools to improve the workload of team members and, consequently, improve health and well-being during research.
- ◯ 3. Apply digital technologies to manage the workload of team members, mitigating issues generated on health and well-being.
- ◯ 4. Research new digital technologies to manage the workload within a research team, mitigating issues generated on health and well-being.

74. Use digital technologies to organize the daily work of a research through digital technologies. *

- ◯ 1.Knowledge of how digital technologies affect the doctoral student's own health and well-being.
- ◯ 2. Ability to balance working with and without digital technologies to improve the health and well-being of the doctoral student.
- ◯ 3. Implements digital technologies to organize daily research work.
- ◯ 4. Researches new digital tools to organize daily research work.

DC17. Protecting the Environment

Definition
Understand the influence of the use of digital technologies on the impact of the environment during research projects on the impact of the environment.

Goal
Ability to analyze how digital technologies used in research projects affect the environmental impact of the project and establish methods to mitigate it.

75. Understand the environmental impact of digital technologies used in research projects. *

- ◯ 1. Understands the basic concepts of environmental impact due to the use of digital technologies.
- ◯ 2. Knows that the use of digital technologies in research affects the environment.
- ◯ 3. Identifies the research project activities that most affect sustainability due to the use of digital technologies
- ◯ 4. Explains to other researchers the criticality of the activities of a research project related to the contamination of digital technologies.

76. Assess the environmental impact of digital technologies used in research projects. *

- ◯ 1. Compare, with assistance, the activities of the research project that most affect sustainability through the use of digital technologies.
- ◯ 2. Independently compares the activities of the research project that most affect sustainability through the use of digital technologies.
- ◯ 3. Evaluates the environmental impact, with support, of the digital technologies used in the activities of a research project.
- ◯ 4. Evaluates the environmental impact, autonomously, of the digital technologies used in the activities of a research project.

77. Design research projects to mitigate the impact of digital technologies. *

- ◯ 1. Identify sustainable research projects using digital technologies.
- ◯ 2. Compare research projects and determine the one that pollutes the least through the use of digital technologies.
- ◯ 3. Designs research projects, with support, where the environmental impact of the digital technologies used is mitigated.
- ◯ 4. Design research projects, in an autonomous way, where the environmental impact of the digital technologies used is mitigated.

78. Establish sustainable strategies for the environmental impact generated by the technologies used in research projects.ogies. *

- ◯ 1. Knows the importance of optimizing the use of digital technologies to minimize the environmental impact in research.
- ◯ 2. Knows good practices to mitigate the environmental impact of digital technologies used in research projects.
- ◯ 3. Designs sustainable strategies to reduce the environmental impact of digital technologies used in research projects.
- ◯ 4. Implements sustainable strategies to reduce the environmental impact of digital technologies used in research projects.

DC18. Troubleshooting technical problems

Definition
Identify and solve technical problems when carrying out research work.

Goal
Be able to solve technical problems at different stages of the research project: preparation, simulation, experimentation and results.

79. Solve technical problems during the elaboration of a research project with digital tools. *

- ◯ 1. Recognises technical issues arising from state-of-the-art analysis and the knowledge gap
- ◯ 2. Evaluates possible solutions to the identified technical problem
- ◯ 3. Appropriately implements the most suitable solution to the identified technical problem
- ◯ 4. Helps colleagues to identify and solve technical problems

80. Solve technical problems during the simulation phase of a research project with digital tools. *

- ◯ 1. Recognises technical problems during the simulation run that prevent consistent results.
- ◯ 2. Evaluates the boundary conditions implemented in the simulation that will prevent consistent results.
- ◯ 3. Implements relevant boundary conditions to lead to simulations consistent with actual experience.
- ◯ 4. Helps peers to develop simulations that are consistent with the real system and lead to robust results.

81. Solve technical problems in the management and analysis of research data with digital technologies. *

- ◯ 1. Recognises technical problems in the analysis of research results that prevent robust conclusions.
- ◯ 2. Assesses possible biases and errors during data acquisition that did not lead to robust conclusions.
- ◯ 3. Implements solutions to avoid technical problems in data analysis that prevent robust conclusions.
- ◯ 4. Assists colleagues in acquiring research data that leads to robust results.

82. Solve technical problems during the experimentation phase of a research project with digital tools. *

- ◯ 1. Identifies technical problems for the commissioning of the equipment used.
- ◯ 2. Examines possible technical problems that arise during the experimentation that did not lead to robust conclusions.
- ◯ 3. Develops preventive measures to avoid technical problems during the experimentation.
- ◯ 4. Supports peers to carry out robust experimentation leading to consistent results.

DC19. Identification of technological needs and responses

Definition
Identify technological needs and assess and implement technological responses during research projects.

Goal
Be able to identify technological needs at different stages of a research project and evaluate and implement appropriate responses to promote consistent results.

83. Identifying technology needs in the preparatory phase of a research project. *

- ◯ 1. Defines the high-level technology needs for the achievement of the goals of a research project.
- ◯ 2. Identifies the technological responses needed to carry out the work envisaged in the project
- ◯ 3. Adequately chooses the technological response (technical equipment and materials) to take on the research work.
- ◯ 4. Assists peers in identifying the technological need and making the appropriate choice of the necessary technological response.

84. Recognise technological needs during the execution of a research project. *

- ◯ 1. Define the specific technological needs (equipment and material) for a given experiment.
- ◯ 2. Identifies the appropriate configuration of the technological response for a given experiment (technological need).
- ◯ 3. Successfully implements the configuration of the technological need for a particular experiment.
- ◯ 4. Supports peers in defining the technological need and its configuration for a particular experiment.

85. Exploring technological needs for managing the implementation of a research project. *

- ◯ 1. Sets out the technological requirements for managing a research project (budget, schedule, communications).
- ◯ 2. Maps the technological responses needed to ensure the success of the project (communications, responsibilities, etc.).
- ◯ 3. Successfully deploys technology solutions ensuring stakeholder involvement.
- ◯ 4. Assists peers in identifying research project management technology needs and supports them in the choice of the technological response.

DC20. Creative use of digital technology

Definition
Employing digital technologies to create and manage processes for understanding and solving problems in complex research situations.

Goal
Be able to use digital technologies to support research work (individual and collective) by improving processes and creating knowledge to understand and solve research problems.

86. Employing digital technologies to improve my productivity in research tasks. *

- ◯ 1. Identifies tools and technologies to standardise and automate research processes.
- ◯ 2. Finds and discusses digital technology needs to standardise and automate research processes-
- ◯ 3. Adapts and implements innovative processes for standardisation and automation of research processes.
- ◯ 4. Creates content on how to implement research process standardisation and automation needs.

87. Applying digital technologies to produce content on the use of laboratory equipment. *

- ◯ 1. Understands digital technologies that will help create content to improve the use of scientific equipment.
- ◯ 2. Modifies and enhances the appearance of existing content using digital technologies
- ◯ 3. Creates content based on digital technologies that help to understand the basic operation of laboratory equipment.
- ◯ 4. Produces highly innovative content based on digital technologies to get the most out of lab equipment.

88. Making use of digital technologies to improve the performance of research software. *

- ◯ 1. He is interested in complementary digital technologies (plug-ins and/or add-ins) to dedicated research software.
- ◯ 2. Be familiar with the operating algorithms of dedicated software to detect complementarity needs.
- ◯ 3. Masters the application of complementary digital technologies that enhance the basic performance of the software.
- ◯ 4. Develops tailor-made applications based on digital technologies to improve the performance of dedicated software.

89. Engaging AI tools to improve technological responses within a research project. *

- ◯ 1. Be familiar and discusses the AI tools available to understand and solve research problems.
- ◯ 2. Assesses and identifies AI requirements needs to meet research problem-solving needs.
- ◯ 3. Adopts and deploys AI tools to improve performance in solving research problems.
- ◯ 4. Builds knowledge on how to use AI tools to support research problem solving.

DC21. Identifying gaps in digital skills

Definition
Encouraging self-learning through continuous improvement in digital skills to increase my level of competence.

Goal
Be able to identify gaps in the development of digital skills useful in my research work in order to improve them.

90. Be aware of the needs of digital technologies for research work. *

- ◯ 1. Identifies gaps in competency level that could improve their performance in research tasks.
- ◯ 2. Recognise useful resources to improve the level of competence in digital technologies applied to research.
- ◯ 3. Consumes content related to the development of digital competences for research work.
- ◯ 4. It implements and evaluates its competence performance to further improve its performance in the use of digital technologies.

91. Boosting the competence level of digital technologies applied to research. *

- ◯ 1. Identifies useful knowledge and skills to improve their level of competence in applied digital technologies.
- ◯ 2. Assimilates new skills and practical knowledge useful for their competence improvement through structured knowledge.
- ◯ 3. Capitalises on tacit (unstructured) knowledge to improve their competence level.
- ◯ 4. Demonstrates an increase in competence performance due to the practical application of newly acquired knowledge.

92. Contributing to the development of digital technology skills of others. *

- ◯ 1. Helps peers to broaden their knowledge about digital competence development.
- ◯ 2. Assists peers in their digital competence development through mentoring.
- ◯ 3. Coaches peers in their competence development and provides them with useful resources to do so.
- ◯ 4. Supports peers in identifying digital skills gaps to foster their continuous improvement.

GC1. Valuing sustainability

Definition
Reflect on how different actions affect the sustainability of a research and align the values of a project/research with the values of sustainability.

Goal
Critical evaluation in terms of sustainability of values and actions during the engineering doctoral student's research career.

93. Understand the concepts and values of sustainability in engineering research. *

- ◯ 1. Identifies the main regional, national and European sustainability values and strategies.
- ◯ 2. Knows how the main regional, national and European sustainability values and strategies affect the scientific community (SDGs/European Green Pact).
- ◯ 3. Knows how the main values and strategies of sustainability affect the doctoral student's own line of research.
- ◯ 4. Researches and elaborates on changes in society's sustainability values and strategies and is able to present them to other doctoral students.

94. Know how to align the values and objectives of a project with sustainability values. *

- ◯ 1. Identifies sustainable values within a research project.
- ◯ 2. Analyzes the sustainable values of a research project.
- ◯ 3. Aligns the values and objectives of a research project with sustainability values (e.g., with the SDGs).
- ◯ 4. Is able to explain to other researchers how they should adapt the objectives or goals of their project to align with sustainable values.

95. Evaluate the sustainability of engineering research projects. *

- ◯ 1. Is aware of how research projects affect sustainability.
- ◯ 2. Identifies research projects that affect the environment.
- ◯ 3. Is able to compare different research projects and determine which is more sustainable in a reasoned manner.
- ◯ 4. Investigates new ways to evaluate the criticality of research projects.

96. Analyze and select the best strategy or course of action to improve research sustainability. *

- ◯ 1. Compares different sustainability strategies within a project and is able to rank them in order of effectiveness.
- ◯ 2. Is able to develop, with the help of his or her mentor or senior researcher, sustainable strategies to reduce the environmental impact of critical project activities.
- ◯ 3. Is able to autonomously develop strategies to reduce the environmental impact of research projects.
- ◯ 4. Investigates new sustainability reduction strategies in research projects and implements environmentally friendly work plans.

GC2. Supporting fairness

Definition
Support equity so that current and future generations can live in a sustainable society. Learn from the experiences of researchers in terms of sustainability.

Goal
Be able to understand and extract all the scientific knowledge that improves the sustainability of society and implement it in current and future projects.

97. Understand successful sustainable practices in engineering research projects. *

- ◯ 1. Identifies good sustainable practices in the field of engineering research projects.
- ◯ 2. Compares good sustainable practices observed in engineering research projects in different communities.
- ◯ 3. Has as an in-depth understanding of the potential for new sustainable best practices in the field of engineering research projects.
- ◯ 4. Researches on new sustainable best practices and determine their impact on current and future research projects.

98. Implement good sustainable practices in current and future research projects. *

- ◯ 1. Evaluates, with the help of the tutor or a senior researcher, the potential for implementing the experiences and results obtained by other authors in the student's own line of research.
- ◯ 2. Analyzes autonomously the potential of implementing the experiences and results obtained by other authors in the doctoral student's own line of research.
- ◯ 3. Implements good sustainable practices in the research projects in which the doctoral student participates.
- ◯ 4. Actively participates in the organization of seminars, conferences and congresses aimed at implementing good sustainable practices in research projects.

99. Develop a methodology based on scientific knowledge to improve the sustainability of research. *

- ◯ 1. Is able to relate the knowledge of sustainability developed by other authors and group them by lines of research.
- ◯ 2. Designs, with the help of his/her tutor or a senior researcher, a work methodology that allows the application of sustainable knowledge in the student's own line of research.
- ◯ 3. Autonomously create a work methodology that allows the application of sustainable knowledge in the doctoral student's own line of research.
- ◯ 4. Develops a general methodology that can be implemented in various fields of study and that is easily reproducible, promoting the sustainability of the research.

100. Design new research projects that focus on today's major sustainability challenges to improve sustainability in the future. *

- ◯ 1. Identifies the main research challenges in terms of sustainability in the field of engineering.
- ◯ 2. In-depth knowledge of the main sustainability challenges in the doctoral student's own line of research.
- ◯ 3. Proposes a new project that encompasses some of the current sustainability research challenges.
- ◯ 4. Clearly establishes the objectives and scope of the project, and develops an appropriate work plan for the achievement of the sustainability challenge.

GC3. Promoting nature

Definition
To know the impact of research on the different nature and restore/regenerate it in order to create a resilient nature.

Goal
Evaluate the impact on the ecosystem of the different actions taken during the PhD student's research career and make decisions that are sustainable for nature.

101. Understand the influence of actions and activities of research projects on the environment. *

- ◯ 1. Identifies the activities that have the greatest influence on nature.
- ◯ 2. Is able to compare two activities from a sustainable point of view with environmental results.
- ◯ 3. Is able to compare two activities from a sustainable point of view without environmental results.
- ◯ 4. Explains to other researchers new ways of understanding the environmental impact of research activities.

102. Assess the environmental impact of research activities on nature. *

- ◯ 1. Knows about methodologies to quantify the environmental impact of research on nature. .
- ◯ 2. Selects the best and most efficient methodology to quantify the environmental impact of research projects.
- ◯ 3. Implements methodologies to quantify the sustainability of tasks within research projects.
- ◯ 4. Investigates new ways to assess the environmental impact of research activities on nature.

103. Establish actions within the research to restore nature. *

- ◯ 1. Learn about different strategies to restore nature.
- ◯ 2. Is able to identify the best strategy to regenerate nature within a research project.
- ◯ 3. Is aware of the latest strategies to improve the environment in research projects.
- ◯ 4. Implements strategies such as circular economy within its research projects.

104. Design research projects in such a way as to maximize their sustainability. *

- ◯ 1. Identifies the weaknesses of research projects from the point of view of sustainability.
- ◯ 2. Designs, with tutor assistance, research projects with more sustainable activities.
- ◯ 3. Designs research projects with more sustainable activities.
- ◯ 4. Investigates new strategies to increase the sustainability of the research group's new projects

GC4. Systems thinking

Definition
Approach sustainability in research from all angles, taking into account time and context and understanding how it interacts with other elements.

Goal
To understand the relationship between sustainability and the main variables of research projects and the interrelation of environmental variables during their phases.

105. Understand the different eays of quantyfing enviromental impact and their interrelationship *

- ◯ 1. Knows that there are different ways to quantify environmental impact and its importance.
- ◯ 2. Determines the environmental impact in all its categories.
- ◯ 3. Is able to analyze the interrelationship of the different environmental impact categories.
- ◯ 4. Draws conclusions from the interrelationship of environmental impact categories within a research project.

106. To know the interrelation between environmental impact and other important variables in research projects. *

- ◯ 1. Identifies other variables that have a bearing on the environmental impact of research projects.
- ◯ 2. Knows, with results, the variable that has the greatest interrelation with the sustainability of research projects.
- ◯ 3. Knows, without results, the variable that has the greatest interrelation with the sustainability of research projects.
- ◯ 4. Is able to obtain correlations between the environmental variable and other research variables.

107. To understand the impact on the nature of research projects throughout their life cycle. *

- ◯ 1. Identifies the phase of the research project with the greatest impact on the environment.
- ◯ 2. Quantifies the environmental impact of a research project throughout its life cycle.
- ◯ 3. Evaluates the environmental impact of a research project throughout its life cycle.
- ◯ 4. Explains, to other researchers, the environmental impact of a research project throughout its life cycle.

108. Manage research projects in a sustainable manner. *

- ◯ 1. Is able to understand the need for sustainable management of projects and research.
- ◯ 2. Learns ways to manage projects in a sustainable way.
- ◯ 3. Implements sustainability in the management of research projects.
- ◯ 4. Designs, with the tutor's help, new actions to manage projects in a sustainable way.

GC5. Critical Thinking

Definition
Have the necessary skills to evaluate and understand information related to sustainability issues, broadening their vision for sustainability.

Goal
To have a critical perspective that improves the capacity of doctoral students, increasing their understanding of sustainability concepts and better assessing sustainability issues.

109. Evaluate and analyze the information generated during their research career, determining its impact on sustainability. *

- ◯ 1. Identifies research results that improve sustainability.
- ◯ 2. Is able to compare different research results and select the most important for sustainability.
- ◯ 3. Thoroughly evaluates the sustainable consequences of research results.
- ◯ 4. Compares his research results with other similar results, determining the impact on the environment.

110. Determine whether a research idea is truly novel in terms of sustainability. *

- ◯ 1. Raises different ideas for sustainable research.
- ◯ 2. Compares the different ideas of sustainable research.
- ◯ 3. Evaluates different sustainable research ideas and establish the best alternative for a given research project.
- ◯ 4. Exposes and defends his research idea before his research group.

111. Analyze the quality of scientific-technical information in terms of sustainability generated by the scientific community. *

- ◯ 1. Knows the main authors who make scientific contributions to sustainability in the PhD student's line of research.
- ◯ 2. Identifies, with the help of his/her tutor, the most relevant scientific contributions and scientific projects in the field of sustainability related to the PhD student's research.
- ◯ 3. Compares the impact of research conducted by other authors in terms of sustainability.
- ◯ 4. Is able to explain and discuss in a scientific seminar the most important sustainable scientific contributions of recent years.

112. To argue for sustainable decisions and actions during the research career. *

- ◯ 1. Identifies the actions and decisions that have the greatest impact on the environment.
- ◯ 2. Argues in writing their own actions and decisions during their research career from the perspective of sustainability.
- ◯ 3. Defends to other researchers their own actions and decisions during their research career from the perspective of sustainability.
- ◯ 4. Is able to argue about the decisions and actions of other researchers in terms of sustainability.

GC6. Problem Framing

Definition
Formulate current or potential challenges as a sustainability issue, in order to identify appropriate approaches to anticipate and prevent problems, and to mitigate and adapt to existing problems.

Goal
Identification of sustainability issues/challenges in engineering research and ability to define strategies to mitigate and resolve these challenges.

113. Identify appropriate strategies to mitigate, adapt and potentially solve sustainability issues in research. *

- ◯ 1. Identifies possible solutions to scientific-technical sustainability challenges/problems.
- ◯ 2. Compares the different solutions, determining the advantages and disadvantages of each.
- ◯ 3. Explains the most appropriate solution to mitigate or resolve sustainability issues in research projects.
- ◯ 4. Defines in depth the sustainable scientific-technical solution to a given problem.

114. Analyze and compare the different sustainability challenges of research project management. *

- ◯ 1. Identifies sustainability challenges in research project management.
- ◯ 2. Compares different sustainability challenges in research project management.
- ◯ 3. Analyzes the challenges of sustainability in the management of research projects from different levels.
- ◯ 4. Investigates new solutions to improve sustainability in the management of research projects.

115. Assess scientific-technical sustainability issues/challenges from the point of view of different stakeholders. *

- ◯ 1. Understands that the challenges differ depending on the stakeholder.
- ◯ 2. Is able to establish which stakeholder has the most interest/power in the sustainability challenge.
- ◯ 3. Analyzes sustainability issues from the perspective of different stakeholders.
- ◯ 4. Is able to explain to the different stakeholders the other stakeholders' perspective on the scientific-technical sustainability problem.

116. Quantify and define the work involved in executing a sustainability challenge in the current one. *

- ◯ 1. Knows the difficulty of implementing the solution to a sustainability problem in current research.
- ◯ 2. Quantifies, with tutor support, the work involved in implementing the challenge.
- ◯ 3. Autonomously defines the work involved in the execution of the challenge.
- ◯ 4. Autonomously defines the work involved in the execution of the challenge.

GC7. Futures Literacy

Definition
Understand future trends in sustainability in engineering research and identify short-, medium- and long-term steps.

Goal
Be able to analyse the limitations and risks of future sustainable research strategies in order to be able to anticipate and establish lines of action.

117. Identify sustainable trends in engineering research. *

- ◯ 1. Recognises general trends in sustainability.
- ◯ 2. Outlines specific examples of trends in engineering research.
- ◯ 3. Identifies relevant and current sources on sustainable trends.
- ◯ 4. Relates identified trends to specific areas of engineering.

118. Assess short-, medium- and long-term sustainable trends in engineering research lines. *

- ◯ 1. Assess with the help of an expert the short-term trends of one's own line of research in terms of sustainability.
- ◯ 2. Autonomously assesses the short-term sustainability trends of its own line of research.
- ◯ 3. Autonomously analyses the medium- and long-term sustainable trends of its own research line.
- ◯ 4. Analyses trends in different lines of research from a sustainable point of view.

119. Assess scientific-technical sustainability issues/challenges from the point of view of different stakeholders. *

- ◯ 1. Identifies constraints to future trends.
- ◯ 2. Identifies constraints, risks and opportunities for future trends
- ◯ 3. Clearly assesses the relationship between constraints, risks and opportunities.
- ◯ 4. Assesses in depth and in detail the relationship between constraints, risks and opportunities.

120. Evaluate and compare different future research strategies in terms of sustainability. *

- ◯ 1. Identifies and superficially analyses future research strategies.
- ◯ 2. Compares advantages and disadvantages of strategies in an appropriate and detailed manner.
- ◯ 3. Evaluates the sustainable impact of each strategy in a thorough and accurate manner.
- ◯ 4. Proposes very detailed and well-founded improvements based on evaluation

GC8. Adaptability

Definition
Manages uncertainty and risk associated with complex situations affecting sustainability during his research career.

Goal
Knows that actions carried out during the research career can generate unpredictable situations that affect the environment.

121. Identify risks and uncertainties affecting sustainability generated in different complex situations during the research career. *

- ◯ 1. Recognises common risks in complex situations.
- ◯ 2. Identifies and describes specific uncertainties in research contexts.
- ◯ 3. Identifies sources of risk in research projects.
- ◯ 4. Assesses the likelihood and impact of the risks and uncertainties analysed.

122. Understand that there are actions affecting the environment that need to be adapted to reduce the impact within engineering research. *

- ◯ 1. Identifies actions with a negative impact on the environment.
- ◯ 2. Analyses the impact of these actions on research projects
- ◯ 3. Proposes adaptations to mitigate negative impacts.
- ◯ 4. Evaluates the effectiveness of proposed adaptations

123. Test different alternative solutions to improve the sustainability of research project management. *

- ◯ 1. Identifies possible alternative solutions.
- ◯ 2. Evaluates the feasibility of each solution.
- ◯ 3. Implements solutions in research projects.
- ◯ 4. Is able to measure the impact of implemented solutions.

124. Adapting research to address unexpected changes (with uncertainty) affecting the environment. *

- ◯ 1. Recognises unexpected changes during the research.
- ◯ 2. Assesses the potential impact of changes on the project.
- ◯ 3. Develops strategies to adapt the research to changes.
- ◯ 4. Implements and reviews adaptive strategies.

GC 9. Exploratory thinking

Definition
Explore different engineering disciplines to improve the sustainability of research and employ new experimentation methods and research methodologies to enhance the sustainability of society.

Goal
Understand different perspectives to successfully address sustainable engineering research and explore new research methods.

125. Explore new methods of experimentation and novel research for the promotion of sustainability. *

- ◯ 1. Identifies superficially one or two novel experimentation and research methods.
- ◯ 2. Explains in a basic manner how these methods can contribute to sustainability.
- ◯ 3. Clearly relates these methods to specific improvements in sustainability.
- ◯ 4. Innovatively integrates these methods into research projects to maximize sustainability.

126. Manage research projects sustainably through innovative methodologies. *

- ◯ 1. Has a limited understanding of novel methodologies for sustainable research project management.
- ◯ 2. Describes several novel methodologies for the sustainable management of research projects.
- ◯ 3. Integrates these methodologies into the planning and execution of specific projects.
- ◯ 4. Continuously evaluates and improves management processes to maximize sustainability in research projects.

127. Propose engineering research projects based on circular economy strategies. *

- ◯ 1. Has a superficial understanding of circular economy strategies.
- ◯ 2. Proposes projects that integrate these strategies in a basic manner.
- ◯ 3. Shows concrete examples of projects that effectively integrate these strategies.
- ◯ 4. Evaluates the impact of these projects and proposes continuous improvements to optimize sustainability.

128. Be able to synthesize and analyze sustainable information obtained from research in different engineering. *

- ◯ 1. Collects information in a limited manner and shows difficulties in synthesizing and analyzing sustainability data.
- ◯ 2. Conducts basic analyses and shows how this information can contribute to sustainability.
- ◯ 3. Effectively applies this knowledge in research to promote sustainability.
- ◯ 4. Innovatively integrates this information into research projects to maximize sustainable impact and propose continuous improvements.

GC10. Political agency

Definition
Navigate the political system, identifying policies that promote sustainability through engineering research. comportamientos insostenibles.

Goal
Be able to understand and analyze political strategies that promote sustainability within their research career.

129. Identify political strategies that promote sustainability within their research career. *

- ◯ 1. Identifies superficially one or two political strategies related to sustainability.
- ◯ 2. Can give specific but limited examples of how these relate to their research career.
- ◯ 3. Identifies and explains in detail multiple political strategies related to sustainability.
- ◯ 4. Effectively integrates these strategies into their research career and proposes improvements or innovations.

130. Understand European political strategies that promote sustainability through engineering research. *

- ◯ 1. Lacks a deep understanding of how these strategies affect engineering research.
- ◯ 2. Can explain generally how these strategies are applied in engineering research.
- ◯ 3. Relates these strategies to concrete examples of projects or policies in their field.
- ◯ 4. Conducts a deep and critical analysis of European political strategies and their relationship with engineering research.

131. Design research political strategies to promote the sustainable development of public and private entities. *

- ◯ 1. Has difficulties connecting these ideas with sustainable development.
- ◯ 2. Designs basic political strategies that promote sustainability in specific contexts.
- ◯ 3. Develops well-founded and detailed political strategies for sustainability.
- ◯ 4. Conducts impact assessments and proposes adjustments based on a deep analysis of public and private entities.

132. Know the main agents that promote sustainability through political strategies. *

- ◯ 1. Has a superficial understanding of their role in sustainability politics.
- ◯ 2. Provides basic examples of their impact on research and sustainable development.
- ◯ 3. Identifies and analyzes in detail multiple key agents in sustainability politics.
- ◯ 4. Proposes new forms of collaboration and strategies to maximize their impact on research and sustainable policies.

GC11. Collective Action

Definition
Faculty to lead and collaborate in collective efforts that address environmental challenges in engineering research projects.

Goal
Develop skills that enable doctoral students to drive sustainability through joint action and implementation of innovative solutions.

133. Identify the main sustainability stakeholders in a scientific-technical sustainability challenge. *

- ◯ 1. Recognizes the importance of knowing the main sustainibility stakeholders
- ◯ 2. Understands the influence of stakeholders on the sustainability of the project.
- ◯ 3. Performs an in-depth analysis of stakeholders and their interconnections in a sustainability challenge.
- ◯ 4. Leads the strategic identification of stakeholders in sustainable challenges

134. To understand the importance of collective action to promote nature and support fairness in research projects. *

- ◯ 1. Recognizes the importance of collective action to implement sustainable research practices
- ◯ 2. Demonstrates a consistent understanding of how collective action contributes to promoting the natural
- ◯ 3. Contributes to the conceptualization and design of collective action strategies to address sustainable challenges.
- ◯ 4. Demonstrates how collective action can significantly transform the direction and impact of research

135. Collaborate with sustainability stakeholders to solve scientific and technical sustainability challenges. *

- ◯ 1. Collaborates in a basic way with stakeholders in sustainable research projects.
- ◯ 2. Consistently collaborates with stakeholders, demonstrating measurable impact in solving scientific-technical challenges.
- ◯ 3. Significantly contributes to the generation of innovative solutions through effective collaboration.
- ◯ 4. Acts as a benchmark in transformative collaboration with stakeholders to solve scientific-technical challenges.

136. Identify individuals and organizations to work collectively on scientific-technical sustainability challenges. *

- ◯ 1. Recognizes a few key individuals and organizations to address scientific-technical sustainability challenges
- ◯ 2. Understands how strategic partner selection contributes to project success
- ◯ 3. Contributes to the design and implementation of collaborative strategies to address sustainable challenges
- ◯ 4. Leads the formation of strategic alliances to address scientific-technical sustainability challenges

GC12. Individual Iniciative

Definition
Ability to recognize opportunities, have confidence in personal influence and act proactively to address sustainable challenges.

Goal
Empower individuals to confidently and consciously take sustainable initiatives in their lives, becoming agents of change and role models to inspire others.

137. Individual Initiative in carrying out Sustainable Research Projects. *

- ◯ 1. Increases awareness of one's own potential to influence positive change
- ◯ 2. Recognizes opportunities for individual actions to promote sustainability
- ◯ 3. Establishes cause-effect relationships to identify the actions with the greatest potential
- ◯ 4. Inspires others to take sustainability initiatives and acts as a role model

138. Initiative in Managing Projects Sustainably. *

- ◯ 1. Recognizes some key elements of sustainability in project management
- ◯ 2. Demonstrates an understanding of how sustainable management can positively impact project outcomes
- ◯ 3. Develops innovative strategies for sustainable project management
- ◯ 4. Uses advanced strategies and innovative approaches to maximize sustainability on major projects

139. Evaluate own potential for improving sustainability in research projects. *

- ◯ 1. Recognizes the importance of personal contribution to improving sustainability in research projects
- ◯ 2. Implements preventive actions whenever there may be possible harmful consequences for the environment.
- ◯ 3. Demonstrates ongoing critical evaluation and adaptation to maximize sustainable impact
- ◯ 4. Inspires others by showing how constant personal evaluation can transform the contribution to research projects towards sustainability.

140. Evaluate own potential for sustainable research management. *

- ◯ 1. Performs a conscious self-assessment of one's own impact on sustainable research management
- ◯ 2. Develops a personal improvement plan to contribute more effectively to sustainable management
- ◯ 3. Develops internal policies that promote social and environmental responsibility in the workplace.
- ◯ 4. Leads teams in the collaborative design of sustainable strategies for companies and institutions.

GREEN AND DIGITAL COMPETENCES ADAPTED FOR PHD STUDENTS

DC1	**Searching and F**	A	Identifies projects carried out in their area of study
4	**Definition** Ability to adapt ensuring that r research need **Establish strategies to search for research-related project calls for proposals** **Goal** Develop and in incorporating i scientific literat	B	Filters projects using criteria such as method, field of application or location
		C	Uses more complex filters, such as date of realization, novelty or economic impact
		D	Expert in the pursuit of projects related to the area of research, with the ability to teach such skills
		A	Uses conventional search engines to find research calls
	Description	B	Uses specialized search engines such as Pivot-RP to search for specific calls
5	**Conduct effective searches for research calls for proposals**	C	Uses specialized databases and customizable alerts to receive notifications of new calls, such as Horizon 2020 or Research Professional
1	**Adjust search strategies according to the specific needs of the research**	D	Applies advanced trend analysis techniques to identify emerging calls, using tools such as Dimensions or Grant Forward.
			and access publications
		D	Expert in autonomous searches in databases such as WOS and ScienceDirect. Shows ability to teach these skills
2	**Modify and adapt data filtering methods according to the specific requirements of the research**	**A**	Ability to apply data filtering strategies, although it shows shortcomings to execute them efficiently
		B	Displays solid knowledge of keyword usage to optimize information filtering
		C	Has a proven ability in data filtering by applying expert Boolean search with "AND", "OR" and "NOT" operators to refine queries with precision
		D	Expert in data flow analysis with the ability to efficiently apply advanced Boolean search and keyword usage
3	**To make the doctoral student aware of the complexities of information searches**	**A**	Recognizes limitations in content accessibility
		B	Recognizes the importance of minimizing information overload and shows ability to avoid distractions in searches
		C	Performs a detailed analysis of the advantages and disadvantages of using artificial intelligence-based search engines
		D	Fully understands the complexity of information search and develops advanced strategies to overcome limitations in content accessibility

DC2	Evaluating Data, Information and Digital Content		
Definition	Critical and systematic analysis of digital datasets, information and relevant content to determine the quality, relevance and reliability of the research information collected		
Goal	Improve the ability to discern the validity and usefulness of digital resources in relation to research objectives		
Knowledge Metrics			
Description		**Progression levels**	
1	**To discern the quality of digital resources, identifying aspects such as accuracy, reliability and timeliness of the data and information evaluated**	A	The PhD student possesses the ability to perform basic assessments of the reliability of digital information sources
		B	Recognizes specific limitations in the information assessed, indicating an intermediate understanding of factors affecting quality
		C	Has an advanced understanding of the validity of the data collection methods used
		D	Autonomously and expertly evaluates the quality and reliability of the information
2	**Understand the different means of recognizing malicious information**	A	Basic understanding of the potential sources of malicious information
		B	Identifies the various software typically employed in plagiarism detection research
		C	Specifically familiar with copyright legislation and knows methods such as cross-validation of data or peer review
		D	Effectively applies advanced strategies and techniques to recognize malicious information, demonstrating an expert level of critical content evaluation
3	**Understand the information presented in digital engineering research content**	A	Identifies basic elements in flowcharts and graphs, recognizing symbols commonly used in their area of research
		B	Analyses complex graphs and flowcharts in scientific articles, identifying causal relationships and dependencies between variables
		C	Synthesizes information from graphs and diagrams to gain an overall understanding and evaluates the effectiveness of Graphical Abstracts in conveying key concepts
		D	Critically evaluates the effectiveness of visual presentation in digital content, providing advanced insights on how to improve clarity and visual communication

4	**Identify the adequacy of the representation of digital content**	A	Identifies the need for visual representations through graphics or images
		B	Evaluates consistency between visual representations and textual content
		C	Evaluates the appropriateness of the type of graphic chosen with the content it represents
		D	Perfectly assesses whether the type and number of graphical representations is optimal for conveying information
5	**Evaluate the suitability of databases used in scientific publications**	A	Recognizes the source of data used in a paper
		B	Understands the relationship of the database to the research objective
		C	Evaluates the adequacy of the data used in an article in relation to its scope, quality and relevance to the purpose of the research
		D	Critically examines the limitations of the database, identifying potential biases or shortcomings that could influence the research findings

DC3	Data, Information and Digital Content Management		
Definition	Efficiently organize, store and manage data and digital information generated during research projects		
Goal	To advance the efficiency of information management through innovative solutions that optimise the handling of digital data in research projects		
Knowledge Metrics			
Description		**Progression levels**	
1	**Acquire skills to design and implement systems that optimize the organization and retrieval of bibliographic information in research projects**	A	Basic knowledge of academic systems such as Mendeley and Zotero to organize bibliographic references in research projects
		B	Sets up a customized database integrated with tools such as Zotero and Mendeley for efficient management of bibliographic information and associated documents
		C	Optimizes a data management system with advanced Mendeley features and EndNote tools, enabling online collaboration and document synchronization in research projects
		D	Leads the development of a data management environment integrating analytical tools to extract key information from references and documents in research projects
2	**Manage standards that promote interoperability and quality in digital data management**	A	Possesses basic knowledge of existing bibliographic standards, such as APA, IEEE or ISO, used in engineering research
		B	Rigorously applies recognized bibliographic standards to ensure correct citation and referencing in research projects
		C	Applies FAIR principles to ensure transparency and accessibility of data in research projects
		D	Expert in the implementation of specialized regulations for data management in engineering research, promoting the integrity and reproducibility of results
3	**Organize the information presented by other authors related to the same research topic**	A	Identifies and summarizes key information from previous studies on a research topic
		B	Organizes state-of-the-art information into a document, highlighting trends, methods, and gaps in research
		C	Effectively manages information overload by applying advanced organization techniques such as concept maps or comparison matrices
		D	Develops innovative strategies to organize and manage large amounts of information, applying data mining and automated analysis techniques

4	**Create a digital information management system for research projects**	A	Uses basic digital tools to organize and store information related to a research project, such as Google Drive
		B	Implements more advanced digital information management systems, such as Trello or Asana, to coordinate tasks and documentation in a project
		C	Designs and customizes an information management system using more complex platforms such as SharePoint, customizing workflows
		D	Adapts customized digital information management systems for complex research projects
5	**Optimal organization of information**	A	Creates simple folders to organize documents related to a research project, using descriptive file names
		B	Applies a more elaborate folder structure and uses consistent naming conventions to facilitate document identification
		C	Designs a folder structure adapted to the specific needs of the project, considering the interrelation of documents and facilitating quick searches
		D	Develops a customized information organization system that incorporates knowledge management principles, with workflow automation and advanced metadata approaches
6	**Manage databases of the research projects**	A	Uses basic tools such as spreadsheets to record and organize manually collected data, keeping a simple structure
		B	Implements simple relational databases using software such as Microsoft Access or MySQL to organize data from a variety of sources
		C	Uses more advanced database management systems, such as PostgreSQL or MongoDB, to handle large datasets and ensure integrity and security
		D	Designs and implements a customized data management system, considering performance optimization, scalability and interoperability with other analytics tools

DC4	Interacting through Digital Technologies		
Definition	Develop knowledge, skills and interaction attitude in research projects through various digital technologies		
Goal	Use and critically integrate digital technologies in the communication of engineering research projects		
Knowledge Metrics			
Description		**Progression levels**	
1	**Manage various digital technologies to facilitate the interaction of the doctoral student in digital environments**	A	Demonstrates familiarity with various digital technologies to facilitate the doctoral student's interaction with digital media, but does not have a deep understanding of their maximum performance
		B	Develops knowledge and skills that enable them to interact with new digital technologies
		C	Dominates digital technologies to facilitate the interaction of the doctoral student in digital environments
		D	Leads the implementation of new innovative ways to facilitate doctoral student interaction in digital environments
2	**Use digital internal communication technologies for the management of research projects**	A	Is fluent in identifying different internal communication tools for research project management, but their knowledge of the different applications is limited
		B	Is proficient in the advanced functions of digital technologies for the management of internal communications (moderating online sessions, internal communication flow, etc.)
		C	Integrates digital tools into cross-cutting aspects of research project management to optimise internal communication
		D	Can improve and optimise the application of digital tools, making innovations, applying emerging digital technologies to improve internal communication for research project management
3	**Understand the platforms for communicating scientific and technical results obtained during research**	A	Compares the purpose and prestige of different digital platforms for disseminating scientific results of research conducted
		B	Ability to develop strategies for selecting digital platforms to disseminate research results
		C	Identifies new innovative ways of disseminating scientific research results
		D	Adapts the results presented to digital platforms for the communication of the results

4	**Interacting through social networks used by the scientific community**	A	Uses social media to increase the dissemination of research project milestones
		B	Regularly contributes to discussions in social networks related to the thematic area of your research project
		C	Attracts followers through their interaction with digital content
		D	Attracts researcher interest through social networking groups in own research social networks (ResearchGate)

DC5	Sharing through Digital Technologies		
Definition	Encourage advanced information sharing and state-of-the-art digital content to establish effective sharing during engineering research projects		
Goal	Develop skills and capacities to share digital content effectively through advanced technology. Promote transparency of research results		
Knowledge Metrics			
Description		**Progression levels**	
1	**Implement the project's corporate identity in scientific communications during research through digital tools**	A	Uses digital technologies to adhere colours, logos and other visual elements in accordance with the corporate identity of the research project
		B	Use of digital technologies to coherently implement the corporate identity of the research project in various digital tools such as presentations and social networks
		C	Identifies digital tools with which to innovate in the creative implementation of visual elements that enhance the corporate identity of the project
		D	Investigates how to incorporate the project's corporate identity into the dissemination of project results
2	**Know the digital technologies for sharing information within research projects through their corporate identity**	A	Understands the essential elements of corporate identity and how they are applied in digital tools
		B	Rational use of common digital tools for sharing information in research projects, incorporating corporate identity
		C	Explores and uses emerging digital technologies (such as AI) to share information, while maintaining a strong integration with the project's corporate identity
		D	Participates in the development of new digital technologies to convey the corporate identity of a research project
3	**Implement digital technologies to share scientific-technical information generated during research**	A	Demonstrates basic understanding of the functions and features of these platforms in terms of information sharing
		B	Customises the presentation of scientific and technical information for different contexts using digital technologies (text editors, draw io...)
		C	Integrates cutting-edge digital technologies to share scientific and technical information
		D	Increases knowledge by disseminating their experience in scientific and technical research work (LinkedIn)

4	**Organise meetings within a research project to share scientific information through digital technologies.**	A	Ensures the effective participation of partners and the clear transmission of scientific information through the application of digital technologies
		B	Efficiently manages advanced functions of digital platforms to enhance the participants' experience
		C	Tailors digital meetings according to the specific needs of the research
		D	Investigates new digital tools to improve the efficiency/organisation of meetings within a research project

DC6	Engaging Citizenship Through Digital Technologies		
Definition	Employ digital technologies appropriately in the context of research projects to enhance community interaction, address societal challenges and contribute to sustainable development		
Goal	Effectively apply digital technologies in research projects to strengthen community interaction, address social challenges and contribute to sustainable development through research in engineering projects		
Knowledge Metrics			
Description		**Progression levels**	
1	**Apply digital technologies to assess the needs of citizens and strengthen the research object of the projects**	A	Adequately identifies relevant digital platforms and tools to capture the needs of society
		B	Applies digital technologies in a proficient way to collect data and strengthen the management of research projects
		C	Introduces innovative practices in the application of digital technologies to assess citizens' needs
		D	Researches new digital technologies to improve data collection and address public needs
2	**Understand various public and private platforms for managing and soliciting engineering research projects**	A	Identifies and understands the functioning of digital platforms for the management and application of research projects
		B	Learns about the advanced functions of various digital platforms optimising the research project management and application process
		C	Customises the use of project management platforms according to the specific needs of the research projects (Jira)
		D	Leads initiatives for the incorporation of new platforms or the development of customised solutions to optimise the management of engineering research projects
3	**Use digital tools to involve citizens in research projects, either in the development of the database or to ensure the applicability of research results**	A	Identifies and uses digital tools to communicate research project information to the public
		B	Develops more advanced strategies to engage citizens through digital tools
		C	Establishes feedback biases using digital technologies to strengthen the applicability of results
		D	Collaborates with other institutions to share experiences and promote continuous improvement in citizen participation in research projects

4	**To adequately represent, through digital technologies, the scientific information generated so that it is accessible to the public**	A	Uses digital technologies to represent scientific information (excel, GraphPad...)
		B	Adapts complex visual representations to make them understandable for citizens (Power BI)
		C	Uses digital technologies to represent visual information in an attractive way through code development (Python, MATLAB...)
		D	Investigates visual data compression strategies through the application of digital technologies

DC7	Collaborating Through Digital Technologies		
Definition	Advanced management of digital technologies in collaborative processes of integrated data and/or resource creation in research projects		
Goal	Dominate the strategic selection of digital technologies for knowledge cocreation and collaboration within engineering research		
Knowledge Metrics			
Description		**Progression levels**	
1	**Know digital technologies that optimise collaboration between stakeholders and/or research project team members**	A	Knows the functionality of various technologies and how it could be adapted to research projects (SharePoint, Microsoft Teams)
		B	Efficient use of collaborative digital technologies
		C	Innovates in the use of digital technologies by new functionalities useful for collaboration (Miro)
		D	Continuously integrates new digital technologies to optimise collaboration between stakeholders and/or project team members
2	**Develop effective strategies to facilitate smooth collaboration of scientific information during a project using digital tools**	A	Learns about different strategies that facilitate effective collaboration through the application of digital technologies
		B	Implements more advanced digital tools to optimise research project communication and collaboration
		C	Designs strategies to suit different contexts and types of projects
		D	Introduces specific innovative features of digital technologies to enhance collaboration during research projects
3	**Use digital tools, in a collaborative context, to assign responsibilities within an engineering research project**	A	Knows different ways of establishing accountability (RACI matrix) through digital tools (e.g. JIRA)
		B	Can integrate the particular scenario of their research project into the functionalities offered by digital responsibility management tools
		C	Develops personalised strategies within the team to allocate responsibilities in innovative ways
		D	Introduces innovations in accountability practices to maximise efficiency

4	**Using specific digital tools to plan and share tasks effectively in the framework of an engineering research project**	A	Efficiently uses digital tools for planning and task allocation in a research project such as Kanban or Miro
		B	Effectively integrates digital tools (Kanban, Miro...) for particular scenarios specific to research projects
		C	Evaluates the effectiveness of strategies used to share tasks with digital tools in engineering research projects
		D	Critically assesses and provides recommendations for improving task-sharing strategies using digital tools in research projects
5	**Co-create, through digital technologies, digital resources that enhance collaboration within an engineering research project**	A	Participates in co-creation activities using digital technologies
		B	Designs digital resources with advanced functionalities that enhance collaboration, such as real-time collaborative editing tools
		C	Customises digital resources to suit the specific needs of the research project
		D	Introduces significant innovations in digital co-creation that transform project collaboration
6	**Know and implement digital technologies that enable the co-creation of digital resources within engineering research projects**	A	Demonstrates familiarity with at least two digital platforms designed for the co-creation of resources in research projects
		B	Uses advanced tools to manage and organise the process of cocreation of digital resources
		C	Facilitates the equitable and meaningful participation of all collaborators during co-creation sessions
		D	Leads the implementation of innovative practices in digital cocreation, contributing to the development of new approaches and technologies

DC8	Netiquette		
Definition	To increase researchers' knowledge related to the way they behave in the use of digital technologies and their interaction to meet the needs of specific audiences		
Goal	To develop skills in understanding norms of behaviour in the use of technologies, as well as specific knowledge in the use of technologies and interaction in digital environments		
Knowledge Metrics			
Description		**Progression levels**	
1	**Understand and apply the rules of behaviour in scientific digital environments, communicating effectively in a manner tailored to the target audience**	A	Identifies variables that relate to the well-being of the working group and the use of digital technology in the research project
		B	Uses digital platforms in an ethical and respectful manner in accordance with established standards
		C	Leads innovative problem-solving strategies in the use of digital technologies
		D	Contributes to the establishment of ethical standards and practices in the digital communication of research projects
2	**Manage conflicts between members of the working group through the application of digital technologies**	A	Ability to identify digital technologies that manage conflicts in the context of research projects (ODR systems)
		B	Demonstrates understanding in the application of these digital conflict management technologies in the framework of research projects
		C	Customises certain functions in the application of digital technologies for research working groups
		D	Controls the resolution of conflicts through the creation of forums on digital platforms, thus helping to share risk management plans
3	**Create digital resources adapted to different contexts, culture or generation for the dissemination of the results or knowledge generated during the PhD student's research**	A	Understands how these characteristics can influence the dissemination of the digital resource created
		B	Develops digital resources tailored to the specific needs of the target population
		C	Identifies areas for improvement through the addition of elements that provide feedback from specific audiences
		D	Demonstrates ability to anticipate potential conflicts in managing the creation of digital content

4	**Be able to interact/adapt the rules of conduct in the use of digital information and communication technologies**	A	Understands the importance of these standards in the context of digital conduct
		B	Demonstrates the ability to interpret and adapt standards to specific research contexts
		C	Develops norms adapted to the use of digital technologies in research projects
		D	Has experience in developing norms of conduct for using digital technologies efficiently

DC9	Managing Digital Identity		
Definition	Manage digital contents of your doctoral thesis to disseminate via social networks the information generated in Project Engineering of your doctoral thesis		
Goal	Achieve a wider dissemination of the achievements and knowledge gained in your doctoral thesis through social networks		
Knowledge Metrics			
Description		**Progression levels**	
1	**Understand the importance of effectively managing digital identity in digital environments, embracing its specific relevance within the field of research**	A	Demonstrates basic understanding of how digital identity management affects online presence in the field of research
		B	Uses various digital platforms to manage basic aspects such as connecting between profiles
		C	Uses their digital identity to disseminate a digital personality
		D	Protects their digital identity through personal identifiers, enforces regulations
2	**Establish a digital identity, such as the use of identifiers like ORCiD, for the management of scientific and technical documentation**	A	Correctly links scientific output to identifiers such as ORCiD
		B	Customises ORCiD profile to highlight scientific contributions and achievements
		C	Ability to manage digital identity with identifiers other than ORCiD
		D	Seamlessly uses all types of identifiers typical of scientific databases (Scopus, Publons, WOS...)
3	**Integrate the digital identity in a way that allows the researcher to establish connections with the various scientific profiles related to the research.**	A	Connects their digital identity with relevant scientific profiles
		B	Shapes their digital identity into relevant scientific profiles in ways that connect with experts in their research area
		C	Uses their own digital identity to connect with other researchers, contributing to knowledge generation
		D	Their digital identity is recognised as a reference in the field, generating an impact on global collaboration

4	**To manage effectively the digital identity and digital environments, ensuring they are kept up to date**	A	Regularly updates information on their digital profiles (e.g. ORCID, ResearchGate)
		B	Participates in training courses or events to keep up to date with the latest digital trends in their field
		C	Uses digital tools to identify trends in research and digital change
		D	Leads initiatives to improve digital identity management at institutional level

DC10	Development of digital multimedia content for research purposes		
Definition	Creation of scientific digital content to improve communication, dissemination and transfer of engineering research information		
Goal	Effective use of digital tools to achieve efficient communication of information generated during doctoral student research		
Knowledge Metrics			
Description		**Progression levels**	
1	**Create synthetic graphical resources of the research results**	A	Summarizes your research adequately, although some relevant information is lost
		B	Creates graphs that accurately represent your research, making it more understandable
		C	Improves the quality of their scientific article thanks to the quality of their multimedia content
		D	Develops highly innovative multimedia resources that significantly enhance the presentation and understanding of the research findings
2	**Employ digital tools for the creation of scientific posters for an engineering research conference**	A	Generates digital content independently and inefficiently
		B	Is fluent in a wide range of software
		C	Creates complex multimedia content seamlessly and semiautomated
		D	Knows the advanced options of all the software that uses in work
3	**Identify and create diagrams to effectively represent research findings**	A	Generates digital diagrams with a formal aesthetic that correctly communicate their ideas
		B	Designs diagrams using the latest software on the market and effectively convey their ideas
		C	Effortlessly represents research data using the software tools needed
		D	Researches new software for creating diagrams and updates its skills on existing ones

4	**Use information technologies to create digital content to improve the management of research projects**	A	Creates digital content when it is completely necessary according to project requirements
		B	Creates digital content comfortably and is aware that it enriches their work
		C	Finds the most effective way to communicate regardless of the type of digital format
		D	Is an expert in digital communication and helps other colleagues to improve their multimedia content

DC11	Digital Content Integration and Reelaboration		
Definition		Modify, refine, improve and integrate information and content into an existing body of knowledge to create new, original and relevant content	
Goal		To develop the ability to rework scientific digital content for the creation of new scientific	
Knowledge Metrics			
Description		**Progression levels**	
1	**Re-elaboration of Proprietary Scientific Multimedia Contents**	A	Makes superficial adjustments to existing multimedia content, with a basic understanding of the subject matter
		B	Modifies specific elements of digital content, improving clarity
		C	Effectively combines and rearranges existing multimedia content to create an original product
		D	Fuses advanced design skills and scientific knowledge to create completely new and meaningful multimedia content
2	**Re-elaborate Scientific Multimedia Content from other Authors**	A	Examines, interprets and reworks content from other authors to suit their research
		B	Can create original content from other authors' publications
		C	Provides new scientific information and knowledge from the research of other scientists
		D	Integrates multimedia content from diverse authors to create comprehensive, innovative resources that advance the field and promote interdisciplinary collaboration
3	**Tailoring Digital Content for Specific Audiences**	A	Customizes digital content to specific audiences, significantly improving relevance and understanding
		B	Tailors advanced digital content for diverse audiences, ensuring optimal comprehension and meaningful relevance
		C	Develops highly personalized content and uses innovative strategies and advanced resources to achieve effective communication
		D	Demonstrates a deep understanding of the specific needs of diverse audiences. Implements advanced and creative strategies that elevate the user experience

4	**Modify scientific digital resources with AI digital technologies**	A	Shows a basic understanding of how these tools can contribute to content enhancement
		B	Uses artificial intelligence tools to make simple modifications to scientific digital assets
		C	Demonstrates advanced skills in the strategic application of artificial intelligence for the reworking of scientific contents
		D	Carries out comprehensive digital content management, generating innovative material that contributes significantly to the advancement of the field

DC12	Copyright and Intellectual Property Licensing		
Definition	Request and manage data, information, and digital content with copyrights and intellectual property licenses		
Goal	Develop the skills and knowledge necessary to understand, manage and ethically and effectively apply copyright and intellectual property licenses in the context of research projects		
Knowledge Metrics			
Description		**Progression levels**	
1	**Identify databases and scientific information that can be legally viewed and downloaded**	A	Knows databases of legal scientific articles and recognizes the importance of legality in the access to scientific information
		B	Demonstrates superior knowledge of license types and their application in research projects
		C	Applies advanced strategies for the legal protection of copyrights in research projects
		D	Offers comprehensive legal advice on copyright and intellectual property rights
2	**Know how to use and share the research results of other researchers in a legal manner**	A	Understands the ethical implications of sharing results from other researchers
		B	Shares research results of others while respecting licenses and copyrights
		C	Demonstrates a thorough understanding of contractual and legal implications, tailored to the academic environment
		D	Demonstrates expertise in regulations and licensing, promoting legal practices in the scientific field
3	**Can check the novelty of their patents or intellectual property through the appropriate databases**	A	Understands basic concepts related to novelty in the context of intellectual property
		B	Uses databases to verify novelty of patents and intellectual property in a basic way
		C	Performs complete and accurate novelty verification, demonstrating advanced skills
		D	Provides leadership in the implementation of advanced standards to ensure novelty in patents and intellectual property

4	**Develop, with support, the necessary documentation to register the rights to the results of an engineering research project**	A	Understands basic concepts related to patent registration documentation
		B	Develops documentation for the registration of intellectual property rights with the support of
		C	Creates complete and accurate documentation for the registration of intellectual property rights
		D	Advises peers on intellectual property registration and documentation development

DC13	Programming		
Definition	Solve problems that arise during engineering research projects, through models, algorithms or programming with digital technologies		
Goal	Develop programming skills for effective process automation, analysis of experimental data and creation of customized computational tools		
Knowledge Metrics			
Description		**Progression levels**	
1	**To know different digital programming tools to improve the creation of databases**	A	Uses simple spreadsheet scripts to automate repetitive tasks in data analysis
		B	Develops simple scripts to process and clean data sets in common formats such as CSV or Excel
		C	Creates basic programs in Python or R to perform more complex data analysis, such as visualizations or descriptive statistics
		D	Uses artificial intelligences to automate specific processes in research projects
2	**Use digital technologies for the development of codes that personalize the processing and filtering of scientific data**	A	Uses scripts to perform basic analysis of experimental data
		B	Develops scripts that implement more advanced statistical techniques such as regression methods
		C	Applies machine learning algorithms to perform predictive or classificatory analysis
		D	Leads the implementation of new data analysis techniques that contribute to research innovation
3	**Simulate or model complex problems within the PhD student's research using digital tools**	A	Recognizes the usefulness of simulation in research and identifies some digital tools for this purpose
		B	Shows basic understanding of how simulations/models inform research
		C	Applies advanced digital tools for simulation with a strategic approach
		D	Uses Artificial Intelligence as a tool to speed up the development of simulations

4	**Solve problems through algorithm development or programming with digital tools**	A	Identifies basic programming concepts and recognizes the importance of programming in research
		B	Develops basic algorithms and programs to solve specific problems
		C	Uses advanced programming to solve complex research problems
		D	Contributes innovative approaches to problem solving through programming

DC 14	Protecting Devices		
Definition	Know, design and execute security and privacy measures/protocols for the protection of information and digital devices, understanding the risks and potential threats in the field of engineering research		
Goal	Critical evaluation in terms of security and adoption of risk prevention, eradication and/or mitigation measures in digital research environments		
Knowledge Metrics			
Description		**Progression levels**	
1	**Identify malicious scientific emails/messages in digital research environments**	A	Knows the severity of malicious scientific emails/messages in digital research environments
		B	Explains to other researchers the severity of malicious emails/messages in digital research environments
		C	Identifies malicious emails/messages in digital research environments
		D	Explains to other researchers how to properly identify malicious emails/messages
2	**Managing passwords for scientific digital environments**	A	Is aware that proper password management in scientific environments is critical
		B	Establishes secure passwords in scientific digital environments
		C	Develops security protocols/codes for setting passwords in different digital environments
		D	Researches new digital tools for password management of digital environments used in research
3	**Establish security measures in digital environments for accessing and editing engineering research project information**	A	Knows the importance of setting access and editing measures in the digital environments used to share research information
		B	Implements standard security measures for accessing and editing research project information in digital environments
		C	Establishes protocols for proper access and editing of information in research project digital environments
		D	Coordinates with the university ICT service to manage access and editing in digital research environments

4	**Evaluate the massive request for malicious information and collaboration in digital research environments**	A	Manages information request and collaboration emails in digital research environments
		B	Knows the origins or main sources of suspicious information requests and collaboration in digital research environments
		C	Evaluates requests for information and collaboration coming through digital research environments
		D	Can implement automatic information filtering in digital environments to eliminate malicious information request emails
5	**Protect research results through patents or intellectual property**	A	Knows the difference between patent and intellectual property
		B	Identifies through digital platforms whether your potential research result has been patented or protected
		C	Identifies and uses the platforms for the protection of research results
		D	Uses digital tools for the protection of research results generated during the PhD student's research career

DC 15	Protecting Personal Data and Privacy		
Definition	Understand how to implement protocols for the protection of personal information and privacy from potential risks in digital research environments		
Goal	Effective protection of privacy and personal data and privacy within research projects against potential digital risks and threats		
Knowledge Metrics			
Description		**Progression levels**	
1	**Information privacy management within research projects through digital tools**	A	Identifies critical information that must be properly privacy managed through digital tools
		B	Classifies documents and information generated in research projects according to their level of privacy
		C	Implements privacy protocols for documents/information generated in research projects through digital technologies
		D	Explains the privacy protocols to the members of the research team of the project
2	**Protect the personal information and privacy of research project stakeholders through digital technologies**	A	Knows the importance of properly managing the privacy of stakeholders in research projects
		B	Identifies the stakeholders with the most sensitive and critical information
		C	Protects the personal information and privacy of stakeholders in the digital environment used in the project
		D	Researches new digital tools to securely protect stakeholders' personal information and privacy
3	**Establish access and editing of personal information in digital environments used in research projects**	A	Gives access to the digital environment to the members of the research project
		B	Defines personal information that cannot be shared through digital tools
		C	Controls access to personal information within digital environments in research projects
		D	Controls editing of personal information within digital environments in research projects

4	**Develop confidentiality agreements with the different public and private partners of research projects for the protection of information shared in digital environments**	A	Understands the need for data protection and intuits the levels of confidentiality of data processed in digital environments
		B	Establishes oral agreements with partners and/or entities in the treatment of information generated and shared in digital environments
		C	Develops, with digital tools, confidentiality agreements with partners and/or entities in the treatment of information generated and shared in digital environments
		D	Researches new digital tools for the generation of confidentiality agreements for the privacy of research projects

DC 16	Protecting Health and Well-Being		
Definition	Ability to identify and mitigate health risks, both physical and mental, derived from the use of digital technologies in research		
Goal	Development of skills and/or technical abilities in identifying and evaluating problems in the use of digital technologies and designing and implementing solutions that protect personal integrity and support the inherent dangers of digital environments		
Knowledge Metrics			
Description		**Progression levels**	
1	**Identify what are the main issues within a research project on the impact of digital technologies on health and wellbeing**	A	Identifies research activities that, using digital technologies, have the greatest potential to affect health and well-being
		B	Identifies the management activities that, using digital technologies, have the greatest potential to affect health and well-being
		C	Determines the people who will be affected using digital technologies in research projects
		D	Explains to other project members the problems generated in health and well-being due to activities that employ digital technologies in research projects
2	**To propose strategies to improve health and well-being and reduce the impact of digital technologies**	A	Knows the importance of mitigating the problems generated in health and well-being by the use of digital technologies in research
		B	Knows strategies to improve health and well-being and reduce the impact of the use of digital technologies in research
		C	Implements strategies to improve health and wellbeing and reduce the impact of the use of digital technologies in research
		D	Researches new strategies with digital tools to improve health and wellness and reduce the impact of the use of digital technologies in research

3	**Employ digital technologies to manage workload among research team members, minimizing the impact of the use of digital technologies on health and well-being**	A	Knows the importance of properly managing the workload of research team members to improve health and well-being
		B	Knows digital tools to improve the workload of team members and, consequently, improve health and wellbeing during research
		C	Applies digital technologies to manage the workload of team members, mitigating issues generated on health and well-being
		D	Researches new digital technologies to manage the workload within a research team, mitigating issues generated on health and well-being
4	**Use digital technologies to organize the daily work of research through digital technologies**	A	Knowledge of how digital technologies affect the doctoral student's own health and well-being
		B	Ability to balance working with and without digital technologies to improve the health and well-being of the doctoral student
		C	Implements digital technologies to organize daily research work
		D	Researches new digital tools to organize daily research work

DC 17	Protecting the Environment		
Definition	Understand the influence of the use of digital technologies on the impact of the environment during research projects on the impact of the environment		
Goal	Ability to analyse how digital technologies used in research projects affect the environmental impact of the project and establish methods to mitigate it		
Knowledge Metrics			
Description		**Progression levels**	
1	**Understand the environmental impact of digital technologies used in research projects**	A	Understands the basic concepts of environmental impact due to the use of digital technologies
		B	Knows that the use of digital technologies in research affects the environment
		C	Identifies the research project activities that most affect sustainability due to the use of digital technologies
		D	Explains to other researchers the criticality of the activities of a research project related to the contamination of digital technologies
2	**Assess the environmental impact of digital technologies used in research projects**	A	Compares, with assistance, the activities of the research project that most affect sustainability using digital technologies
		B	Independently compares the activities of the research project that most affect sustainability using digital technologies
		C	Evaluates the environmental impact, with support, of the digital technologies used in the activities of a research project
		D	Evaluates the environmental impact, autonomously, of the digital technologies used in the activities of a research project
3	**Design research projects to mitigate the impact of digital technologies**	A	Identifies sustainable research projects using digital technologies
		B	Compares research projects and determine the one that pollutes the least using digital technologies
		C	Designs research projects, with support, where the environmental impact of the digital technologies used is mitigated
		D	Designs research projects, in an autonomous way, where the environmental impact of the digital technologies used is mitigated

4	**Establish sustainable strategies for the environmental impact generated by the technologies used in research projects**	A	Knows the importance of optimizing the use of digital technologies to minimize the environmental impact in research
		B	Knows good practices to mitigate the environmental impact of digital technologies used in research projects
		C	Designs sustainable strategies to reduce the environmental impact of digital technologies used in research projects
		D	Implements sustainable strategies to reduce the environmental impact of digital technologies used in research projects

DC18	Troubleshooting technical problems		
Definition	Identify and solve technical problems when carrying out research work		
Goal	Be able to solve technical problems at different stages of the research project: preparation, simulation, experimentation and results		
Knowledge Metrics			
Description		**Progression levels**	
1	**Solve technical problems during the elaboration of a research project with digital tools**	A	Recognises technical issues arising from state-of-the-art analysis and the knowledge gap
		B	Evaluates possible solutions to the identified technical problem
		C	Appropriately implements the most suitable solution to the identified technical problem
		D	Helps colleagues to identify and solve technical problems
2	**Solve technical problems during the simulation phase of a research project with digital tools**	A	Recognises technical problems during the simulation run that prevent consistent results
		B	Evaluates the boundary conditions implemented in the simulation that will prevent consistent results
		C	Implements relevant boundary conditions to lead to simulations consistent with actual experience
		D	Helps peers to develop simulations that are consistent with the real system and lead to robust results
3	**Solve technical problems in the management and analysis of research data with digital technologies**	A	Recognises technical problems in the analysis of research results that prevent robust conclusions
		B	Assesses possible biases and errors during data acquisition that did not lead to robust conclusions
		C	Implements solutions to avoid technical problems in data analysis that prevent robust conclusions
		D	Assists colleagues in acquiring research data that leads to robust results

4	**Solve technical problems during the experimentation phase of a research project with digital tools**	A	Identifies technical problems for the commissioning of the equipment used
		B	Examines possible technical problems that arise during the experimentation that did not lead to robust conclusions
		C	Develops preventive measures to avoid technical problems during the experimentation
		D	Supports peers to carry out robust experimentation leading to consistent results

DC19	Identification of technological needs and responses		
Definition	Identify technological needs and assess and implement technological responses during research projects		
Goal	Be able to identify technological needs at different stages of a research project and evaluate and implement appropriate responses to promote consistent results		
Knowledge Metrics			
Description		**Progression levels**	
1	**Identifying technology needs in the preparatory phase of a research project**	A	Defines the high-level technology needs for the achievement of the goals of a research project
		B	Identifies the technological responses needed to carry out the work envisaged in the project
		C	Adequately chooses the technological response (technical equipment and materials) to take on the research work
		D	Assists peers in identifying the technological need and making the appropriate choice of the necessary technological response
2	**Recognise technological needs during the execution of a research project**	A	Defines the specific technological needs (equipment and material) for a given experiment
		B	Identifies the appropriate configuration of the technological response for a given experiment (technological need)
		C	Successfully implements the configuration of the technological need for a particular experiment
		D	Supports peers in defining the technological need and its configuration for a particular experiment
3	**Exploring technological needs for managing the implementation of a research project**	A	Sets out the technological requirements for managing a research project (budget, schedule, communications)
		B	Maps the technological responses needed to ensure the success of the project (communications, responsibilities, etc.)
		C	Successfully deploys technology solutions ensuring stakeholder involvement
		D	Assists peers in identifying research project management technology needs and supports them in the choice of the technological response

DC20	Creative use of digital technology		
Definition	Employing digital technologies to create and manage processes for understanding and solving problems in complex research situations		
Goal	Be able to use digital technologies to support research work (individual and collective) by improving processes and creating knowledge to understand and solve research problems		
Knowledge Metrics			
Description		**Progression levels**	
1	**Employing digital technologies to improve my productivity in research tasks**	A	Identifies tools and technologies to standardise and automate research processes
		B	Finds and discusses digital technology needs to standardise and automate research processes
		C	Adapts and implements innovative processes for standardisation and automation of research processes
		D	Creates content on how to implement research process standardisation and automation needs
2	**Applying digital technologies to produce content on the use of laboratory equipment**	A	Understands digital technologies that will help create content to improve the use of scientific equipment
		B	Modifies and enhances the appearance of existing content using digital technologies
		C	Creates content based on digital technologies that help to understand the basic operation of laboratory equipment
		D	Produces highly innovative content based on digital technologies to get the most out of lab equipment
3	**Making use of digital technologies to improve the performance of research software**	A	Is interested in complementary digital technologies (plug-ins and/or add-ins) to dedicated research software
		B	Is familiar with the operating algorithms of dedicated software to detect complementarity needs
		C	Masters the application of complementary digital technologies that enhance the basic performance of the software
		D	Develops tailor-made applications based on digital technologies to improve the performance of dedicated software

4	**Engaging AI tools to improve technological responses within a research project**	A	Is familiar and discusses the AI tools available to understand and solve research problems
		B	Assesses and identifies AI requirements needs to meet research problem-solving needs
		C	Adopts and deploys AI tools to improve performance in solving research problems
		D	Builds knowledge on how to use AI tools to support research problem solving

DC21	Identifying gaps in digital skills		
Definition	Encouraging self-learning through continuous improvement of digital skills to enhance competence		
Goal	Identify gaps in the development of digital skills relevant to research work to improve them		
Knowledge Metrics			
Description		**Progression levels**	
1	**Be aware of the needs of digital technologies for research work**	A	Identifies gaps in competency level that could improve their performance in research tasks
		B	Recognises useful resources to improve the level of competence in digital technologies applied to research
		C	Consumes content related to the development of digital competences for research work
		D	Implements and evaluates their competence performance to further improve its performance in the use of digital technologies
2	**Boosting the competence level of digital technologies applied to research**	A	Identifies useful knowledge and skills to improve their level of competence in applied digital technologies
		B	Assimilates new skills and practical knowledge useful for their competence improvement through structured knowledge
		C	Capitalises on tacit (unstructured) knowledge to improve their competence level
		D	Demonstrates an increase in competence performance due to the practical application of newly acquired knowledge
3	**Contributing to the development of digital technology skills of others**	A	Helps peers to broaden their knowledge about digital competence development
		B	Assists peers in their digital competence development through mentoring
		C	Coaches peers in their competence development and provides them with useful resources to do so
		D	Supports peers in identifying digital skills gaps to foster their continuous improvement

GC1	Valuing sustainability		
Definition	Reflect on how different actions affect the sustainability of research and align the values of project/research with the values of sustainability		
Goal	Critical evaluation in terms of sustainability of values and actions during the engineering doctoral student's research career		
Knowledge Metrics			
Description		**Progression levels**	
1	**Understand the concepts and values of sustainability in engineering research**	A	Identifies the main regional, national and European sustainability values and strategies
		B	Knows how the main regional, national and European sustainability values and strategies affect the scientific community (SDGs/European Green Pact)
		C	Knows how the main values and strategies of sustainability affect the doctoral student's own line of research
		D	Researches and elaborates on changes in society's sustainability values and strategies and can present them to other doctoral students
2	**Know how to align the values and objectives of a project with sustainability values**	A	Identifies sustainable values within a research project
		B	Analyses the sustainable values of a research project
		C	Aligns the values and objectives of a research project with sustainability values (e.g., with the SDGs)
		D	Can explain to other researchers how they should adapt the objectives or goals of their project to align with sustainable values
3	**Evaluate the sustainability of engineering research projects**	A	Is aware of how research projects affect sustainability
		B	Identifies research projects that affect the environment
		C	Can compare different research projects and determine which is more sustainable in a reasoned manner
		D	Investigates new ways to evaluate the criticality of research projects

4	**Analyse and select the best strategy or course of action to improve research sustainability**	A	Compares different sustainability strategies within a project and can rank them in order of effectiveness
		B	Can develop, with the help of their mentor or senior researcher, sustainable strategies to reduce the environmental impact of critical project activities
		C	Can autonomously develop strategies to reduce the environmental impact of research projects
		D	Investigates new sustainability reduction strategies in research projects and implements environmentally friendly work plans

GC2	Supporting fairness	
Definition	Support equity so that current and future generations can live in a sustainable society. Learn from the experiences of researchers in terms of sustainability	
Goal	Be able to understand and extract all the scientific knowledge that improves the sustainability of society and implement it in current and future projects	
Knowledge Metrics		
Description		**Progression levels**
1	**Understand successful sustainable practices in engineering research projects**	A: Identifies good sustainable practices in the field of engineering research projects
		B: Compares good sustainable practices observed in engineering research projects in different communities
		C: Has as an in-depth understanding of the potential for new sustainable best practices in the field of engineering research projects
		D: Researches on new sustainable best practices and determine their impact on current and future research projects
2	**Implement good sustainable practices in current and future research projects**	A: Evaluates, with the help of the tutor or a senior researcher, the potential for implementing the experiences and results obtained by other authors in the student's own line of research
		B: Analyses autonomously the potential of implementing the experiences and results obtained by other authors in the doctoral student's own line of research
		C: Implements good sustainable practices in the research projects in which the doctoral student participates
		D: Actively participates in the organization of seminars, conferences and congresses aimed at implementing good sustainable practices in research projects

3	**Develop a methodology based on scientific knowledge to improve the sustainability of research**	A	Can relate the knowledge of sustainability developed by other authors and group them by lines of research
		B	Designs, with the help of their tutor or a senior researcher, a work methodology that allows the application of sustainable knowledge in the student's own line of research
		C	Autonomously creates a work methodology that allows the application of sustainable knowledge in the doctoral student's own line of research
		D	Develops a general methodology that can be implemented in various fields of study and that is easily reproducible, promoting the sustainability of the research
4	**Design new research projects that focus on today's major sustainability challenges to improve sustainability in the future**	A	Identifies the main research challenges in terms of sustainability in the field of engineering
		B	In-depth knowledge of the main sustainability challenges in the doctoral student's own line of research
		C	Proposes a new project that encompasses some of the current sustainability research challenges
		D	Clearly establishes the objectives and scope of the project, and develops an appropriate work plan for the achievement of the sustainability challenge

GC3	Promoting nature		
Definition	To know the impact of research on the different nature and restore/regenerate it to create a resilient nature		
Goal	Evaluate the impact on the ecosystem of the different actions taken during the PhD student's research career and make decisions that are sustainable for nature		
Knowledge Metrics			
Description		**Progression levels**	
1	**Understand the influence of actions and activities of research projects on the environment**	A	Identifies the activities that have the greatest influence on nature
		B	Can compare two activities from a sustainable point of view with environmental results
		C	Can compare two activities from a sustainable point of view without environmental results
		D	Explains to other researchers new ways of understanding the environmental impact of research activities
2	**Assess the environmental impact of research activities on nature**	A	Knows about methodologies to quantify the environmental impact of research on nature
		B	Selects the best and most efficient methodology to quantify the environmental impact of research projects
		C	Implements methodologies to quantify the sustainability of tasks within research projects
		D	Investigates new ways to assess the environmental impact of research activities on nature
3	**Establish actions within the research to restore nature**	A	Learns about different strategies to restore nature
		B	Can identify the best strategy to regenerate nature within a research project
		C	Is aware of the latest strategies to improve the environment in research projects
		D	Implements strategies such as circular economy within its research projects

4	**Design research projects in such a way as to maximize their sustainability**	A	Identifies the weaknesses of research projects from the point of view of sustainability
		B	Designs, with tutor assistance, research projects with more sustainable activities
		C	Designs research projects with more sustainable activities
		D	Investigates new strategies to increase the sustainability of the research group's new projects

GC4	Systems thinking		
Definition	Approach sustainability in research from all angles, considering time and context and understanding how it interacts with other elements		
Goal	To understand the relationship between sustainability and the main variables of research projects and the interrelation of environmental variables during their phases		
Knowledge Metrics			
Description		**Progression levels**	
1	**Understand the different ways of quantifying environmental impact and their interrelationship**	A	Knows that there are different ways to quantify environmental impact and its importance
		B	Determines the environmental impact in all its categories
		C	Can analyse the interrelationship of the different environmental impact categories
		D	Draws conclusions from the interrelationship of environmental impact categories within a research project
2	**To know the interrelation between environmental impact and other important variables in research projects**	A	Identifies other variables that have a bearing on the environmental impact of research projects
		B	Knows, with results, the variable that has the greatest interrelation with the sustainability of research projects
		C	Knows, without results, the variable that has the greatest interrelation with the sustainability of research projects
		D	Can obtain correlations between the environmental variable and other research variables
3	**To understand the impact on the nature of research projects throughout their life cycle**	A	Identifies the phase of the research project with the greatest impact on the environment
		B	Quantifies the environmental impact of a research project throughout its life cycle
		C	Evaluates the environmental impact of a research project throughout its life cycle
		D	Explains, to other researchers, the environmental impact of a research project throughout its life cycle

4	**Manage research projects in a sustainable manner**	A	Can understand the need for sustainable management of projects and research
		B	Learns ways to manage projects in a sustainable way
		C	Implements sustainability in the management of research projects
		D	Designs, with the tutor's help, new actions to manage projects in a sustainable way

GC5	Critical thinking		
Definition	Have the necessary skills to evaluate and understand information related to sustainability issues, broadening their vision for sustainability		
Goal	To have a critical perspective that improves the capacity of doctoral students, increasing their understanding of sustainability concepts and better assessing sustainability issues		
Knowledge Metrics			
Description		**Progression levels**	
1	**Evaluate and analyse the information generated during their research career, determining its impact on sustainability**	A	Identifies research results that improve sustainability
		B	Can compare different research results and select the most important for sustainability
		C	Thoroughly evaluates the sustainable consequences of research results
		D	Compares their research results with other similar results, determining the impact on the environment
2	**Determine whether a research idea is truly novel in terms of sustainability**	A	Raises different ideas for sustainable research
		B	Compares the different ideas of sustainable research
		C	Evaluates different sustainable research ideas and establish the best alternative for a given research project
		D	Exposes and defends their research idea before their research group
3	**Analyse the quality of scientific-technical information in terms of sustainability generated by the scientific community**	A	Knows the main authors who make scientific contributions to sustainability in the PhD student's line of research
		B	Identifies, with the help of their tutor, the most relevant scientific contributions and scientific projects in the field of sustainability related to the PhD student's research
		C	Compares the impact of research conducted by other authors in terms of sustainability
		D	Can explain and discuss in a scientific seminar the most important sustainable scientific contributions of recent years

4	**To argue for sustainable decisions and actions during the research career**	A	Identifies the actions and decisions that have the greatest impact on the environment
		B	Argues in writing their own actions and decisions during their research career from the perspective of sustainability
		C	Defends to other researchers their own actions and decisions during their research career from the perspective of sustainability
		D	Can argue about the decisions and actions of other researchers in terms of sustainability

GC6	Problem Framing
Definition	Formulate current or potential challenges as a sustainability issue, to identify appropriate approaches to anticipate and prevent problems, and to mitigate and adapt to existing problems
Goal	Identification of sustainability issues/challenges in engineering research and ability to define strategies to mitigate and resolve these challenges

Knowledge Metrics

Description		Progression levels	
1	**Identify appropriate strategies to mitigate, adapt and potentially solve sustainability issues in research**	A	Identifies possible solutions to scientific-technical sustainability challenges/problems
		B	Compares the different solutions, determining the advantages and disadvantages of each
		C	Explains the most appropriate solution to mitigate or resolve sustainability issues in research projects
		D	Defines in depth the sustainable scientific-technical solution to a given problem
2	**Analyse and compare the different sustainability challenges of research project management**	A	Identifies sustainability challenges in research project management
		B	Compares different sustainability challenges in research project management
		C	Analyses the challenges of sustainability in the management of research projects from different levels
		D	Investigates new solutions to improve sustainability in the management of research projects
3	**Assess scientific-technical sustainability issues/challenges from the point of view of different stakeholders**	A	Understands that the challenges differ depending on the stakeholder
		B	Can establish which stakeholder has the most interest/power in the sustainability challenge
		C	Analyses sustainability issues from the perspective of different stakeholders
		D	Can explain to the different stakeholders the other stakeholders' perspective on the scientific-technical sustainability problem

4	**Quantify and define the work involved in executing a sustainability challenge in the current one**	A	Knows the difficulty of implementing the solution to a sustainability problem in current research
		B	Quantifies, with tutor support, the work involved in implementing the challenge
		C	Autonomously plans the steps required to execute the challenge
		D	Autonomously manages and adapts the work during the execution of the challenge

GC7	Futures literacy		
Definition	Understand future trends in sustainability in engineering research and identify short-, medium- and long-term steps		
Goal	Be able to analyse the limitations and risks of future sustainable research strategies to be able to anticipate and establish lines of action		
Knowledge Metrics			
Description		**Progression levels**	
1	**Identify sustainable trends in engineering research**	A	Recognises general trends in sustainability
		B	Outlines specific examples of trends in engineering research
		C	Identifies relevant and current sources on sustainable trends
		D	Relates identified trends to specific areas of engineering
2	**Evaluate short-, medium-, and long-term sustainable trends in engineering research lines.**	A	Assesses with the help of an expert the short-term trends of one's own line of research in terms of sustainability
		B	Autonomously assesses the short-term sustainability trends of its own line of research
		C	Autonomously analyses the medium- and long-term sustainable trends of its own research line
		D	Analyses trends in different lines of research from a sustainable point of view
3	**Understand the constraints, risks and opportunities of future sustainable research trends**	A	Identifies constraints to future trends
		B	Identifies constraints, risks and opportunities for future trends
		C	Clearly assesses the relationship between constraints, risks and opportunities
		D	Assesses in depth and in detail the relationship between constraints, risks and opportunities

4	**Evaluate and compare different future research strategies in terms of sustainability**	A	Identifies and superficially analyses future research strategies
		B	Compares advantages and disadvantages of strategies in an appropriate and detailed manner
		C	Evaluates the sustainable impact of each strategy in a thorough and accurate manner
		D	Proposes very detailed and well-founded improvements based on evaluation

GC8	Adaptability		
Definition	Manage uncertainty and risk associated with complex situations affecting sustainability during their research career		
Goal	Know that actions carried out during the research career can generate unpredictable situations that affect the environment		
Knowledge Metrics			
Description		**Progression levels**	
1	**Identify risks and uncertainties affecting sustainability generated in different complex situations during the research career**	A	Recognises common risks in complex situations
		B	Identifies and describes specific uncertainties in research contexts
		C	Identifies sources of risk in research projects
		D	Assesses the likelihood and impact of the risks and uncertainties analysed
2	**Understand that there are actions affecting the environment that need to be adapted to reduce the impact within engineering research**	A	Identifies actions with a negative impact on the environment
		B	Analyses the impact of these actions on research projects
		C	Proposes adaptations to mitigate negative impacts
		D	Evaluates the effectiveness of proposed adaptations
3	**Test different alternative solutions to improve the sustainability of research project management**	A	Identifies possible alternative solutions
		B	Evaluates the feasibility of each solution
		C	Implements solutions in research projects
		D	Can measure the impact of implemented solutions
4	**Adapting research to address unexpected changes (with uncertainty) affecting the environment**	A	Recognises unexpected changes during the research
		B	Assesses the potential impact of changes on the project
		C	Develops strategies to adapt the research to changes
		D	Implements and reviews adaptive strategies

GC9	Exploratory thinking		
Definition	Explore different engineering disciplines to improve the sustainability of research and employ new experimentation methods and research methodologies to enhance the sustainability of society		
Goal	Understand different perspectives to successfully address sustainable engineering research and explore new research methods		
Knowledge Metrics			
Description		**Progression levels**	
1	**Explore new methods of experimentation and novel research for the promotion of sustainability**	A	Identifies superficially one or two novel experimentation and research methods
		B	Explains in a basic manner how these methods can contribute to sustainability
		C	Clearly relates these methods to specific improvements in sustainability
		D	Innovatively integrates these methods into research projects to maximize sustainability
2	**Manage research projects sustainably through innovative methodologies**	A	Has a limited understanding of novel methodologies for sustainable research project management
		B	Describes several novel methodologies for the sustainable management of research projects
		C	Integrates these methodologies into the planning and execution of specific projects
		D	Continuously evaluates and improves management processes to maximize sustainability in research projects
3	**Propose engineering research projects based on circular economy strategies**	A	Has a superficial understanding of circular economy strategies
		B	Proposes projects that integrate these strategies in a basic manner
		C	Shows concrete examples of projects that effectively integrate these strategies
		D	Evaluates the impact of these projects and proposes continuous improvements to optimize sustainability

4	**Be able to synthesize and analyse sustainable information obtained from research in different engineering disciplines**	A	Collects information in a limited manner and shows difficulties in synthesizing and analysing sustainability data
		B	Conducts basic analyses and shows how this information can contribute to sustainability
		C	Effectively applies this knowledge in research to promote sustainability
		D	Integrates information into research projects to enhance sustainability and drive improvements.

GC10	Political agency		
Definition	Navigate the political system, identifying policies that promote sustainability through engineering research		
Goal	Be able to understand and analyse political strategies that promote sustainability within their research career		
Knowledge Metrics			
Description		**Progression levels**	
1	**Identify political strategies that promote sustainability within their research career**	A	Identifies superficially one or two political strategies related to sustainability
		B	Can give specific but limited examples of how these relate to their research career
		C	Identifies and explains in detail multiple political strategies related to sustainability
		D	Effectively integrates these strategies into their research career and proposes improvements or innovations
2	**Understand European political strategies that promote sustainability through engineering research**	A	Lacks a deep understanding of how these strategies affect engineering research
		B	Can explain generally how these strategies are applied in engineering research
		C	Relates these strategies to concrete examples of projects or policies in their field
		D	Conducts a deep and critical analysis of European political strategies and their relationship with engineering research
3	**Design research political strategies to promote the sustainable development of public and private entities**	A	Has difficulties connecting these ideas with sustainable development
		B	Designs basic political strategies that promote sustainability in specific contexts
		C	Develops well-founded and detailed political strategies for sustainability
		D	Conducts impact assessments and proposes adjustments based on a deep analysis of public and private entities

4	**Know the main agents that promote sustainability through political strategies**	A	Has a superficial understanding of their role in sustainability politics
		B	Provides basic examples of their impact on research and sustainable development
		C	Identifies and analyses in detail multiple key agents in sustainability politics
		D	Proposes new forms of collaboration and strategies to maximize their impact on research and sustainable policies

GC11	Collective Action		
Definition	Faculty to lead and collaborate in collective efforts that address environmental challenges in engineering research projects		
Goal	Develop skills that enable doctoral students to drive sustainability through joint action and implementation of innovative solutions		
Knowledge Metrics			
Description		**Progression levels**	
1	**Identify the main sustainability stakeholders in a scientific-technical sustainability challenge**	A	Recognizes the importance of knowing the main sustainability stakeholders
		B	Understands the influence of stakeholders on the sustainability of the project
		C	Performs an in-depth analysis of stakeholders and their interconnections in a sustainability challenge
		D	Leads the strategic identification of stakeholders in sustainable challenges
2	**To understand the importance of collective action to promote nature and support fairness in research projects**	A	Recognizes the importance of collective action to implement sustainable research practices
		B	Demonstrates a consistent understanding of how collective action contributes to promoting the natural
		C	Contributes to the conceptualization and design of collective action strategies to address sustainable challenges
		D	Demonstrates how collective action can significantly transform the direction and impact of research
3	**Collaborate with sustainability stakeholders to solve scientific and technical sustainability challenges**	A	Collaborates in a basic way with stakeholders in sustainable research projects
		B	Consistently collaborates with stakeholders, demonstrating measurable impact in solving scientific-technical challenges
		C	Significantly contributes to the generation of innovative solutions through effective collaboration
		D	Acts as a benchmark in transformative collaboration with stakeholders to solve scientific-technical challenges

4	**Identify individuals and organizations to work collectively on scientific technical sustainability challenges**	A	Recognizes a few key individuals and organizations to address scientific-technical sustainability challenges
		B	Understands how strategic partner selection contributes to project success
		C	Contributes to the design and implementation of collaborative strategies to address sustainable challenges
		D	Leads the formation of strategic alliances to address scientific-technical sustainability challenges

GC12	Individual Initiative		
Definition	Ability to recognize opportunities, have confidence in personal influence and act proactively to address sustainable challenges		
Goal	Empower individuals to confidently and consciously take sustainable initiatives in their lives, becoming agents of change and role models to inspire others		
Knowledge Metrics			
Description		**Progression levels**	
1	**Individual Initiative in carrying out Sustainable Research Projects**	A	Increases awareness of one's own potential to influence positive change
		B	Recognizes opportunities for individual actions to promote sustainability
		C	Establishes cause-effect relationships to identify the actions with the greatest potential
		D	Inspires others to take sustainability initiatives and acts as a role model
2	**Initiative in Managing Projects Sustainably**	A	Recognizes some key elements of sustainability in project management
		B	Demonstrates an understanding of how sustainable management can positively impact project outcomes
		C	Develops innovative strategies for sustainable project management
		D	Uses advanced strategies and innovative approaches to maximize sustainability on major projects
3	**Evaluate own potential for improving sustainability in research projects**	A	Recognizes the importance of personal contribution to improving sustainability in research projects
		B	Implements preventive actions whenever there may be possible harmful consequences for the environment
		C	Demonstrates ongoing critical evaluation and adaptation to maximize sustainable impact
		D	Inspires others by showing how constant personal evaluation can transform the contribution to research projects towards sustainability

4	**Evaluate own potential for sustainable research management**	A	Performs a conscious self-assessment of one's own impact on sustainable research management
		B	Develops a personal improvement plan to contribute more effectively to sustainable management
		C	Develops internal policies that promote social and environmental responsibility in the workplace
		D	Leads teams in the collaborative design of sustainable strategies for companies and institutions

STUDENT SATISFACTION SURVEY

1. How many TECSKILL project trainings have you participated in? *

- ○ 1
- ○ 2
- ○ 3
- ○ 4

2. Please rate your level of satisfaction (low, medium, high) on the following questions regarding TECSKILL training *

	LOW	MEDIUM	HIGH
The activities of the training programmes were well-organized.	○	○	○
I found the content of the training sessions to be practical and applicable.	○	○	○
The methodology used during training is suitable for engineering PhD students.	○	○	○
Support was readily available whenever I encountered difficulties.	○	○	○
During the training programmes, the collaboration among participants was encouraged.	○	○	○
I gained valuable insights from interacting with other participants.	○	○	○
I appreciated the opportunity to visit different countries and explore their cultures.	○	○	○
I had the chance to bond and engage with other participants during extracurricular activities.	○	○	○
Thanks to the activities carried out during the training programmes, I can better evaluate sustainability issues in research.	○	○	○
I am more skilled in using digital tools for data analysis and research.	○	○	○
The activities carried out during the training programmes were relevant to my academic and professional goals.	○	○	○
The training programmes I attended met my expectations.	○	○	○
Should other editions of TECSKILL Erasmus+ project be organised in the future, I would recommend other PhD students to attend.	○	○	○
I would participate in a similar project in the future if given the chance.	○	○	○

Enviar

PROFESSORS SURVEY

1. How many training sessions have you delivered within the TECSKILL project? (1, 2, 3, 4...) *

Escriba su respuesta

2. During these sessions, did you focus on Digital competence, Green competence, or both? *

- ◯ Digital competences
- ◯ Green competences
- ◯ Both competences

3. How satisfied are you with the teaching methodology proposed in the project? *

- ◯ Low
- ◯ Medium
- ◯ High

4. In your opinion, is this methodology appropriate for training PhD students in engineering? *

- ◯ Low
- ◯ Medium
- ◯ High

5. Answer yes or no to the following questions. *

	Yes	No
Did you use project-based learning (PBL) as the main strategy in your classes?	◯	◯
Did you propose real or simulated challenges (CBL) in the classes to stimulate critical thinking and creativity?	◯	◯
Did you implement Research-based learning (RBL) allowing students to explore and formulate hypotheses and analyze data?	◯	◯
Did you use gamification during the training sessions?	◯	◯
Did you facilitate the active role of the student as the protagonist of his or her learning?	◯	◯
Do you feel comfortable applying these methodologies for engineering PhD students?	◯	◯

6. Lessons learned: do you propose any changes or improvements for future similar trainings that you have detected during your participation in the project?

Escriba su respuesta

Enviar

EXTERNAL EXPERT SURVEY

1. Full name *

Escriba su respuesta

2. University *

- University of Gävle
- University of Parma
- University of Évora
- University of Extremadura

3. Indicates the level of applicability of the teaching methodology developed in this project: *

- LOW
- MEDIUM
- HIGH

4. Indicate satisfaction with the teaching methodology proposed in this project: *

- LOW
- MEDIUM
- HIGH

5. The teaching methodologies described above have been adequately incorporated into the workshops proposed: *

- Proper incorporation
- Improper incorporation

6. Indicates the level of adequacy of the evaluation method proposed in the project: *

- BAD
- REGULAR
- GOOD

7. Indicates the level of satisfaction of each of the green/digital competences adapted for engineering PhD students: *

	LOW	MEDIUM	HIGH
GC1 - Valuing sustainability	○	○	○
GC2 - Supporting fairness	○	○	○
GC3 - Promoting nature	○	○	○
GC4 - Systems thinking	○	○	○
GC5 - Critical thiking	○	○	○
GC6 - Problem Framing	○	○	○
GC7 - Futures literacy	○	○	○
GC8 - Adaptability	○	○	○
GC9 - Exploratory thinking	○	○	○
GC10 - Political agency	○	○	○
GC11 - Collective Action	○	○	○
GC12 - Individual Iniciative	○	○	○
DC1 - Searching and Filtering Data, Information and Digital Content	○	○	○
DC2 - Evaluating Data, Information and Digital Content	○	○	○
DC3 - Data, Information and Digital Content Management	○	○	○
DC4 - Interacting through Digital Technologies	○	○	○
DC5 - Sharing through Digital Technologies	○	○	○
DC6 - Engaging Citizenship Through Digital Technologies	○	○	○
DC7 - Collaborating Through Digital Technologies	○	○	○
DC8 - Netiquette	○	○	○

8. Indicates the level of satisfaction of each of the green/digital competences adapted for engineering PhD students: *

	LOW	MEDIUM	HIGH
DC9 - Managing Digital Identity	○	○	○
DC10 - Development of digital multimedia content for research purposes	○	○	○
DC11 - Digital Content Integration and Reelaboration	○	○	○
DC12 - Copyright and Intellectual Property Licensing	○	○	○
DC13 - Programming	○	○	○
DC14 - Protecting Devices	○	○	○
DC15 - Protecting Personal Data and Privacy	○	○	○
DC16 - Protecting Health and Well-Being	○	○	○
DC17 - Protecting the Environment	○	○	○
DC18 - Troubleshooting technical problems	○	○	○
DC19 - Identification of technological needs and responses	○	○	○
DC20 - Creative use of digital technology	○	○	○
DC21 - Identifying gaps in digital skills	○	○	○

Enviar

GREEN AND DIGITAL SKILLS DEVELOPMENT FOR EUROPEAN ENGINEERING PHD CANDIDATES

This project has been funded with support from the European Commission. This publication document reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Avoid printing this document if possible.

Co-funded by
the European Union

TECSKILL

ERASMUS +

KA220 - HED