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Improvement of Transversal Skills and SDG Awareness in Nuclear Engineering: Coordination and Assessment of Final Degree and Master's Projects

Belen Juste Vidal[a,1], Teresa Barrachina[a], Rafael Miró[a], Sandra Oliver[b], Aina Noverques[c]

[a] Department of Chemical and Nuclear Engineering, Universitat Politècnica de València

[b]Department of Applied Physics, Polytechnic University of Valencia

[c]Department of Applied Mathematics, Polytechnic University of Valencia Politècnica de València, Spain

ABSTRACT

Final Degree Projects (FDPs, Undergraduate Theses) and Final Master's Projects (FMPs, Master's Theses) constitute key educational experiences within competency-based engineering education, providing opportunities for students to integrate technical knowledge with transferable skills and sustainability-related competences. This study evaluates the contribution of FDPs and FMPs in Nuclear Engineering to the development of Transversal Skills (TS) and awareness of the Sustainable Development Goals (SDGs).
The study combines a review of course guides to characterize the educational framework and a student self-assessment questionnaire to evaluate perceptions regarding the development of Sustainable Development Goals and Transversal Skills during FDP and FMP activities The systematic review of project guides was developed over a two-year period. The analysis focused on students' perceptions of competence development and sustainability awareness associated with their project experience.
Results indicate notable improvements in innovation, creativity, social commitment, and decision-making skills. In contrast, communication skills showed more moderate progress, suggesting opportunities for further educational enhancement. Students also demonstrated increased awareness of the SDGs and a greater ability to connect technical nuclear engineering work with broader sustainability challenges.
The findings suggest that FDPs and FMPs constitute valuable project-oriented learning environments for fostering both transferable skills and sustainability awareness. Beyond supporting the acquisition of technical expertise, these projects contribute to preparing future nuclear engineers to address complex professional and societal challenges in a responsible and sustainable manner.

KEYWORDS

Transversal Skills,
SDG,
Sustainability,
Capstone Projects,
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[1] Corresponding Author : Belen Jeanne Juste Vidal, Department of Chemical and Nuclear Engineering, Universitat Politècnica de València, Camí de Vera s/n, 46022 Valencia, Spain – bjuste@upv.es

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Introduction

Competency-Based Engineering Education

The creation of the European Higher Education Area (EHEA), initiated by the Bologna Declaration of 1999 (European Ministry of Education, 1999), has driven a fundamental shift in university education from a model of knowledge transmission to one focused on the acquisition of competencies. This student-focused paradigm is designed to prepare graduates for a dynamic labor market and a constantly evolving socio-economic environment (Yi, E. et al, 2024). Within this framework, the Final Degree Project (FDP) for undergraduate students and Final Master Project (FMP) for master students serve as critical academic milestones. These culminating experiences require students to synthesize their learning and demonstrate the comprehensive and practical skills essential for their professional futures (Du-Babcock, B., 2016).

Competency-based education focuses on the achievement of specific learning outcomes that integrate knowledge, skills, and attitudes required for professional practice. Within this framework, constructive alignment ensures consistency between intended learning outcomes, learning activities, and assessment methods. In engineering education, this approach has been increasingly linked to sustainability-oriented education, which seeks to prepare graduates to address environmental, social, and economic challenges through responsible professional practice.

Transversal Skills in Engineering

The FDP/FMP are fundamental elements in the assessment of university students and constitute a key tool in the acquisition of transversal competences or Transversal Skills; those skills that are not only specific to a single discipline but can be applied across a wide range of professional and personal contexts (Winberg et al. 2020).

In this study, the term Transversal Skills (TS) is adopted to describe competencies that can be applied across different professional and disciplinary contexts beyond specific technical knowledge. These competencies include effective communication, teamwork and leadership, innovation and creativity, social and environmental commitment, and responsibility and decision-making. Transversal Skills are increasingly recognized as essential components of engineering education, as they support graduates in addressing complex societal and technological challenges.

Throughout university studies, students are not only assessed through exams and practical assignments, but the FDP and the FMP function as a culmination of the entire educational process, aligning with the idea of integrative learning with knowledge skills and attitudes (Biggs and Tang, 2011). These projects, which often represent a significant percentage of the final grade in many academic programs, allow students to demonstrate the knowledge acquired over the years while also requiring them to put into practice a set of abilities that go far beyond the technical content of their degree and preparing them to the lifelong learning. From an academic perspective, the FDP and the FMP are mainly assessed based on their capacity to address a research topic or project with depth, originality and methodological rigor (Creswell 2014). However, beyond this purely academic dimension these projects serve to evaluate the extent to which students have developed key competences that will prepare them for their future professional lives (González and Wagenaar, 2005). The ability to manage a complex project with autonomy in decision-making, the capacity for synthesis and critical analysis, the skills to communicate ideas clearly and in a structured manner, and problem-solving are just some of the transversal skills that students must demonstrate during the process of developing their FDP/FMP.

At the Universitat Politècnica de València (UPV), the FDP/FMP is an original, individual work that consolidates a student's academic journey. The Nuclear Engineering Department at UPV contributes to courses across several programs within the School of Industrial Engineering (ETSII), including the Degree in Industrial Technologies Engineering, the Degree in Energy Engineering, Biomedical Engineering Degree and the University Master's Degree in Nuclear Safety and Radiological Protection, among others. In these programs, the FDP/FMP is a 12-ECTS project, corresponding to approximately 20% of a full academic year (60 ECTS credits), explicitly aligned with research areas such as nuclear engineering, emergency risk assessment, medical physics, and radiation protection. A key institutional initiative at the UPV has been the establishment of a framework of thirteen transversal competencies, developed in collaboration with the Institute of Education Sciences (ICE) and integrated across the university curriculum (UPV, 2021; UPV, 2022). These competencies, integral to all Industrial Engineering courses at the ETSII, are: Social and Environmental Commitment, Innovation and Creativity, Teamwork and Leadership, Effective Communication, Responsibility and Decision-Making (Alvarez Blanco, 2016).

Furthermore, educational directives like those of Government of Spain, (Royal Decree 822/2021, No. 233 establishing the organization of official university education and the quality assurance procedure), mandate the integration of Sustainable Development Goals (SDGs) into the curriculum. This creates a powerful, yet complex, educational challenge: effectively weaving together technical rigor, transversal competencies, and sustainability principles.

Sustainable Development Goals in Nuclear Engineering Education

This challenge is particularly acute in specialized fields like nuclear engineering. While the curriculum is technically rigorous, it often lacks a sustained focus on the broader societal, environmental, and ethical implications of the discipline, precisely the competencies required for responsible professional practice. The 2030 Agenda for Sustainable Development, adopted by the United Nations in 2015, provides a global framework composed of 17 Sustainable Development Goals (SDGs) aimed at addressing major economic, social, and environmental challenges while promoting sustainable development worldwide. Within the context of Nuclear Engineering education, particular attention is given to SDG 3 (Good Health and Well-Being), SDG 7 (Affordable and Clean Energy), SDG 9 (Industry, Innovation and Infrastructure), and SDG 13 (Climate Action). These goals are closely related to the professional responsibilities of nuclear engineers, including radiation protection, energy production, technological innovation, infrastructure development, and climate change mitigation. Consequently, a gap can persist between students' technical proficiency and their ability to contextualize their work within global sustainability frameworks (United Nations, 2015), (Brundiers et al., 2021).

Final Degree Projects and Master's Thesis as Learning Environments

One of the most significant aspects of these projects is the research process, which involves both the collection and analysis of information and the formulation of hypotheses or relevant research questions. In this sense the FDP/FMP require from students an intellectual and methodological maturity that goes beyond the simple presentation of content learned in class. The student must be able to identify a problem, propose a possible solution or answer, and justify it coherently which implies the integration of knowledge acquired in different subject areas. This capacity for synthesis, which is not only crucial in the academic field but also in the professional one, allows students to develop a critical approach that will be useful when facing future challenges in their working lives. Another fundamental pillar of these projects is the level of autonomy they demand. During its development,

the student is responsible for managing time, organizing tasks and making decisions about how to approach the work. This capacity for self-management is essential in any professional environment where individuals are expected to carry out tasks independently plan projects and meet established deadlines. In addition, the need to deal with the challenges that arise during the completion of a research project implies that the student must also be able to make decisions and adapt to unforeseen circumstances which strengthens resilience and flexibility qualities that are highly valued in the professional world. The Final Degree Project and the Final Master Project also provide an important space for students to develop communicative competences both in written form and through oral presentation. The ability to structure a piece of work in a logical and coherent way to use appropriate language and to be precise in the ideas presented is fundamental in these works. But assessment does not end with the submission of the written document since students must also defend their work to an evaluation committee. This aspect of assessment the oral defense adds an important dimension in which communication skills are tested as the student must be able to present and argue ideas clearly and convincingly. The ability to answer questions and defend conclusions before a panel of experts also contributes to the development of transversal skills such as persuasion, negotiation, and stress management. Furthermore these projects allow students to have direct contact with research and cutting-edge knowledge in their discipline which provides valuable experience that can open doors in both academic and professional fields. The relationship with the supervisors of the Final Degree Project and the Final Master Project can play an important role in the development of transversal skills through guidance, feedback, and academic mentoring throughout the project process (Winberg, 2020). Supervisors act as guides but also as evaluators of autonomy, rigor and creativity. The constant interaction with them allows students to improve collaboration, negotiation and teamwork skills since the supervision process is not isolated but collaborative. The feedback received from supervisors also helps students to better understand their strengths and weaknesses, In conclusion the Final Degree Project enabling them to improve both their technical abilities and their Transversal Skills. Final Degree and Master's Projects provide valuable opportunities for students to develop critical thinking skills by addressing complex problems, evaluating alternatives, and making evidence-based decisions (Wiek et al., 2011). Through research students must question information evaluate different perspectives and build a solid discourse based on facts and evidence. This critical competence is not only useful in the academic sphere but also in the professional one where the ability to assess information make informed decisions and challenge the status quo is essential. In this way, the Final Degree Project and the Final Master Project contribute significantly to the education of individuals who not only possess technical knowledge but are also capable of applying that knowledge reflectively and critically in their professional environment. In general, both the Final Degree Project and the Final Master Project represent a crucial moment in students' academic development as they require not only the application of acquired knowledge but also the demonstration of a wide range of transversal skills that are essential for professional success. The ability to work autonomously, manage projects communicate effectively and think critically are just some of the competences developed during the preparation of these projects. Moreover, the fact that these projects are closely linked to the professional world gives students an advantage when entering the labor market since many of them are directly related to the demands and needs of industry or specific research areas. It is important to note that although the Final Degree Project and the Final Master Project are fundamental for the acquisition of transversal skills they also present challenges. Many students face the pressure of completing a large-scale project which can generate stress and anxiety however these challenges are also part of the educational process as they teach students how to manage pressure, organize time effectively and deal with uncertainty. Success in completing these projects does not depend solely on technical knowledge but also on the students' ability to navigate a long and complex process that involves making decisions receiving constructive criticism and adapting to new situations.

Research Gap and Objectives

The FDP/FMP presents a strategic opportunity to bridge the gap between the acquisition of technical engineering knowledge and the development of transversal and sustainability-related competencies required to address real-world professional challenges. By framing projects within the context of professional practice and the SDGs, students can develop a more holistic understanding of their field's societal role (Kestin, T., 2017; Martínez et al., 2006; Lozano et al., 2017). However, while the theoretical value of this approach is recognized, empirical evidence on its systematic implementation and effectiveness within nuclear engineering education remains scarce. It is not enough to simply assign SDG-related topics; the central question is whether the FDP/FMP process itself actively fosters the intended competencies and awareness.

Final degree and capstone projects have long been recognized as valuable educational experiences for integrating disciplinary knowledge and fostering transversal competencies such as communication, problem-solving, teamwork, and self-directed learning (Dutson et al., 1997). Previous studies have reported positive effects of these projects on students' professional preparedness and employability (Paretti, M. C., 2019).

In parallel, growing attention has been devoted to the integration of sustainability principles and the Sustainable Development Goals (SDGs) into engineering education, (Wiek et al., 2011). Several authors have emphasized the need to equip future engineers with competencies related to ethical responsibility, systems thinking, sustainability awareness, and social commitment [Jalali, Y. , 2022]. This study evaluates the contribution of Final Degree Projects (FDPs) and Final Master's Projects (FMPs) in Nuclear Engineering to the development of transferable skills and sustainability awareness among students. Specifically, the study analyses students' perceptions before and after completing their projects in order to assess changes in transversal competencies and awareness of the Sustainable Development Goals (SDGs), as well as the educational value of these project experiences.

To achieve this aim, the following specific research objectives were defined:

- To systematically review the Nuclear Engineering courses offered within the Bachelor's and Master's programmes at the School of Industrial Engineering (ETSII), analysing their curricular characteristics (mandatory or elective status and ECTS credits) and evaluating the extent to which Sustainable Development Goals (SDGs) and Transversal Skills (TS) are incorporated throughout the curriculum.
- To design and implement a structured assessment framework, including well. defined indicators and evaluation criteria, to measure stucent's achievement of the identified competencies and their projects' alignment with the SDG.
- To evaluate and analyze the results obtained from this assessment to determine the strengths and weaknesses in students' acquisition of Transversal Skills and their understanding of the SDG through their project work.

Despite the growing integration of sustainability principles and transversal skills into engineering curricula, educational programmes remain predominantly focused on technical knowledge and disciplinary competencies. Consequently, limited evidence exists regarding the extent to which Final Degree Projects (FDPs) and Final Master's Projects (FMPs) contribute to the development of sustainability awareness and transversal competencies among Nuclear Engineering students. This study seeks to address this gap by analyzing students' perceptions of competency development during their FDP and FMP experiences.

This study will serve to propose evidence-based improvements for the design and supervision of future FDP/FMP to better strengthen the integration of sustainability principles and Transversal Skills in nuclear engineering education.

Methodology

Students individually developed a research or applied engineering project under the supervision of one or more academic advisors over an academic period of approximately 4 to 9 months, depending on the project scope and academic level. Throughout the project, students were required to identify a relevant engineering problem, review the scientific and technical literature, define objectives, develop and apply appropriate methodologies, analyze results, and present conclusions. Regular meetings with supervisors were held to provide guidance, monitor progress, discuss technical challenges, and support decision-making processes. The projects involved independent learning, problem-solving, technical report writing, data analysis, and oral presentation activities, which provided opportunities for the development of transferable competencies including communication, critical thinking, innovation, responsibility, and autonomous learning. No specific intervention was introduced for the purpose of this study. Instead, the study evaluated the educational impact of the standard FDP/MFP process as implemented within the programme.

The methodology adopted in this study aims to assess the initial competencies of students undertaking their FDP/FMP in the field of nuclear engineering. Data were collected using a structured self-assessment questionnaire designed by the teaching team.

The questionnaire consists of thirty items and is administered at two time points: at the beginning of the FDP/FMP (baseline) and upon completion (post-project). The complete questionnaire is provided in Appendix A. This pre-post design enables the analysis of changes in students' knowledge, perceptions, and engagement with Sustainable Development Goals (SDGs) and essential Transversal Skills associated with professional engineering practice.

The questionnaire is structured as follows:

- Questions 1 to 5: Collection of project-related contextual information related to the student and characteristics of the project.
- Questions 6 to 12: Assessment of students' general knowledge of the SDGs and the 2030 SD Agenda, including their ability to identify the main promoting institutions and their self-perceived level of familiarity with sustainability-related concepts.
- Questions 16 to 20: Evaluation of key Transversal Skills relevant to nuclear engineering practice, such as leadership, effective communication, teamwork, and responsible decision-making.
- Final Open-Ended Question: An open-response item inviting students to propose suggestions for enhancing the integration of nuclear engineering content and sustainability-related competencies within university curricula.

The analytical methodology combines both descriptive and comparative approaches. A quantitative analysis calculates frequencies and percentages, allowing for the characterization of students' awareness of the SDGs. Furthermore, a pretest-posttest analysis is conducted to measure progress in knowledge and engagement throughout the FDP/FMP. Correlations between self-reported SDG knowledge and the development of related competencies are also examined to identify potential educational synergies.

This study involved the collection of anonymized, self-reported data from university students through a voluntary questionnaire administered as part of their Final Degree Project and Final Master's Project academic activities. The study protocol was reviewed and approved by the Research Ethics Committee of the Universitat Politècnica de València. All participants were informed about the purpose of the study, participation was voluntary, and no personally identifiable data were collected. Informed consent was obtained from all participants prior to the completion of the questionnaires.

The questionnaires were completed anonymously, and only aggregated results were retained for analysis. Consequently, individual pre-project and post-project responses could not be matched, preventing the application of paired inferential statistical analyses. Therefore, the results presented in this study should be interpreted as descriptive indicators of perceived changes rather than statistically validated effects.

Integration of Transversal Skills & SDG

This study employs a robust, evidence-based methodology to monitor and evaluate Transversal Skills in FDPs and FMPs within the Nuclear Engineering program at the UPV. The methodology is grounded in principles of competency-based education, constructive alignment, and sustainability-oriented higher education. It is structured across two main phases: design and implementation, combining both quantitative and qualitative instruments to ensure methodological rigor.

Phase I: Design and Validation of the Competency Monitoring Framework

A comprehensive audit was carried out across 18 course guides from six degree programs related to nuclear engineering (ETSII, 2025).

- Degree in Industrial Technologies Engineering
- Degree in Energy Engineering
- Degree in Biomedical Engineering
- University Master's Degree in Chemical Engineering
- University Master's Degree in Industrial Engineering
- University Master's Degree in Nuclear Safety and Radiological Protection

The study was based on an analysis of all subjects related to nuclear engineering offered in these degree programs. For each course, the analysis focused on identifying the SDGs addressed and the Transversal Skills developed throughout the curriculum (Juste Vidal et al., 2024). This audit aimed to identify the Transversal Skills formally included in the curriculum and to map them against an institutional competency framework comprising five dimensions: social and environmental commitment, innovation and creativity, teamwork and leadership, effective communication, and responsibility and decision-making. The audit also assessed the presence of sustainability content within course descriptions and learning outcomes, resulting in a competency-SDG matrix that serves as a baseline for aligning final project topics with both competency development and sustainability objectives.

The curriculum audit was carried out by members of the research team with experience in Nuclear Engineering education and curriculum design. Course guides, programme documentation, and project-related materials were systematically reviewed to identify explicit references to Sustainable Development Goals and Transversal Skills.

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A systematic classification was conducted for all FDP/FMP topics within the Nuclear Engineering area. Each project was categorized by thematic areas (e.g., radiological protection, medical physics, reactor physics) and evaluated its implicit relation to relevant SDGs, particularly SDGs 3, 7, 9, and 13. This classification ensures that final projects are not only technically rigorous but also socially and environmentally relevant.

Phase II: Implementation, Monitoring, and Data Collection

To assess changes in student's Transversal Skills and sustainability awareness attributable to the FDP/FMP experience, the self-assessment questionnaire is administered twice: at the beginning (baseline) and at the end (post-project) of the project period. This pre-post design allows for the identification of changes in students' perceptions regarding their competencies.

Throughout the development of the project, supervisors actively monitor student progress, providing formative feedback and recording structured observations based on predefined competency indicators.

In the academic years 2024-2025, a total of 23 final projects were conducted, comprising 9 FDP and 14 FMP. The average grade for these Degree and Master's final projects in this study was 8.66 out of 10. In the Spanish higher education system, grades range from 0 to 10. Scores between 7.0 and 8.9 are generally considered very good, while grades above 9.0 are classified as excellent. In the previous academic year, 2023-2024, there were 16 projects, consisting of 7 FDP and 9 FMP. The average grade for final projects during this period was 9.04, compared to an average of 8.49 at the Technical School of Industrial Engineering (ETSII-UPV). A total of 39 students participated in the survey, with their project topics distributed as follows in Table 1.

Table 1. Distribution of research themes in the 39 projects analyzed in this study.

Topic	*Number of Projects*
Monte Carlo Simulation & Dose Analysis	11
Neutronics & Neutron Transport	8
Thermal-hydraulics	7
Shielding & Radiation Protection	4
Nuclear Safety/Risk analysis	4
Radiographic Imaging	3
Environmental Radiation	2

The curriculum review and questionnaire served complementary purposes. While the curriculum review identified the formal presence of SDGs and Transversal Skills within the programme documentation, the questionnaire explored students' perceptions regarding the development of these

competencies during their project experience. Together, both sources provide a broader understanding of the educational environment surrounding FDPs and FMPs.

Results

Data analysis was restricted to descriptive statistics based on the aggregated distribution of responses. The study was designed as an exploratory evaluation of students' perceptions before and after the completion of their Final Degree or Master's Project.

Improvement in Transversal Skills

The comparative analysis of student self-perceptions before and after their participation in FDP/FMP projects, as Figure 1 shows, reveals notable advancements in key Transversal Skills, essential for professional environments.

- Innovation and Creativity: A marked increase in students' abilities to identify new challenges and opportunities, with recognition rising from 55% at the start to 95% after completing their projects. This improvement highlights the effectiveness of dissertation-based learning through Final Degree Projects enhancing students' capacity for innovation and creativity, allowing them to critically analyze trends and generate solutions.
- Social and Environmental Commitment: Students' perceptions of their projects' societal and environmental impacts improved significantly, with the belief that their work proposed creative solutions increasing from 67% to 87%. This finding reflects a growing understanding of the broader relevance of their work and fosters a stronger sense of social responsibility.
- Responsibility and Decision-Making: Notable gains were identified in competencies related to responsibility and autonomous decision-making. Active collaboration in goal definition increased from 53% to 92%, and the percentage of students reporting autonomous decision-making rose from 54% to 87%. These results suggest that the FDP/FMP experience encourages students to take ownership of their work.
- Effective Communication: Students showed a slight improvement in their ability to communicate effectively in collaborative settings, with scores rising from 72% to 75% in terms of empathy and assertiveness. While this indicates positive development, it also suggests that communication challenges may become more evident in applied, project-based contexts than in traditional coursework.
- Teamwork and Leadership: The assessment of teamwork and leadership skills showed consistency, with 89% of students reporting strong collaboration skills prior to the projects. This stability suggests that the academic curriculum effectively cultivates these foundational skills, while the FDP/FMP provides opportunities for further refinement.

Overall, the FDP/FMP experience significantly enhances students' Transversal Skills, particularly in innovation, social commitment, and decision-making, while identifying areas for growth in effective communication. These results highlight the importance of project-oriented learning in developing essential competencies that prepare students for their future careers (International Atomic Energy Agency, 2023; Eriksen, B. et al., 2019).

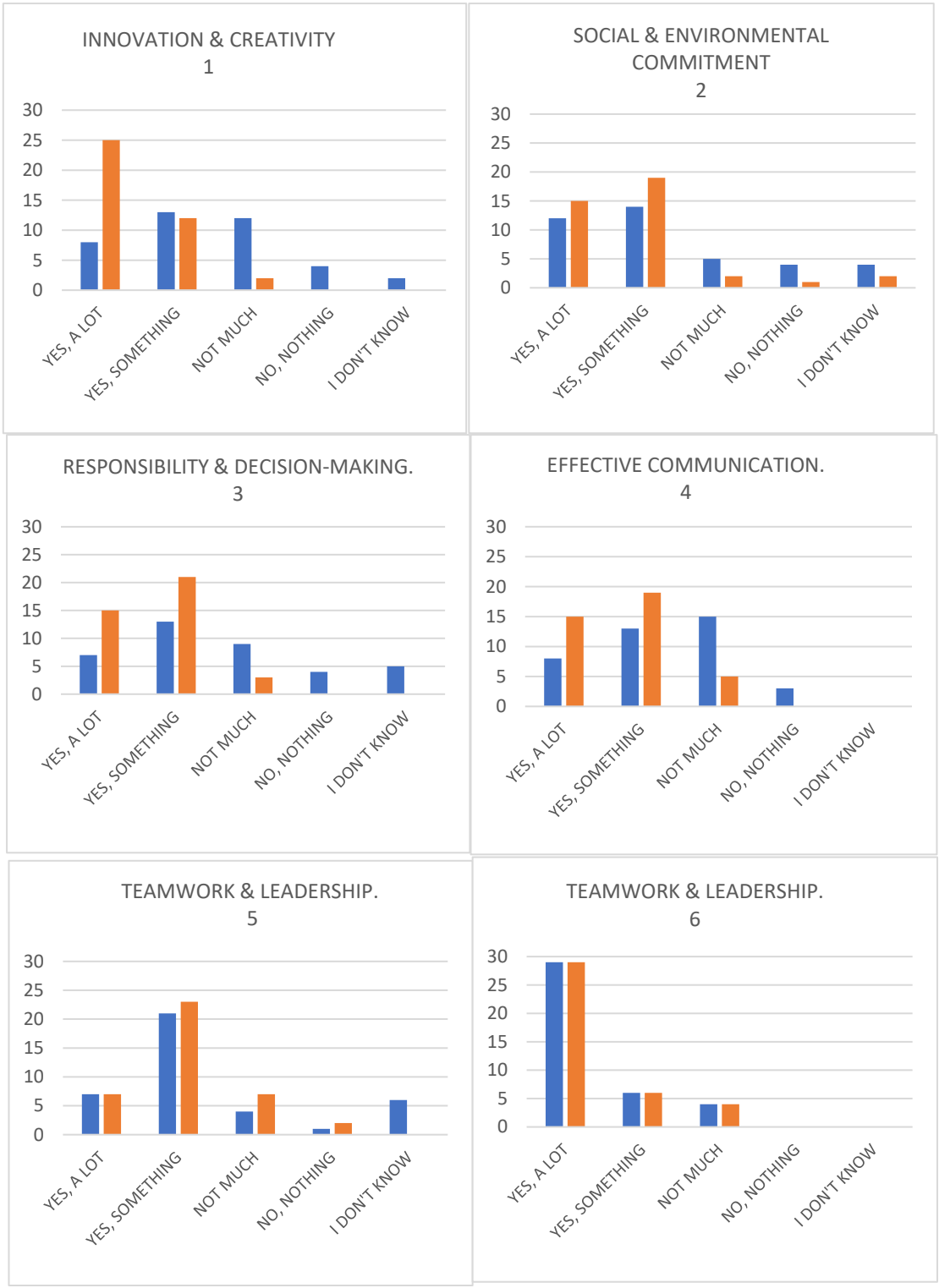


Figure 1. Improvement in Transversal Skills. Data before project marked in blue bars and data after project marked in orange. Questions:

1. During the completion of your FDP/FMP have you identified new challenges, projects or opportunities for improvement aligned with future trends and advances?
2. Does your work propose creative solutions to satisfactorily address real societal needs and problems?

3. During your FDP/FMP, do you collaborate proactively in developing work, setting goals and achieving objectives?
4. Do you act autonomously in learning, making informed decisions in different contexts, making judgments based on experimentation and analysis, and transferring knowledge to new situations?
5. Do you contribute to the search for solutions to challenges or projects, demonstrating empathy and assertiveness when sharing ideas, reflections and arguments within collaborative work?
6. During your studies, have you acquired learning skills that allow you to work both in a Team and in autonomous manner?

SDG Awareness and Knowledge Gaps

The survey results indicate a substantial enhancement in students' awareness of the SDGs following their participation in FDP/FMP projects, as Figure 2 shows. The increase in awareness of the SDGs was particularly pronounced in key areas like health (SDG 3), energy (SDG 7), and climate action (SDG 13). Students reported that although their projects were focused on nuclear engineering, they were intrinsically linked to these wider global goals (Llopis-Albert et al., 2022; Ramírez et al., 2019).

- Initially, only 51% of students reported having a high level of knowledge regarding the SDGs. However, this result increased dramatically to 92% after completing their projects, highlighting a profound improvement in their self-perceived understanding. This increase suggests that the individual project-oriented learning experience approach effectively immerses students in real-world issues, allowing them to engage with complex topics relevant to nuclear engineering such as energy, environmental impact, and safety, while inherently integrating SDG principles. Such an experience is critical for preparing a new generation of engineers who understand the importance of sustainability in their professional practices.

- In addition to general awareness of the SDGs, the study assessed how students perceived their FDP/FMP's direct contributions to meeting social demands aligned with these goals. When asked whether their projects contributed to solutions addressing social needs with reference to the SDGs, 60% of students felt their work had that alignment before starting their projects. This perception shifted dramatically, with 90% affirming their projects' contributions after completion, demonstrating a significant change in their understanding of the broader implications of their work. This shift signifies that engagement in the FDP/FMP experience actively encourages students to connect their technical competencies with global sustainability objectives.

- To evaluate the lasting significance of SDG education, participants were questioned about their desire for further knowledge and training on the SDGs even after completing their projects. The responses indicated a consistently high demand for additional SDG knowledge and training, with 90% of students expressing this need both before and after their FDP/FMP experiences. This demonstrates a strong, ongoing demand among students for more in-depth engagement with SDGs.

- By engaging in their FDP/FMP projects, students were able to apply their technical knowledge in broader contexts that addressed societal needs and contributed to developing solutions aligned with the SDGs. To explore the specific actions through which students believed their projects could contribute to advancing the SDGs, they were asked how their work might collaborate on these goals. The responses showed a consistent identification of “Applied

research with simulations" as the main strategy, followed by "Design of new equipment" and "Protocol Design". This consistency suggests a clear understanding among students of how their technical work can directly advance sustainability objectives.

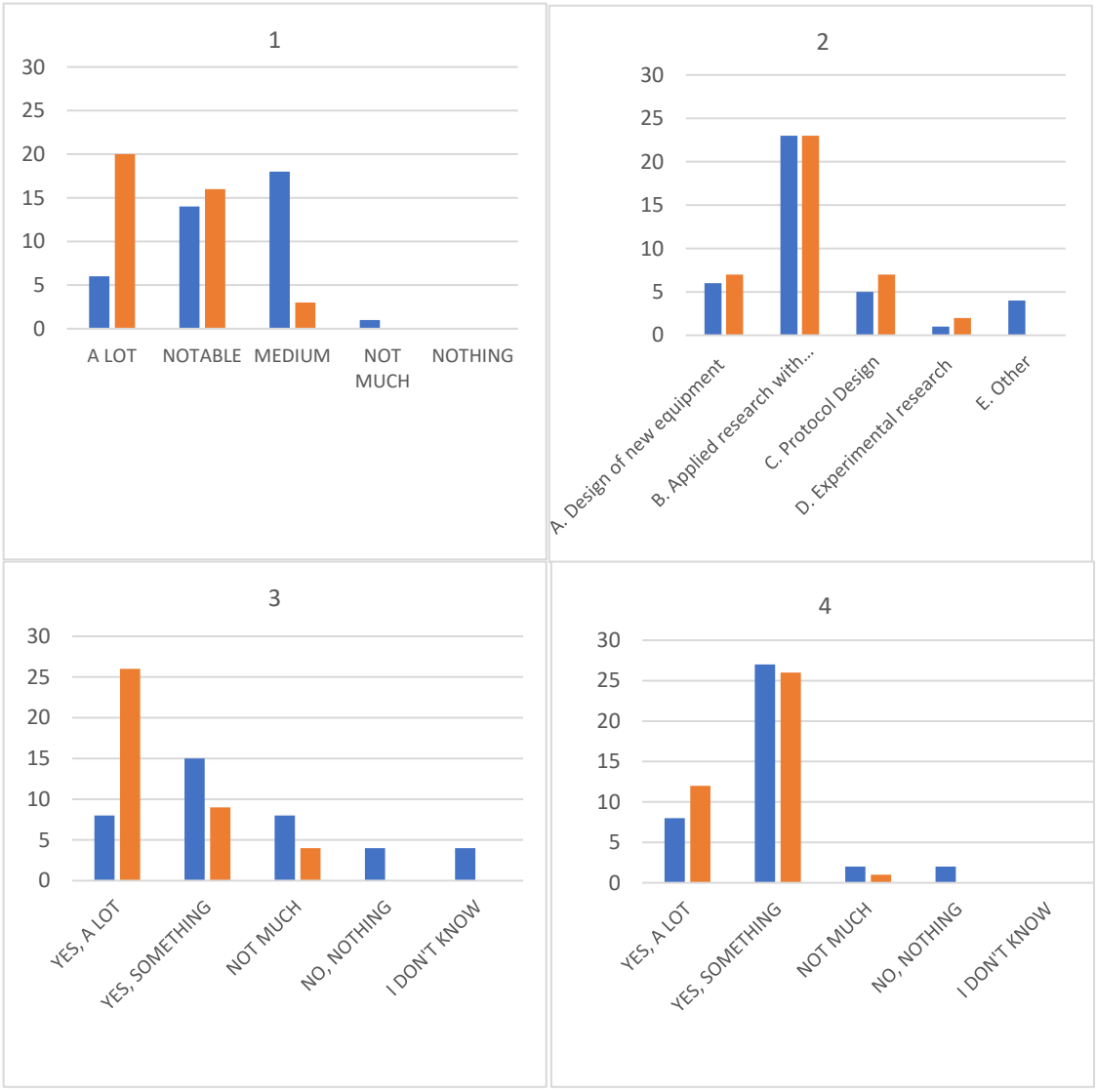


Figure 2. Improvement in SDG Knowledge. Data before project marked in blue bars and data after project marked in orange. Questions:

1. To what extent do you know the SDGs?
2. In what actions do you think your project could collaborate to advance towards the SDGs?
3. Does your FDG/FMP contribute to the design, development and execution of solutions that respond to social demands, taking into account the Sustainable Development Goals as a reference?
4. Would you consider it necessary to know more about the SDGs and receive training on them?

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Connection to Nuclear Safety and Radiological Protection

Although students demonstrated a solid foundational knowledge of nuclear safety and radiological protection before beginning their FDP/FMP, the project experience enabled them to apply this knowledge in realistic engineering and research contexts. These included activities such as radiation shielding assessments, radiation protection studies, Monte Carlo simulations, environmental radioactivity analyses, dosimetric evaluations, radioactive waste management studies, and nuclear safety assessments associated with actual engineering or research problems. The survey revealed that students' understanding of nuclear safety protocols and the regulatory frameworks surrounding the nuclear industry were integral components of their projects, as Figure 3 shows. These competencies are essential for ensuring the safe operation of nuclear facilities and mitigating environmental and public health risks, aligning with SDGs related to responsible consumption and production (SDG 12) and climate action (SDG 13).

The analysis of the surveys conducted before and after the completion of the FDP/FMP shows a notable improvement in students' knowledge and needs awareness to nuclear energy from the perspective of Nuclear Safety and Radiological Protection, as well as their understanding of the relevant scientific, technological, and mathematical methods applied in this field.

After the FDP/FMP, most students reported a deeper understanding, indicating increased comprehension and the recognition of the importance of applying this knowledge in their training. Additionally, the proportion of students recognizing the necessity of understanding and applying legislation, standards, and scientific-technological principles remained consistently high, underscoring the critical role of regulatory compliance and safety culture in their professional development,

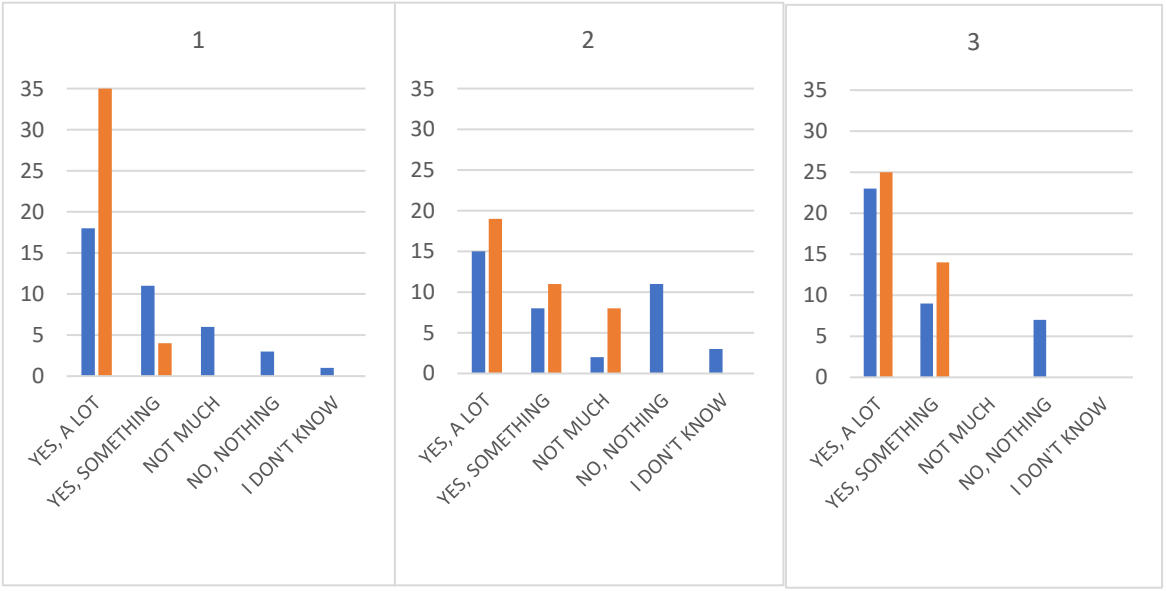


Figure 3. Improvement in Nuclear Engineering, Safety and Legislation. Data before project marked in blue bars and data after project marked in orange. Questions:

1. Does your FDP/FMP have fundamentals of nuclear energy from the point of view of Nuclear Safety and Radiological Protection?

2. Do you need to know and apply the necessary legislation in the field of Nuclear Engineering in the development of your FDP/FMP?

3. Does your FDP/FMP require knowledge of the scientific and technological aspects related to mathematical, analytical and numerical methods applied in the field of Nuclear Engineering?

Conclusions

The integration of Transversal Skills and Sustainable Development Goals within higher education, particularly in nuclear engineering, is a key challenge in contemporary university education. This study suggests that the Final Degree Project (FDP) and Final Master's Project (FMP) at the UPV are highly effective mechanisms for bridging the gap between technical expertise and broader societal relevance.

Based on the results of the surveys analyzed in this study, a significant outcome was the dramatic increase in students' SDG awareness after completing their FDP/FDM. Self-perceived knowledge of SDGs surged from 51% to 92% after project completion. Similarly, recognition of their projects' contribution to SDG-aligned social demands rose from 60% to 90%, particularly for SDGs related to health, energy, and climate action. Moreover, students consistently expressed a high and sustained demand for further SDG knowledge and training.

The FDP/FMP also proved highly effective in developing crucial Transversal Skills. "Innovation and Creativity" saw a substantial increase (from 55% to 95%), as did "Responsibility and Decision-Making" (proactive collaboration from 53% to 92%; autonomous decision-making from 54% to 87%). "Social and Environmental Commitment" also improved significantly (from 67% to 87%). While "Teamwork and Leadership" remained consistently high, reflecting prior curriculum effectiveness, the FDP/FMP provided a practical context for applying these skills. "Effective Communication" showed a modest increase (from 72% to 75%), suggesting areas for further targeted development.

In summary, this study highlights the relevance of the FDP/FMP experience for enhancing both SDG awareness and critical Transversal Skills in nuclear engineering students. This individual project-oriented learning approach not only strengthens technical skills but also cultivates a holistic understanding of professional responsibilities and sustainability principles. The findings underscore the FDP/FMP's indispensable role in preparing engineers equipped to address complex global challenges with both expertise and a strong sense of social and environmental responsibility.

The findings offer also clear directions for curriculum restructuring: capitalizing on students' high demand and increased SDG awareness, the curriculum should integrate these goals more explicitly and earlier, broadening its focus beyond core nuclear-related SDGs (7 and 13) to include others like SDG 3 (Health) and 9 (Industry), reflecting students' identified project contributions. Furthermore, continuous Transversal Skill development must be prioritized, actively cultivating and assessing key skills such as “Innovation”, “Social Commitment” and “Responsibility” from foundational courses, while implementing targeted interventions and structured feedback for “Effective Communication” throughout the curriculum to address its more modest gains. This can be accomplished by using project-based learning throughout the program, building on the successful track record of the FDP/FMP in promoting well-rounded skill development. By embracing this method, nuclear engineering programs can ensure that graduates not only have solid technical skills but also a deep understanding of sustainability, innovation, and social responsibility. This approach helps meet academic standards and prepares students for the demands of their future careers.

Several limitations should be acknowledged. First, the study relies primarily on self-reported perceptions collected through questionnaires, which may be influenced by individual subjective interpretations. Second, no qualitative evidence was collected to explore how students experience competency development throughout the project process. Future studies should incorporate semi-structured interviews, focus groups, and reflective learning journals to obtain a deeper understanding of how sustainability awareness and Transversal Skills evolve during FDP and FMP activities.

Ethics Statement

This study involved the collection of anonymized, self-reported data from university students through a voluntary questionnaire administered as part of their Final Degree Project and Final Master’s Project academic activities. The study protocol was reviewed and approved by the Research Ethics Committee of the Universitat Politècnica de València. All participants were informed about the purpose of the study, participation was voluntary, and no personally identifiable data were collected.

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Conflict of Interest Statement

The authors have no relevant financial or non-financial interests to disclose.

Data Availability Statement

The data presented in this study is available from the corresponding author upon reasonable request. The data is not published due to ethical and privacy considerations.

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