

Article

SDG-Driven Entrepreneurship Through Technology Solutions in Higher Education Enhanced by Problem-Based Learning: An Active Learning Approach in a Smart Classroom Environment

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Abstract

This article describes a problem-based learning (PBL) intervention enhanced by a smart classroom environment, which supported online interactions and class activities. The academic experience was centered on the United Nations Sustainable Development Goals (SDGs). Multidisciplinary teams of first-year students worked with private companies on briefs explicitly mapped to the SDGs, where instruction combined coaching sessions, peer feedback, and short videos that scaffolded problem analysis, value proposition design, business-model development, and Minimum Viable Product (MVP) prototyping. Once the student teams completed the activity, a qualitative survey using the Bipolar Laddering (BLA) tool was administered to analyze the suitability of the PBL methodology for the activity. BLA elicits respondent-generated positive and negative poles and associated justifications through open questions; unlike structured questionnaires, it does not condition answers and foregrounds the students' own categories of meaning. Findings are reported as observed patterns across teams and briefs rather than as claims of impact. The analysis attends to the role of technological scaffolds for first-year university students. The contribution of this research is twofold: (1) providing a replicable course design that situates sustainability and the SDGs in a real-world context, positioning early-stage undergraduates to practice design thinking and entrepreneurial action within an active learning approach; and (2) preserving students' voices through the BLA tool in an activity that links PBL implementation to SDG-oriented outcomes.



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Keywords: active learning; problem-based learning; SDGs; smart classroom; technological solution

1. Introduction

The United Nations (UN) Sustainable Development Goals (SDGs) saw the light and were defined in the 2030 Agenda for Sustainable Development, which was adopted at the United Nations Sustainable Development Summit on 25 September 2015 [1]. The 2030 Agenda is focused on sustainable development through 17 SDGs and 169 targets, balancing three dimensions—i.e., economic, social, and environmental—using a multifaceted approach [2]. It can be highlighted that technology is mentioned in the document as a

potentially useful instrument to achieve and leverage different SDGs [2], an approach that is consistent with findings identified in diverse research works [3–5]. As the SDGs are usually addressed in capstone or senior projects, there is limited understanding of how first-year university students engage with sustainability trade-offs when working under real-world corporate constraints. To promote solving real-world problems formulated by companies that match diverse SDGs, this work presents an initiative based on the use of an active learning tool, problem-based learning (PBL), in the context of higher education. To do that, first-year university students who were enrolled in diverse degrees related to technology were mixed and joined in multidisciplinary teams. Once they were taught basic entrepreneurship topics and a method to work, they produced a solution to one specific problem proposed by diverse companies or Non-Governmental Organizations (NGOs), which was then crystallized in a Minimum Viable Product (MVP). Finally, each team presented their solution to an audience that included both their classmates and a three-member evaluation panel (a representative of the organization that raised the problem, an instructor of the Institution that was not explicitly involved in the activity, and the students' mentor) to assess the students' work. It should be noted that this research focused solely on problems identified by private companies, as their briefs clearly aligned with market-oriented solutions. The activity also received proposals from NGOs that fell outside of the scope of this study, because most of them did not lead to business-oriented solutions.

The aims of this research work were twofold: (1) summarize and examine the first-year students' technical solutions to the different SDGs-related problems proposed by diverse private companies; and (2) collect and analyze the students' perceptions about problem-based learning (PBL) once they completed the whole activity.

2. Background and Context of the Educational Experience

To contextualize this study, the following sub-sections outline key SDG-related topics that underpin the suitability of PBL for this study and illustrate its relevance to the learning experience explored in this research.

2.1. Sustainable Development Goals (SDGs)

The United Nations General Assembly (2015) agreed on a list of 17 SDGs, crystallized in 'The 2030 Agenda for Sustainable Development' [2]. The Resolution A/RES/70/1, adopted by the UN General Assembly on 25 September 2015, includes a literal and detailed explanation of each of these 17 goals (see [2]). Since 2015, the UN has published diverse reports on the SDGs to provide a global overview about their progress over time, evaluating diverse SDGs differently, as being "on track or making moderate progress on 35 per cent of the 137 Sustainable Development Goal targets [. . .], 47 per cent of the targets is insufficient, and [a] regression from the 2015 baseline in relation to 18 per cent" [6].

Technology, which includes ICTs (Information and Communication Technologies), may become a critical element in achieving the SDGs, as stated in 'The 2030 Agenda' [2], a point that has also been affirmed in various academic contributions by scholars [7–12]. As stated by Ref [9], diverse digital technologies (such as Artificial Intelligence, Internet of Things, Blockchain, Cloud computing or Big data analytics) have played a key and critical role in achieving different SDGs, as pointed out in different research articles included in their review contribution. Ref [12] highlighted the effect of digital technologies on the success of the SDGs, adding a third variable to the binomial: different businesses and processes. On the other hand, Ref [4] identified in their article a triad of interconnected elements: the SDGs, digitalization and entrepreneurship. Regarding entrepreneurship, problem-based learning (PBL) constitutes a methodology widely deployed [13]. In fact,

interactions between the SDGs, PBL and entrepreneurship have been studied in diverse research works [14].

2.2. Problem-Based Learning (PBL)

Active learning emphasizes student engagement in the learning process [15], offering benefits such as improved participation, communication, and interactivity [16]. This article adopts the following definition: “active learning is a classroom situation in which the instructor and instructional activities explicitly afford students agency for their learning” [17] (p. 15). However, some students were found to be reluctant to engage with active learning instruction [18,19]. Active learning approaches have proven effective for sustainability education as hands-on, constructivist methodologies that help students engage with complex sustainability challenges, developing critical thinking abilities and real-world problem-solving skills [20]. These experiential methods build sustainability-oriented capabilities—knowing, doing, interacting, and being—through authentic engagement that enhances participation in sustainability programs [21].

A wide range of instructional strategies fall under the umbrella of active learning, such as problem-based learning (PBL), project-based learning, case-based learning, flipped classrooms, jigsaws, team-based learning, discussions, simulations, cooperative learning, games, clickers, role playing, inquiry-based learning, Q&A, and debates [15]. PBL is an active learning methodology that can be defined as “a method of learning that prompts students to learn concepts and skills through the solution of complex, real-world problems rather than from the presentation of theories, concepts, and facts by a teacher” [22] (p. 2). As summarized in Ref [23], PBL is characterized by: “starting [...] with a problem to activate students’ prior knowledge and interest [...]; student-centered, active learning; small group collaboration [...]; teacher guidance; and self-directed learning”. PBL is associated with increasingly diverse participants’ benefits, such as a positive effect on learning outcomes [24,25], entrepreneurial learning [26], teamwork [27], problem solving [28,29], scientific writing skills [29], engagement [30–32], or generic competences [27]. Specifically, critical thinking skills emerged prominently among diverse contributions, as they are strongly developed through PBL activities [33–35].

Since PBL is focused on solving problems, it has been successfully implemented in diverse educational contexts, such as medical, engineering, economics, and architecture [13,36]. Similarly, PBL is extensively used in frameworks centered on real and complex problems, such as entrepreneurship [13,37,38] and sustainable development [39–41], often enhanced by the use of technology as an instrumental tool in teaching [14].

2.3. The Context of the Educational Experience

In the first year of their degree program, undergraduate students, enrolled in diverse technological degrees, carried out a learning practice that applied a PBL methodology to address real and specific problems linked to the SDGs proposed by external organizations. The class activities were designed to: (1) develop the ability to define the basic concepts of social entrepreneurship; (2) embrace the social and ethical responsibilities of the profession; (3) apply appropriate methodologies and practices to promote creativity and innovation; and (4) strengthen the ability to foster an inclusive culture and support corporate social responsibility.

The educational experience was supported by a smart classroom infrastructure that provided the technological foundation for implementing the PBL approach. This environment included a Moodle-based Learning Management System (LMS) and smart classroom technology. As explained in detail in [42], all the classrooms were equipped with: (1) a sound system comprised of speakers and microphones; (2) an image system (which in-

cluded a robotized camera to follow the speaker in the classroom, a second camera to capture a full view of the classroom, and two TV sets to show all the off-campus participants); (3) a smart board; and (4) software to connect all the class hardware with on- or off-campus personal devices.

The academic activities were delivered in seven two-hour class sessions (CSs) structured as follows: (CS1) an introduction to the logic behind the SDGs; (CS2) a presentation of the company proposals and explanation of the steps to follow throughout the program; (CS3) ideation, competitive benchmarking and value propositions; (CS4) Business Model Canvas (BMC) and customer discovery; (CS5) a first prototyping stage (interview conclusions, BMC validation, and MVP); (CS6) a second prototyping stage (final MVP, video script and pitch preparation); and (CS7) a student evaluation session conducted by a panel using a rubric (see Figure A1 in Appendix A). Furthermore, Table A1 provides a detailed session-by-session breakdown of the program's instructional design. Each of the seven sessions was structured with specific activities and their durations in minutes.

The students were organized into 71 multidisciplinary teams of six or seven members each. The initial design was to ensure that each team included students enrolled in different academic degrees. However, because some students withdrew from the subject at the last minute or abandoned the program altogether, the above criterion was not satisfied everywhere, resulting in 70.4% of teams composed of at least four different degrees. Once assigned to a class group, each team selected a problem to solve from a set of three to five available options. The activity followed the logic of PBL, given the benefits associated with its implementation discussed in Section 2.2. Two peer-to-peer assessments were conducted in class sessions CS5 and CS7, as this practice has been shown to positively impact students' competencies and skills [43,44]. Class session 7, the last program unit, served as the evaluation phase. During this session, each team was assessed by a three-member panel consisting of the team's mentor and one or two other evaluators. One student team with the highest evaluation in each class group was chosen to participate in the Final Event (in total, twelve student teams who worked on solutions for the private companies' proposals), where four expert evaluators, in combination with company representatives, chose two overall winners of the contest.

While the specific technologies are not the focus of this study, we describe them briefly to provide context for how the pedagogical activities were practically implemented. Various tasks and activities benefited from the specific advantages of the smart system, as detailed below: (1) in all the sessions, a video explaining synthetically all the tasks to perform, was shown asynchronously in all the classrooms; (2) In CS2, company managers were able to present their proposals virtually from their headquarters through an interactive Zoom session, instead of physical presence in the classroom. In fact, one manager presented live through a unique Zoom presentation to two different classrooms; (3) from CS3 to CS6, students shared their solutions with their classmates and the instructor on the smart board from their own personal computers; and (4) in CS7, teams also presented their final solutions to the panel in the form of a PowerPoint presentation plus a video through the smart board from their computer. As for the LMS, students could: (1) review all the video presentations broadcast at the beginning of the class session; and (2) download their tasks at any moment before the scheduled deadline.

3. Materials and Methods

This section includes details of the participants in the experience, as well as the process of collecting and processing the data.

3.1. Participants

All the participants in this research study were first-year university students enrolled in different technology-related degree programs (ICT Engineering, Health Engineering, Artificial Intelligence, Digital Arts & Animation, Management & Technology, Digital Business & Design and Innovation, Business Intelligence & Data Analytics, and Architecture) during the 2024–2025 academic year at La Salle, Ramon Llull University (La Salle-URL). A total of 778 students took part in the academic activity, including 478 males (61.44%) and 300 females (38.56%).

Data on the problems proposed by the organizations (excluding NGO proposals) and on the students' corresponding solutions are detailed as follows: (1) external private companies formulated specific problem definitions, with six firms identifying a total of 24 problems; (2) Students uploaded their proposed solutions, including an MVP, to the Institution's Learning Management System (LMS). A total of 449 students participated in solving the problems suggested by the private companies, including 260 males (57.91%), with an average age of 19.61 years old ($SD = 1.167$), and 189 females (42.09%), with an average age of 18.99 years old ($SD = 1.290$). All data was included in an Excel file for analysis of the solutions proposed by the students.

Once all the class sessions had finished, a BLA tool survey to analyze the PBL methodology was carried out using Microsoft Forms (Microsoft 365 web service), and later, all survey data were compiled in an Excel file for analysis. The number of students who completed the BLA survey was 87 (three surveys were invalid), resulting in a valid sample of 84 responses. In terms of gender, 59 respondents were male (70.24%), with an average age of 19.71 years old ($SD = 1.527$), and 25 were female (29.76%), with an average age of 19.20 years old ($SD = 0.88$).

3.2. Proposals (Problems & SDGs) and Solutions (Value Propositions & MVPs)

The problems proposed by private companies were first mapped to the corresponding SDGs. To analyze and classify these problems into clusters, all briefs were compiled in a Microsoft Excel (Microsoft 365 subscription) file.

Once the student teams completed their work, their solutions (including value propositions and all prototypes developed as MVPs) were also entered into a Microsoft Excel file. Each researcher analyzed the data independently, and the final clustering decisions were agreed upon by three researchers. This process constitutes researcher triangulation, aimed at minimizing potential biases and enhancing the validity of the findings [45,46].

3.3. The Bipolar Laddering Tool

The Bipolar Laddering (BLA) tool enables the collection of users' perceptions of their experiences once the entire process has been completed [47]. In this research, the BLA tool was employed to collect students' feedback on the PBL activity after they had finalized their proposed solution. The BLA tool has been applied in a variety of contexts [48–50], including educational settings [51–53]. This survey method is designed to capture users' experience while minimizing potential biases that may arise from the questions themselves. It does so by prompting respondents, in an open-ended format, to identify the positive and negative elements they perceived, along with other considerations related to those elements (such as why they were viewed as positive or negative, numerical assessments of the experience, and suggestions for improvement) [47].

4. Findings

This section presents the findings derived from analyzing the companies' proposals and the various MVP solutions suggested by the students. It also includes students'

perceptions of the problem-based learning (PBL) method after completing the activity in order to evaluate the learning process.

Table A2 displays all the problems formulated by the private firms that participated in the activity, each mapped to the corresponding SDGs. In terms of frequency, as shown in Figure 1, SDGs 9 and 12 were associated with 12 problems, while SDGs 8 and 13 were mentioned by the companies in 10 and 9 problems, respectively. In the second tier, SDGs 4 and 10 appeared with 6 and 5 citations, respectively. In the third tier, SDGs 11 and 17 were mentioned 3 times; SDGs 3 and 7 were both cited in 2 problems; and SDGs 5, 6, 14, 15 and 16 were mentioned just once. And finally, the fourth tier, which includes SDGs 1 and 2, was not cited in any problem statement.

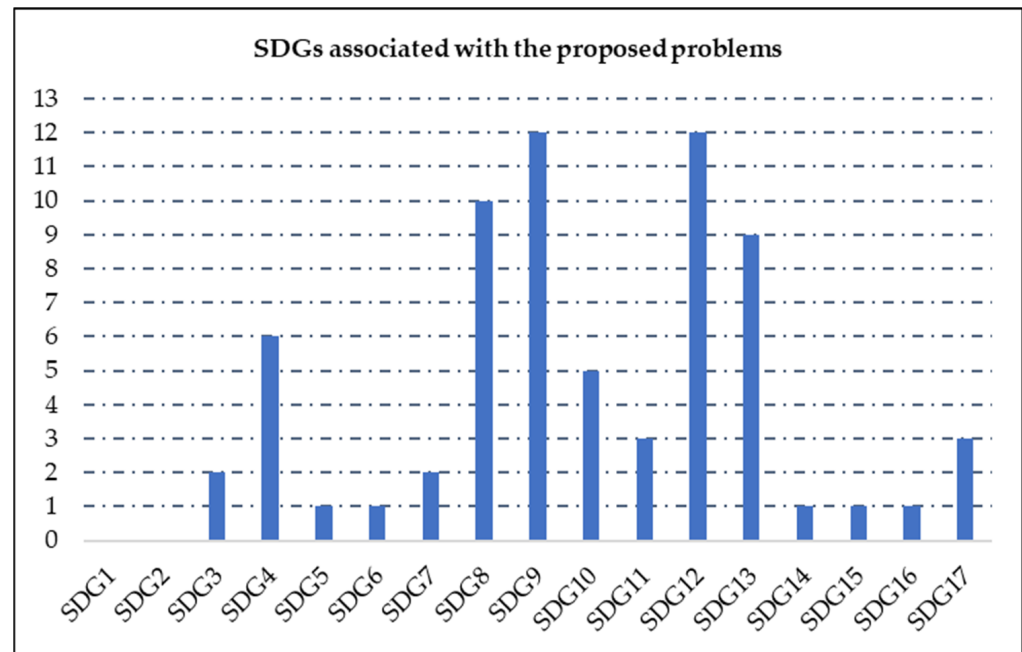


Figure 1. The frequency of the SDGs mentioned by private companies. See a detailed description of the diverse SDGs associated with each problem in Table A2.

Table 1 displays a summary of all the value propositions (VPs) displayed in Table A3 (see Appendix A), reflecting the ‘type of solution’ that each team implemented, according to a taxonomy, as follows: software (SW), hardware (HW), product, service, event, and program. The following is a synthetic explanation of these labels. A ‘service’ has been defined as a specialized activity that creates value by applying expertise to specific needs, transforms capabilities or facilitates experiences while promoting sustainability, social impact or environmental responsibility. A ‘product’ represents a tangible good or physical system designed to meet specific needs while minimizing environmental impact through sustainable materials, circular economy principles or eco-friendly functionality. An ‘event’ is typically a structured, time-bound gathering for the purpose of networking, knowledge sharing, collaboration or hands-on experiences around specific themes, such as innovation, entrepreneurship or technology. Finally, a ‘program’ can be defined as a structured initiative with defined standards and processes aimed at achieving systematic change towards specific goals, such as sustainability, innovation or behavioral transformation.

Table 2 includes a summary of the information given in Table A3, which shows how the proposed student solutions align with the SDGs. The alignment can be High, Medium-High, Medium-Low or Low.

Table 1. The number of teams that chose the same type of solution.

Number of Teams	Type of Solution
48	Software
9	Software & Service
4	Service
3	Product
2	Event
2	Hardware
2	Software & Hardware
1	Program
71	TOTAL

Type of solution: a taxonomy of the different solutions proposed by the participants.

Table 2. SDG alignment.

SDG Alignment	Number of Occurrences
High	32
Medium-High	25
Medium-Low	14
Low	0
TOTAL	71

Table 3 below presents the positive elements recognized by the students after completing their experience through the BLA tool, generating sets of common and unique elements from participant feedback. As detailed in [51,52], each one of the identified items were categorized as follows: (1) PcE_X (X being a number) is associated with positive (P), common (c), element (E), identified by two or more students as a positive element, and (2) PuE_X is an item identified as a positive element by a single student (the letter u stands for ‘unique’). The average score represents the mean rating given by surveyed students for each item, indicating the degree of satisfaction with that item. The calculated variances measure the heterogeneity of responses for each item, revealing how much opinions diverged among students. Finally, the number of mentions captures the total number of respondents who identified each element (in this study, the maximum number of mentions associated with each element is 84, which is the number of valid responses of students who answered the survey). As a last step, three researchers independently analyzed all responses before collaboratively agreeing on the categorizations using a triangulation process to enhance validity and ensure consistency in the findings. Following an initial survey distribution that yielded 84 valid responses, analysis of the PBL activity feedback revealed a notably low frequency of unique elements and a substantial number of common elements, characterized by a high number of mentions. This pattern suggests that code saturation was achieved within the respondent sample, thereby reinforcing the quality of the findings [54]. It should be noted that the findings derived from this qualitative research constitute an exploratory and illustrative study on the perceptions of the surveyed students, rather than a fully representative compilation of the entire student cohort. Furthermore, there is a gender imbalance when comparing the proportion of respondents versus the entire participant cohort, which could influence the ranking of the identified elements. However, these two observations do not alter the validity of the BLA findings, which are related to the identification and evaluation of positive and negative elements of the PBL experience.

Table 3. Student perceptions of positive elements that enhance their learning.

Item	Positive Elements: Theme (<i>Description</i>)	Average	Variance	Mentions
PcE_01	Interdisciplinary Collaboration & Diversity of Perspectives (<i>Working with students from other programs and benefiting from their diverse perspectives and problem-solving approaches</i>).	8.26	1.22	46
PcE_02	Acquiring New Knowledge & Learning New Skills (<i>Gaining competencies beyond one's main degree, such as business, marketing, design thinking, or extra technical skills, plus soft skills like leadership and presenting</i>).	7.71	1.13	35
PcE_03	Teamwork (<i>Developing collaboration skills: clear communication, coordination, fair task distribution, and working effectively toward shared goals</i>).	8.00	1.44	28
PcE_04	Engagement & Class Quality (<i>Participating in dynamic, interactive, well-structured sessions with motivated instructors who act as guides or mentors</i>).	7.80	1.36	20
PcE_05	Real-World Problems (<i>Solving real problems for actual companies or organizations, rather than only hypothetical cases</i>).	8.07	1.28	15
PcE_06	Career & Future Preparation (<i>Building professional skills and experiences useful for future employment, including project management and understanding workplace dynamics</i>).	8.07	1.38	14
PcE_07	Sustainability & SDG Awareness (<i>Deepening understanding of global challenges (e.g., SDGs) and strengthening social and environmental responsibility</i>).	9.10	1.29	10
PcE_08	Creativity & Innovation (<i>Having space to generate original ideas, think beyond conventional solutions, and innovate without rigid constraints</i>).	7.40	1.43	10
PcE_09	Company & Business Engagement (<i>Learning how companies operate in practice, how they identify problems and design solutions</i>).	7.30	1.16	10
PcE_10	Student Autonomy & Independence (<i>Enjoying autonomy in how to tackle problems, make project decisions, and build independent problem-solving abilities</i>).	8.88	1.13	8
PcE_11	Manageable Workload (<i>Having a manageable workload that fits largely into class time and does not heavily conflict with other courses</i>).	7.86	1.07	7
PcE_12	Incentives & Rewards (<i>Being motivated by elements like prizes, competitions, recognition, or trips</i>).	8.50	0.71	2
PuE_01	Peer Evaluation (<i>Being able to assess teammates' contributions, promoting accountability and fairer grading within teams</i>).	7.00	-	1

Elements (E) are identified as positive (P), common (c), or unique (u). Positive elements are sorted by the number of mentions. In bold are the items with 10 or more mentions.

Examining key representative quotes linked to the positive elements shown in Table 3, it can be highlighted that participants found that working with colleagues from diverse backgrounds (PcE_01) offered multiple benefits (e.g., “widens the perspective of the person to be able to think outside what is needed in their course”; it helps students recognize that “each one has a knowledge in different aspects that makes us all find a better solution together”; and “forces you to adapt and bring out the best of each person in the group”). Students also highlighted that PBL enabled them to “work within a group” and gain experience “practicing leadership skills” by “having to delegate tasks and manage a team”, while also “exercising public speaking” through presentations. Many valued acquiring

practical business competencies, such as “how to develop an idea and turn it into a business proposal”, which they regarded as especially relevant because “I am interested in having my own company in the future”. In addition, PBL also helped students to “think sustainably and responsibly”, as one student stated, “we need to protect the environment in order to have a future”. Working on the SDGs (PcE_07) not only broadened students’ knowledge across different domains, but also prompted reflection on fundamental rights; in the words of a student “we should all have the right and easy access to learning” and the “right to minimum living standards”, while also increasing their sensitivity to the SDGs, as one student noted, “challenges from our environment, problems that can engage us”.

Regarding the negative elements, Table 4 summarizes all the participants’ answers. The negative element labelling scheme aligns with the way positive elements have been captured in Table 3, just changing the letter P to a letter N.

Table 4. Student perceptions of negative elements that hinder their learning.

Item	Negative Elements: Theme (<i>Description</i>)	Average	Variance	Mentions
NcE_01	Team Dynamics/Non-working Members (<i>Issues with team members not working, unbalanced effort, people not participating, attendance issues</i>).	2.58	1.53	26
NcE_02	Workload/Time Pressure (<i>Too much work, not enough time, homework outside class, tight deadlines, overlapping with other subjects</i>).	3.11	1.60	18
NcE_03	Team Composition/Selection (<i>Cannot choose teams, unbalanced team sizes, random assignment issues</i>).	3.47	1.59	17
NcE_04	Unclear Instructions/Objectives (<i>Confusing objectives, unclear expectations, poor explanations, lack of feedback, unclear grading criteria</i>).	2.73	1.16	15
NcE_05	Schedule/Timing (<i>Problems with class timing, schedule, duration, inconvenient time slot, 2 h classes, after lunch</i>).	2.92	1.32	13
NcE_06	Problem Issues (<i>Cannot choose challenges, problems too ambitious/complex, not interesting, unrealistic topics, not relevant</i>).	2.50	1.69	8
NcE_07	Grading/Evaluation (<i>Unclear grading, unfair evaluation, peer evaluation issues, inconsistent criteria between classes</i>).	2.83	1.60	6
NcE_08	Autonomy/Flexibility (<i>Lack of freedom in approach, rigid templates, predetermined problems, cannot choose format or topic</i>).	4.00	1.41	2
NcE_09	Company Interaction During the Activity (<i>Lack of feedback from companies, insufficient engagement with external partners</i>).	4.50	0.71	2
NuE_01	Language Difficulties.	5.00	-	1

Elements (E) are identified as negative (N), common (c), or unique (u). The negative elements are sorted by the number of mentions. In bold are the items with 10 or more mentions.

Table 4 shows that team-based activities often expose challenges in team dynamics, workload distribution and cross-disciplinary collaboration. Motivation emerged as a concern as “not everyone has the same enthusiasm to work”, and because participation was mandatory, some students reported that “some people didn’t work and created issues in the program and in the group”, leaving “only one or two to do all the work”. Workload management added further strain as students “struggle to balance activity demands with

other subjects”, and experienced uneven peaks in effort across weeks (e.g., “sometimes there was more work in one week and less in another”). Interdisciplinary teams faced additional challenges when “they don’t make things easy, it is difficult to contact team members from other degrees”, compounding coordination issues when motivation within the team was already uneven.

An analysis of the improvement proposals gathered through the BLA tool—which invites students to suggest enhancements to both positive and negative aspects of their learning experience—revealed several strengths in the SDG program that contributed to meaningful learning experiences. Among the most frequently mentioned strengths were the interdisciplinary nature of the course, the value of practical application (one student noted “being able to apply it in the future”), and the real-world relevance of collaborating with actual companies and addressing authentic sustainability problems (another student suggested that “it could be even more engaging to bring people from the company over to the university or take students there”). As for the challenges that hindered the effectiveness of the SDG course, the most frequently cited concern involved team composition and balance, with some students reporting that their teams lacked diversity across degree programs. As one student explained, “there were teams where there was not much variety of members, that is, many students studied careers from the same field”, while another suggested “that all teams should have students from different degrees”. Workload and time management emerged as critical pain points, with the issue of unequal participation in some teams proving especially frustrating. One respondent advocated for “challenges where everyone in the team must work obligatorily”, while another observed that “some students were working whereas others not as hard”. Additional concerns included requests for clearer instructions about assignment expectations, better scheduling of class sessions, increased autonomy in selecting team members, and more substantive feedback from instructors throughout the course.

5. Discussion

As shown in Figure 1, the private companies’ briefs were specially focused on SDG 9 (Industry, Innovation and Infrastructure) and SDG 12 (Responsible Consumption and Production), as well as on SDG 8 (Decent Work and Economic Growth) and SDG 13 (Climate Action). In fact, the set of problems to address included 15 SDGs; only SDG1 (No Poverty) and SDG2 (Zero Hunger) did not appear. Notably, only four out of 24 problems were associated with a single SDG (P-01_Co1, P-05_Co1, P-09_Co3 and P-12_Co3), while 16 problems were linked to three or more SDGs. This shows that companies were able to connect most proposed problems with multiple sustainability dimensions. Moreover, the fact that companies identified relevant SDGs, while articulating their business problems, indicates that participant organizations have genuine awareness and sensitivity to the sustainable development topics outlined in the 2030 Agenda. It suggests the companies approached the business challenges not merely through the lens of economic and financial rationality, but with broader consideration for sustainability imperatives. Hence, it illustrates the possibility of university–industry partnerships in tackling sustainability imperatives and indicates a growing corporate commitment to the 2030 Agenda.

Regarding the solutions proposed by the first-year students, it is important to acknowledge that all participants undertook this activity during their second semester after entering university. Consequently, the intended learning outcome in terms of an MVP was to introduce them to how to solve real problems posed by real companies using a specific method. Hence, developing a commercially viable final product was not the objective, as students had not yet acquired the necessary skills. To achieve the desired learning outcomes, students received training in basic business concepts and entrepreneurial tools to be

applied within a PBL framework, which has proven to be a feasible approach in previous research [39–41]. It should be noted that, after a brief introduction to the SDGs, students were given freedom to design an MVP. Table 1 summarizes their solutions according to a proposed classification, revealing that the vast majority were software-based (59 out of 71). Two solutions proposed hardware devices, meaning that a total of 61 solutions were implemented through ICTs. The level of alignment of individual solutions to the SDGs is displayed in Table A3 and summarized in Table 2. It is worth mentioning that all the participants were enrolled in technology-related degree programs, which may have influenced the nature of the proposed solutions. Overall, these findings are in line with the leverage potential of ICTs to advance the SDGs, as stated in the 2030 Agenda [2] and supported by various academic contributions [7–12].

This study also evaluates the adequacy of PBL for addressing corporate problems and providing solutions to SDGs challenges. Upon completing their experience, students were surveyed to collect their perspectives on PBL through a BLA survey, which is a suitable tool to capture user experience, as done in other research studies [51–53]. Among the positive elements displayed in Table 3, PcE_01 (Interdisciplinary Collaboration & Diversity of Perspectives) emerged as the most frequently cited topic, mentioned by 46 students. Closely related, PcE_03 (Teamwork) was cited by 28 students. These findings indicate that participants highly valued collaboration with peers as a key outcome of the PBL approach (in line with other studies, e.g., [27]), particularly when such interactions involved students from diverse disciplinary backgrounds. The second most cited positive common element by the participants (35 students) was PcE_02 (Acquiring New Knowledge & Learning New Skills), again a theme already identified in previous studies [19,20]. Engagement was identified as an attribute derived from the use of PBL (PcE_04 and PcE_09), aligning with previous findings [30–32]. It should also be highlighted that respondents found PBL a useful tool to work with ‘Real-World Problems’ (PcE_05) and ‘Sustainability & SDG Awareness’ (PcE_07), which is consistent with other academic contributions [39–41]. Regarding PcE_07, some students highly valued the approach that integrated sustainable and responsible thinking into real-world problem-solving with a strong awareness of environmental protection.

The activity design included two peer-to-peer assessments to enhance teamwork and individual engagement. Even so, the most mentioned common negative element, NcE_01, shown in Table 4 and cited by 26 students, was related to team dynamics and relationships, especially uneven involvement and the free-rider conduct of some team members. Therefore, next editions of the program should consider changing or adding other mechanisms to avoid or minimize this behavior (e.g., including more peer-to-peer assessments instead of just two, or increasing the weight of peer-to-peer assessments in the students’ final grades). Furthermore, 18 students complained about the workload (NcE_02), even though seven students explicitly highlighted that the activity was well balanced in terms of workload (PcE_11). Hence, further adjustments should be considered to improve this issue in future editions of the program. On the other hand, despite being mentioned by only two participants, a greater interaction with companies during the activity (NcE_09) could result in transforming a negative element into a strength, in addition to mitigating other negative elements, such as NcE_04 and NcE_06. The robustness of all findings presented in Tables 3 and 4 confirms that the BLA answers attained code saturation within the respondent sample, given the high number of mentions for common elements and few unique responses.

It can be also mentioned that smart classroom environment and the LMS underpinned the course implementation, as they facilitated companies’ virtual participation (through synchronous class presentations) and, at the same time, supported the student learning pro-

cess and information sharing throughout the program (reviewing class presentations and additional content in the LMS; uploading student submissions to the LMS; and delivering PowerPoint presentations using the smart board).

Overall, the initiative can be considered successful in terms of: (1) familiarizing students with the SDGs; (2) providing them with basic training in business model implementation to address real-world problems; (3) offering an initial introduction to entrepreneurship; (4) training students in the use of the technological solutions provided by the smart classroom system; and (5) applying PBL, an active learning methodology with proven effectiveness in supporting knowledge acquisition while addressing real problems [22], as well as generating a range of additional positive effects (e.g., interdisciplinary collaboration, teamwork, and soft skills). In future editions, a greater involvement of partner companies during the activity (for example, halfway through the activity, once the first proposed solution has been suggested by the students) could mitigate some of the negative feedback received from students (such as NcE_04, NcE_06, and NcE_09).

Several limitations of this research work are listed below. Firstly, the solutions provided by student teams are not functional prototypes, but rather, they represent user-validated MVP proposals. Addressing this kind of activity with last-year university students, most likely, would have resulted in real and operative MVP designs, which could add more value to the private companies that identified real business problems. Secondly, the activity involved students of different higher educational degrees, all being somehow technologically oriented. Therefore, future research could explore similar implementations in non-technical university programs. Thirdly, given the above two limitations, further research into the suitability of the PBL methodology could be undertaken to contrast the present findings. Due to the anonymous nature of the survey design, individual responses cannot be linked to specific teams. Hence, the analysis treats individual student responses as independent observations, despite students working in teams. Future research should consider collecting team identifiers to account for the nested data structure. Finally, NGO briefs and solution proposals were considered out of scope for this study. Future research could examine their adequacy and feasibility beyond financial and economic parameters.

6. Conclusions

This study presents and analyzes a set of solutions given by first-year university student teams enrolled in different technology-related programs to problems associated with SDGs raised by private companies. It is important to highlight that private companies were explicitly asked to associate their briefs with SDGs, which gave students the opportunity to work on solutions to real-world problems linked to the 2030 Agenda for Sustainable Development [1]. Once students were familiar with the SDGs, they were also acquainted with basic entrepreneurial tools (which included ideation, competitive benchmarking, value proposition, BMC, and prototyping), to be able to design solutions that later crystallized in MVPs. Most of the proposed answers were based on ICTs, predominantly software-oriented solutions. On the other hand, the BLA survey findings reveal that students gained significant value from the experience of PBL, building new knowledge and soft skills through active learning. The interdisciplinary aspect of the activity proved especially beneficial, indicating that future iterations should purposefully incorporate cross-disciplinary collaboration.

Based on the findings of this research, future practitioners seeking to advance SDG 4 (Quality Education) through industry collaboration can implement diverse practical PBL-based strategies. First, consider designing learning experiences around authentic, real-world problems proposed directly by industry partners, to ensure educational content remains relevant and applicable to current professional challenges. Second, where

possible, facilitate multiple touch points with industry partners throughout the PBL experience, as sustained collaboration deepens learning and strengthens university–industry relationships. Third, give deliberate attention to team composition by actively ensuring that student teams are multidisciplinary whenever possible. Fourth, when designing the PBL activity, articulate clear learning objectives and intended outcomes at the program’s outset, communicating expectations, deliverables, and assessment criteria to students to minimize confusion and support pedagogical rigor while collaborating with external partners. Fifth, incorporate opportunities for meaningful student autonomy and flexibility within course design, including options for teammate selection or choice of deliverable formats when feasible. Finally, when available, leverage technological tools, such as a smart classroom environment, to support the activity implementation, strengthening the engagement and keeping industry collaboration aligned with the SDGs.

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Abbreviations

The following abbreviations are used in this manuscript:

BLA	Bipolar Laddering
CSs	Class sessions
ICT	Information and Communication Technology
LMS	Learning Management System
MVP	Minimum Viable Product
NcE	Negative Common Element
NuE	Negative Unique Element
NGO	Non-Governmental Organization
P-ID	Problem-ID
PBL	Problem-Based Learning
PcE	Positive Common Element
PuE	Positive Unique Element
SDGs	Sustainable Development Goals
StTe	Student Team
UN	United Nations
URL	Universitat Ramon Llull

Appendix A

Appendix A.1

Table A1. Details of all the activities carried out during each class session.

Session	Theme	Session Overview	Activities & Duration (in Minutes)
1	Introduction	Program team introduces the challenge and Candy Innovation Model: methodology, content, activities, rules and evaluation.	Students in classroom (20'); program presentation (10'); present last years' winners—inspirational (10'); show how to formally enroll into the program through the LMS (5'); share interesting SDG data (40'); class mentor introduction (5'); mentor asks students to review companies and problems and think about questions for S2 (20'); closing and next steps (5').
2	Framing the Challenge	Form multidisciplinary teams through team building. Conduct research to define a specific, real-world problem to solve.	Take attendance and check wi-fi connection (10'); companies connecting to Zoom (5'); company and problem presentations (30'); student Q&A (15'); teams choose their problems in LMS (10'); complete "What's the problem?" form & group discussion (40'); homework reminder and closing (10').
3	Ideation	Generate solution ideas through team ideation tools. Teams present ideas, reach consensus on final solution, and develop Business Model Canvas (Product Market Fit).	Take attendance and check wi-fi connection (10'); introduction to ideation, competitive benchmarking and value proposition (10'); explanation of the activity and group discussion (10'); ideation deliverable (20'); competitive benchmarking deliverable (20'); value proposition canvas deliverable (45'); upload deliverables to LMS and closing (5').
4	Business Model and Interview Preparation	Develop Business Model Canvas and structure customer interviews.	Take attendance and check wi-fi connection (10'); teams start searching for the template in MIRO and share it with all the team members (15'); Business Model Canvas (BMC) introduction (4'); BMC steps: (1) value proposition, and (2) customer segments & teamwork (10'); BMC steps: (3) channels, and (4) customer relationships & teamwork (11'); BMC steps: (5) revenue streams & teamwork (20'); BMC steps: (6) key activities, (7) key resources and (8) key partners & teamwork (15'); BMC steps: (9) cost structure & teamwork (5'); introduction: customer discovery and interview structure & teamwork (20'); explanation role play & teamwork (2'); practice role playing (10'); remind students to do the customer interviews and prepare a summary for the next session (5').
5	Prototype	Work on developing Minimum Viable Product (MVP).	Take attendance and check wi-fi connection (10'); session explanation (10'); peer evaluation (10'); teamwork interview conclusions (10'); teamwork BMC validation (10'); teamwork MVP (30'); team presentations and feedback on site, three minutes per team (20'); continue working on prototype (33').
6	Prototype and Pitch	Work on developing Minimum Viable Product (MVP) and product video creation.	Take attendance and check wi-fi connection (10'); discuss solution evaluation and explain methodology (3'); preparation for prototype presentation (3'); prototype presentation and feedback by the mentor (15'); explain rules and tips to make the video, pitch and video recording (13'); teamwork (58'); closing and reminder of deliverables and deadlines (3'); deliveries and next session (3').
7	Class Pitch	Class competition.	Take attendance and check wi-fi connection (10'); final presentation guidelines and preparation (20'); presentation rehearsal (40'); presentations (5 min each team) and Q&A (45'); jury deliberation (5'); award of SDG program certificate (7').

Appendix A.2

Table A2 shows a synthetic description of all the problems to be solved presented by private companies, including all the associated SDGs.

Table A2. Problem descriptions and SDGs. Source: private companies.

Problem-ID	Problem Description	SDGs
P-01_Co1	Integration of sustainable strategies in the decision-making of an engineering firm.	8
P-02_Co1	Developing a responsible supply chain.	8, 12
P-03_Co1	Electronic waste management.	11, 12
P-04_Co1	The adoption of universal accessibility.	10, 11
P-05_Co1	Transparency and impact reporting.	12
P-06_Co2	How to make Barcelona 4.0 district (transformation of Zona Franca towards a new tech hub devoted to innovative industrial production) known among the new generations?	4, 8, 9
P-07_Co2	How to make the 3DIncubator known among the new generations (the 3DIncubator is a public incubator of start-ups specialized in new additive impression business)?	4, 8, 9
P-08_Co2	How to make the ‘Logistics 4.0 incubator’ known among the new generations (Logistics 4.0 incubator is a public incubator of start-ups specialized in new logistics business)?	4, 8, 9
P-09_Co3	Organizations have made progress in reducing greenhouse gas emissions, but decarbonizing the supply chain (often, the main source of emissions) remains difficult. Limited transparency and data gaps, especially among smaller suppliers that lack the tools and resources to measure and manage emissions, make it hard to cut emissions without undermining competitiveness.	13
P-10_Co3	Hiring people with disabilities, especially individuals with intellectual disabilities.	8, 10
P-11_Co3	How can companies obtain useful and reliable supply chain data, going beyond their direct (tier-1) suppliers?	3, 6, 8, 12, 13, 14, 15
P-12_Co3	How can we leverage the knowledge of our professionals to contribute to SDG 4?	4
P-13_Co4	A lack of standardization is slowing progress toward more sustainable packaging printing.	12, 13
P-14_Co4	How can organizations keep pace with the 200+ new environmental regulations introduced globally each year (17,700 tracked to date) and maintain compliance across such a broad set of requirements (e.g., energy, Co2, circularity, chemical, aging, accessibility, and more)?	3, 12, 13
P-15_Co4	Recovering and recycling empty ink supplies from customers worldwide is expensive and carries a significant environmental footprint, largely driven by logistics.	9, 11, 12
P-16_Co5	Implementing Circular Economy practices in customer hardware management.	9, 12, 13, 17
P-17_Co5	Reducing CO2 emissions by optimizing software scheduling on data center servers.	7, 9, 12, 13
P-18_Co5	Verifying the renewable origin of energy supplied at electric vehicle charging points.	7, 12, 13, 17
P-19_Co5	Promoting digital inclusion for people at risk of exclusion.	4, 8, 9, 10, 17
P-20_Co6	Reducing the gender gap in the ICT sector: limited gender diversity can hinder team innovation and productivity, weakening competitiveness, and the underrepresentation of women in technology can lead to substantial talent losses.	5, 8, 9
P-21_Co6	Minimizing cybersecurity threats in the digital age: the rising volume of cyberattacks puts our systems and our customers’ confidential data at increasing risk.	8, 9, 16
P-22_Co6	The massive and unregulated use of Artificial Intelligence to address sustainability problems can generate inequalities and an excessive increase in energy consumption, contradicting the goals of sustainability.	9, 10, 12, 13
P-23_Co6	Promoting the circular economy in the technology sector: inadequate electronic waste management in the ICT industry harms the environment and wastes valuable resources.	9, 12, 13
P-24_Co6	Improving technological accessibility for vulnerable populations: digital technologies remain out of reach for a sizable share of the population, creating barriers to essential services and employment opportunities.	4, 9, 10

SDGs identified in ‘The 2030 Agenda for sustainable Development’: SDG 1, No Poverty; SDG 2, Zero Hunger; SDG 3, Good Health and Wellbeing; SDG 4, Quality Education; SDG 5, Gender Equality; SDG 6, Clean Water and Sanitation; SDG 7, Affordable and Clean Energy; SDG 8, Decent Work and Economic Growth; SDG 9, Industry, Innovation and Infrastructure; SDG 10, Reduced Inequalities; SDG 11, Sustainable Cities and Communities; SDG 12, Responsible Consumption and Production; SDG 13, Climate Action; SDG 14, Life below Water; SDG 15, Life on Land; SDG 16, Peace, Justice and Strong Institutions; and SDG 17, Partnership for the Goals.

Appendix A.3

Figure A1 shows the rubric criteria and their fulfillment across the different three-member panels assessing the students' solutions.

SDG Challenges 2024–2025

Classroom / Teams:

			EVALUATION CRITERIA							
	Teams	Team name	Innovation and Scalability	Alignment with the SDGs	Idea Development and Validation	Presentation (Stage Presence)	Video (Creativity, Solution)	Handling of Questions	AVERAGE	Comments
MENTOR: Name & Surname	T10	Team Name 10	8	9	8	8	9	9	8.50	Comment T10
	T8	Team Name 8	7	7	7	7	8	7	7.17	Comment T8
	T12	Team Name 12	6	7	6	6	4	7	6.33	
	T9	Team Name 9	6	8	6	6	5	6	6.17	Comment T9
	T11	Team Name 11	5	8	7	6	7	8	6.83	
	T7	Team Name 7	7	8	8	7	8	7	7.50	
JUDGE 1: Name & surname	T10	Team Name 10	7	9	7	7	8	10	8.00	
	T8	Team Name 8	6	7	6	6	8	7	6.67	Comment T8
	T12	Team Name 12	6	7	5	5	7	7	6.17	
	T9	Team Name 9	7	9	6	4	4	6	6.00	
	T11	Team Name 11	4	9	8	6	7	9	7.17	Comment T11
	T7	Team Name 7	5	9	6	7	8	9	7.33	
JUDGE 2: Name & Surname	T10	Team Name 10	8	9	7	7	9	8	8.00	Comment T10
	T8	Team Name 8	7	7	6	7	8	6	6.83	Comment T8
	T12	Team Name 12	6	7	6	6	6	7	6.33	
	T9	Team Name 9	6	9	5	5	5	6	6.00	Comment T9
	T11	Team Name 11	5	9	7	6	7	8	7.00	
	T7	Team Name 7	7	8	8	7	8	8	7.67	

Note: Assign a score from 1 to 10 for each criterion, where 1 is the lowest and 10 is the highest.

SUMMARY								
	Team name	Innovation and Scalability	Alignment with the SDGs	Idea Development	Presentation	Video	Questions	TOTAL
T10	Team Name 10	7.67	9.00	7.33	7.33	8.67	9.00	8.17
T8	Team Name 8	6.67	7.00	6.33	6.67	8.00	6.67	6.89
T12	Team Name 12	6.00	7.00	5.67	5.67	6.33	7.00	6.28
T9	Team Name 9	6.33	8.67	5.67	5.00	4.67	6.00	6.06
T11	Team Name 11	4.67	8.67	7.33	6.00	7.00	8.33	7.00
T7	Team Name 7	6.33	8.33	7.33	7.00	8.00	8.00	7.50

Figure A1. Rubric.

Appendix A.4

Table A3 displays all the value propositions (VPs) suggested by each student team (StTe) to address each of the problems posed by the companies. In addition to the VPs, the table also indicates the nature of the implemented solutions (hardware, software, product, service, event, or program).

Table A3. All the value propositions generated from students' proposals.

Problem-ID	StTe	Students' Value Proposition	SDG Alignment	Type of Solution
P-01	StTe01	App that offers detailed building maps and guided routes, showing key information for better space navigation. Designed to support people who benefit from extra guidance, helping them move confidently and independently.	High SDG 8 SDG 10	SW
P-01	StTe02	An eco-trained LLM that reviews company's project designs and recommends sustainable, practical improvements, serving as an online consultant.	High SDG 8 SDG 12	SW
P-01	StTe03	A project design app that embeds sustainability from the start, estimating cost and the project environmental impact.	High SDG 8 SDG 12	SW
P-01	StTe04	Anonymous, effective communication app between workers and companies, with skill-based training, forums, and AI-driven reports to resolve workplace issues.	High SDG 8	SW
P-02	StTe05	Next-gen supply chain platform delivering end-to-end transparency, efficiency, and sustainability from production to distribution, including sustainable sourcing, carbon-footprint monitoring, waste reduction, and ESG reporting.	High SDG 12 SDG 13	SW & Service
P-03	StTe06	App to track, collect and recycle company e-waste.	Medium-High SDG 12	SW & Service
P-03	StTe07	Repair shop with an app that lets customers track the repair process and status of their repairs.	Medium-Low SDG 12	SW & Service
P-03	StTe08	Sustainable Building Transformation Program: consultancy service for sustainable engineering and infrastructure modernization.	High SDG 9 SDG 11	Service
P-04	StTe09	A mobile app offering real-time building navigation, help with mobility or communication needs, and live support to enhance independence and end-user experience.	High SDG 10	SW
P-05	StTe10	Real-time digital dashboard to measure, visualize and communicate company's social and environmental impact.	High SDG 9 SDG 12	SW
P-06	StTe11	App connecting young residents to turn forgotten areas into places full of energy and community life.	Medium-High SDG 9 SDG 11	SW
P-06	StTe12	Mobile-first platform where users create a profile via a brief survey, get matched with mentors (career-dating style), and connect via 1:1 chats or scheduled calls. Users can also post visual work-updates—no followers, just visibility. Each month, one project is featured in our digital magazine and funded through a share of subscriptions.	Medium-High SDG 8 SDG 10	SW

Table A3. Cont.

Problem-ID	StTe	Students' Value Proposition	SDG Alignment	Type of Solution
P-06	StTe13	Promote Barcelona 4.0 to younger generations via social media & interactive experiences: bring Industry 4.0 opportunities to students. Make innovation engaging, accessible, and fun to explore.	Medium-Low SDG 4 SDG 9	SW
P-06	StTe14	Event tackling limited access to cutting-edge technology, networking and innovation-driven education for students, startups, and industry professionals. The event provides a platform for collaboration, knowledge-sharing, and hands-on experiences with technologies like AI, VR, and blockchain.	Medium-High SDG 4 SDG 9	Event
P-07	StTe15	Goody Basket: subscription box featuring products from small businesses in Zona Franca.	Medium-Low SDG 9	SW
P-07	StTe16	Interactive online course teaching 3D printing to young people and adults through four learning stages, building practical & creative skills that impact innovation and education.	High SDG 4 SDG 9	SW
P-07	StTe17	3D printing enthusiasts who want to challenge themselves and fight for a future in the 3D printing world.	Medium-Low SDG 9	SW & HW
P-08	StTe18	For young entrepreneurs and early-stage startup founders in Spain: Logi NextGen, a swipe-based mobile app matching startups with incubators and firms by profile, goals, and pitch. Unlike traditional app systems, this app is intuitive, fast, video-first and gamified.	Medium-High SDG 8 SDG 9	SW
P-08	StTe19	Engage young people with the 'Logistics 4.0 Incubator' by turning logistics into a fun, interactive mobile game learning experience.	Medium-Low SDG 4	SW
P-08	StTe20	Interactive, hands-on workshops tailored to young innovators.	Medium-Low SDG 4	Service
P-08	StTe21	Organize dynamic startup fairs, strengthen financial education, and improve mentorship access.	Medium-High SDG 4 SDG 8	Event
P-09	StTe22	Website where businesses publish and verify sustainability data on goods/services. Users can filter suppliers by name or sustainability, making sustainable sourcing faster, more reliable & affordable.	High SDG 12	SW
P-09	StTe23	Digital platform for management of carbon emissions data.	High SDG 13	SW
P-10	StTe24	Building systems that help people feel supported and seen from the start so this app can identify skilled, motivated candidates who lack the same opportunities due to their disabilities.	High SDG 8 SDG 10	SW

Table A3. Cont.

Problem-ID	StTe	Students' Value Proposition	SDG Alignment	Type of Solution
P-10	StTe25	Exclusive online job platform for job candidates with intellectual disabilities.	High SDG 8 SDG 10	SW
P-10	StTe26	Platform that matches company vacancies with profiles of people with disabilities.	High SDG 8 SDG 10	SW
P-10	StTe27	Platform specifically designed to enable hiring of people with disabilities.	High SDG 8 SDG 10	SW
P-11	StTe28	Enhance environmental impact tracking for small supply chain companies by offering an affordable solution that benefits both suppliers and large companies.	High SDG 12 SDG 17	SW
P-11	StTe29	AI chatbot that helps companies get clear and reliable information from all parts of the supply chain—not just direct suppliers.	Medium-High SDG 12	SW
P-11	StTe30	AI-based tool that analyzes and verifies the reliability of information before uploading it to a shared cloud that centralizes technical and labor-related data.	Medium-High SDG 8 SDG 16	SW
P-12	StTe31	Platform for training professionals.	Medium-Low SDG 4	SW
P-12	StTe32	Creating a meaningful learning experience that connects young people with role models in the world of work, generating a real and lasting impact.	Medium-High SDG 4 SDG 8	SW & Service
P-13	StTe33	Sustainable ink solution for packaging manufacturers and printing companies that need eco-friendly options to reduce environmental impact. It offers compostable, petroleum-free formulas compatible with materials like paper, cardboard, and bioplastics.	High SDG 12	Product
P-13	StTe34	QR-based digital item packaging for delivery standardization and simplification.	Medium-Low SDG 9 SDG 12	SW
P-13	StTe35	App developed in collaboration with 'Company Name', provides a universal, easy-to-adopt labeling and certification system for sustainable packaging.	High SDG 12	SW
P-13	StTe36	Biodegradable ink and recycled plastics used to create new cartridges.	High SDG 12	Product
P-14	StTe37	Using AI to automate legal interpretation, tailor alerts by department, and help businesses stay compliant with less effort and risk.	Medium-High SDG 13 SDG 16	SW
P-14	StTe38	Monthly subscription: procedurally scalable, always up to date, reliable legal advice—anywhere, anytime—cheaper than any lawyer.	Medium-High SDG 13 SDG 16	SW

Table A3. Cont.

Problem-ID	StTe	Students' Value Proposition	SDG Alignment	Type of Solution
P-14	StTe39	The programmed system retrieves and condenses regulatory updates published in the Official State Bulletin (in Spanish, Boletín Oficial del Estado—BOE).	Medium-High SDG 13 SDG 16	SW
P-14	StTe40	Provides real-time updates and automated compliance tailored to specific industries and regulatory needs.	Medium-High SDG 13 SDG 16	SW
P-15	StTe41	Simple recycling system with drop-off points, return kits, and digital rewards.	Medium-High SDG 12	Product
P-15	StTe42	Revolutionizing Cartridge Recycling: a mobile platform that helps users find nearby recycling points, track environmental impact, and earn incentives.	Medium-High SDG 12	SW
P-15	StTe43	Give Your Ink Cartridges a Second Life.	Medium-High SDG 12	SW
P-15	StTe44	Mobile app for recycling locations with return points worldwide (e.g., supermarkets and all kinds of shops).	Medium-Low SDG 12	SW
P-16	StTe45	Offering high-quality second-hand hardware at competitive prices, enabling companies with fewer resources to access technology that would otherwise be costly, and supporting sustainability through the reuse of technological equipment.	High SDG 9 SDG 10	HW
P-17	StTe46	User-friendly app that offers consulting and educational tools. It helps users understand their carbon footprint and provides practical advice on adopting greener habits and improving energy efficiency.	High SDG 13	SW & Service
P-17	StTe47	Refresh is a digital platform that allows users to manage and control energy use within a business.	High SDG 7 SDG 13	SW
P-17	StTe48	Certification program that creates a trusted ecosystem where energy-efficient innovation is rewarded, policy is supported, and consumers are empowered to make greener choices—one certified product at a time.	High SDG 7 SDG 12	Program
P-17	StTe49	App created to remove unnecessary documents that consume device storage through different methods.	Medium-Low SDG 13	SW
P-17	StTe50	Real-time monitoring of energy consumption per device.	Medium-High SDG 7 SDG 13	SW
P-18	StTe51	App that provides EV users with information and support related to their energy consumption.	Medium-High SDG 7 SDG 13	SW
P-18	StTe52	Blockchain-secured app that certifies the origin of electricity used at EV charging stations.	High SDG 7 SDG 13	SW

Table A3. Cont.

Problem-ID	StTe	Students' Value Proposition	SDG Alignment	Type of Solution
P-18	StTe53	Hardware recycling service (recycling, restoring, and reusing).	Medium-High SDG 12	Service
P-19	StTe54	Personalized learning tool on YouTube and website for marginalized groups.	Medium-High SDG 4 SDG 10	SW
P-20	StTe55	A shift focused on building a more inclusive future in the IT sector—inspiring change, fostering innovation, and breaking down barriers to create a digital world that empowers everyone and ensures technology for all.	Medium-Low SDG 5 SDG 10	SW & Service
P-20	StTe56	A comprehensive platform offering inclusive technology training, professional mentoring, visibility for female talent, and guidance for companies on gender equity practices.	High SDG 5 SDG 10	SW & Service
P-20	StTe57	Platform offering ICT training, hands-on experience, community support and a direct connection between women and employers.	High SDG 5 SDG 8	SW & Service
P-20	StTe58	An app for a fair and inclusive hiring platform that prioritizes candidates' talent and abilities, without bias toward race, gender, or age.	High SDG 5 SDG 10	SW
P-21	StTe59	Train company employees to be self-sufficient, not only online but also with their own company software.	Medium-High SDG 4 SDG 8	Service
P-21	StTe60	App providing accessible, real-time and interactive technology education for marginalized communities, bridging the digital divide while creating employment opportunities.	High SDG 9 SDG 10	SW
P-21	StTe61	A secure customizable password generator where users can create accounts to store encrypted notes and receive regular notifications to update passwords.	Medium-Low SDG 16	SW
P-22	StTe62	Personalized AI to reduce consultations and environmental waste.	Medium-Low SDG 13	SW
P-22	StTe63	App providing an integrated platform and real-time, automated ethical support in the workflow using AI, without affecting productivity.	Medium-High SDG 9	SW
P-22	StTe64	AI education programs for universities, companies and government.	Medium-Low SDG 4 SDG 9	SW
P-22	StTe65	A regulated-AI plugin that measures its energy consumption during use and warns users through trees that appear to burn as time passes.	Medium-High SDG 13	SW
P-23	StTe66	Reconditioning electronic products, providing adequate electronic waste management while saving money at the same time.	High SDG 12	SW & Service

Table A3. Cont.

Problem-ID	StTe	Students' Value Proposition	SDG Alignment	Type of Solution
P-24	StTe67	App designed to help older or vulnerable people to use technology and apps.	High SDG 10	SW
P-24	StTe68	A smart pendant provides an easy-to-use, voice-controlled device offering communication, health monitoring, and emergency aid.	High SDG 3 SDG 10	HW
P-24	StTe69	Smart wardrobe, smart mirror, and smart kitchen adaptations to increase accessibility and ease daily living.	High SDG 10	SW & HW
P-24	StTe70	Promote the sale and/or exchange of second-hand technological devices.	Medium-High SDG 9 SDG 12	SW
P-24	StTe71	An accessible and customizable technological solution, focused on user autonomy and easing their interaction with the digital environment.	Medium-High SDG 10	SW

Type of solution: HW stands for hardware; SW stands for software. StTe stands for student team. SDG alignment can be High, Medium-High, Medium-Low or Low.

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