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CO-CREATION: WHY COOPERATION BETWEEN HEIS AND COMPANIES IS A PEDAGOGICAL TOOL IN TEACHING-LEARNING KNOWLEDGE TRANSFER PROCESSES – A CASE STUDY OF UNIVERSITY POLYTECHNIC OF PORTO

Abstract: *PORTO has been working on the Link ME UP – 1000 Ideas project for the past three years with the goal of implementing an innovative and pedagogical methodology that is based on the design thinking methodology. This work examines the co-creation axe's outcomes over six editions in terms of learning, expectations, and lessons to be improved. To solve a challenge, 48 teachers/facilitators were trained in the approach, 250 students took part in the development of competencies, and 48 projects were established and developed in collaboration with the participating organizations. The key findings are the following: the teachers'/facilitators' good integration of the new methodologies and tools used in this project and the opportunities this opens up for their classes; the companies' recognition of the project's added value and willingness to repeat the co-creation experience; and the students' increased development of soft skills and competencies.*

Keywords: *Co-creation, Cooperation, HEI, Pedagogical Methodologies, Innovation*

1. Introduction

The importance of innovation and cooperation has been recognized by many countries as the global response to the COVID-19 pandemic. Following this trend, Europe established the Horizon Europe programme called for effective ways of integrating research, innovation, and their application. It stressed prioritising international innovation cooperation and demanded more investment and implementation strategies. (European Commission & Directorate-General for Research and Innovation, 2021).

In the rapidly evolving digital landscape, co-creation has emerged as a powerful approach for organizations to harness collective intelligence, foster innovation, and enhance cooperation.

Co-creation, as a concept and practice, has gained significant traction in the digital age, where connectivity and collaboration have become the cornerstones of organizational success (Audretsch, Belitski, Caiazza, & Phan, 2023; Ji, Zou, & Liu, 2023; Østergaard & Drejer, 2022). The digital age has ushered in an era of unprecedented change and disruption across industries (Cai, 2023; Omol, 2023). Organizations are constantly challenged to innovate and adapt in response to rapidly evolving technologies, shifting

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consumer behaviours, and dynamic market conditions. At the heart of this transformation lies innovation and collaboration—two key drivers that can distinguish between success and obsolescence in the digital landscape (Costa, Crupi, De Marco, & Di Minin, 2023; Ocampo et al., 2022).

In Europe, as in other world regions, these issues are fundamental for developing and transforming society and market (European Commission & Directorate-General for Research and Innovation, 2017, 2021). Higher education has a huge impact on transforming society and for that the importance of integrating various innovative pedagogical techniques to create a student-centred learning environment that aligns the principles of Industry 4.0 (I4.0), with High Education 4.0 (HE4.0), and Work 4.0 (W4.0). It calls for a transgressive, innovative, transformative, diverse, and inclusive approach to teaching and learning (AlMalki & Durugbo, 2023; Chigbu, Ngwevu, & Jojo, 2023; Eyal & Gil, 2020; Kalnbalkite, Brakovska, Terjanika, Pubule, & Blumberga, 2023; Kärkkäinen, Jääskelä, & Tynjälä, 2023; Niemi, 2021; Riera et al., 2020; Rybnicek & Königsgruber, 2019). Here lies the implementation and development of entrepreneurship and co-creation programmes to promote the relationship between industry and university and to ensure effective knowledge transfer processes (Cai, 2023; de Wit-de Vries, Dolfsma, van der Windt, & Gerkema, 2019; Gretsch, Salzmann, & Kock, 2019; Osorno-Hinojosa, Koria, & Ramírez-Vázquez, 2022; Østergaard & Drejer, 2022).

On the last decades innovative pedagogical methodologies have been developed. With the new paradigm of I4.0, one of the research focuses on this decade is the gap between skills needed on the companies and the Hight Education Institutions (HEIs)' offer and the impact of the IT on the teaching-learning pedagogies. Several authors explore the effectiveness of innovative pedagogy in the context of Industry 4.0, emphasizing the importance of adapting education to the changing technological landscape (AlMalki & Durugbo, 2023; Chigbu et al., 2023; Niemi, 2021; Sasson, Yehuda, Miedijensky, & Malkinson, 2022; Syed, Singh, & Spicer, 2023).

The Polytechnic of Porto (P.PORTO) recognising the importance of collaborating with the surrounding industrial context and following international trends about co-creation projects and entrepreneurship programmes in higher education, decided to implement the Link ME UP – 1000 ideas project as part of the consortium of 13 polytechnics. This project is a Support System for the Co-creation of Innovation, Creativity and Entrepreneurship, with two axes (Co-creation and entrepreneurship) that promote co-creation through real projects given by companies, which are involved for eight to ten weeks in support, together with facilitators, to the students' elaboration of a project use an innovative methodology of design thinking - Demola methodology - to respond to a societal challenge of the company. The entrepreneurship axe through training young students and/or entrepreneurs to improve employment quality and create innovative businesses, will not be the subject of this paper. The Link ME UP project, with 600 co-creation cases and 400 generation idea development considering all partners, seeks also to strengthen collaboration between Portuguese Polytechnics as agents for qualified entrepreneurship in the co-creation of innovation within the business environment, with the goal of producing creative ideas and new businesses (Sequeira, Teixeira, & Samartinho, 2023).

In this work are presented the results of P.PORTO' Link ME UP – 1000 Ideas, related with co-creation axe over the six editions, with 48 P.PORTO's teachers, and 12 teachers from the professional education teachers (facilitators), trainees in the methodology for co-creation and innovation, and 250 students participating in the 48 projects with the involved 48 companies,

solving a challenge by applying the forementioned methodology and support tools during eight to ten weeks period, over the last 3 years. The main goal of work is to analyse how Link ME UP Project with its co-creation methodologies promoted new skills in students, new pedagogical methodologies for teachers and improved collaboration and cooperation between HEIs and Industry.

In this work, the scope, objectives, project description, main contributions of this research and the topics of interest for the development project are provided in the introduction – Section 1. Section 2 provides the methodology for data analysis. Section 3 presents the results obtained during the six editions of implementing co-creation projects in P.PORTO. Section 4 presents the discussion is presented. Finally, Section 5 concludes the paper with some considerations, identification of limitations and future work suggestions.

2. Methods and data

In order to evaluate the Link ME UP project at P.PORTO, after the implementation of co-creation projects using a design thinking methodology, data from the three surveys related to the scope of P.PORTO were analysed: i) regarding the facilitators, from each of the eight organic schools, who received training on the methodology for implementing the co-creation and innovation process; ii) the students enrolled in the same co-creation and innovation process; iii) as well as the companies/organisations that launched the challenges and were part of the co-creation process.

The P.PORTO Link ME UP – 1000 Ideas co-creation axe was implemented since 04 January of 2021 until 30 June 2023, with six editions. Each edition had the participation of a facilitator of each P.PORTO school (Health, Hospitality, Engineering, Accounting & Management, Technologies & Management, Midia & Design, Arts, Education), and one teacher from a vocational school of the Portuguese network. A total of 10 facilitators per edition (8 organic units from P.PORTO + 2 vocational schools) with a total of 60 facilitators, were involved in the co-creation and innovation methodology, 48 projects set up together with 48 companies, each project with five to six students, in a total of 250 students participating, solving a challenge by applying the forementioned methodology during eight to ten weeks.

A questionnaire survey was developed following a literature review, with two parts: the first one was used to characterise the sample and the second part, with a Likert scale from 1 (strongly disagree) to 7 (strongly agree), was used to find answers to the research questions and to evaluate qualitative level of satisfaction, skills capacitation, entrepreneurship capacitation, value added perception with the project.

The research questions proposed were:

Q1: The project had a significant impact on the participants (Students, facilitators, and Entities)?

Q2: Do the students perceive themselves as more capacitated because of co-creation methodology and support tools used?

Q3: There are in the students group a difference between editions concerning level satisfaction.

Q4: There are in the students group a difference between editions concerning soft-skills competences development.

The questionnaire was sent using Link Me Up platform to the registered co-creation teams contact lists for all editions (lists of contacts from companies, facilitators, and students),

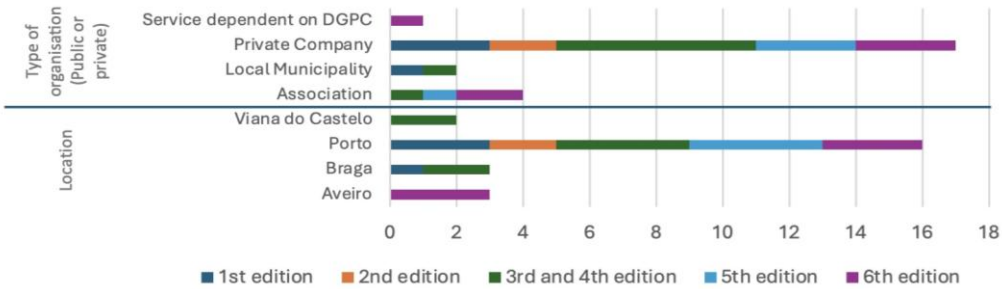
The statistical analysis, descriptive (frequencies, central tendency, and variability measures) and inferential analysis (Kruskal Wallis test), was performed with IBM SPSS Statistics 29 version.

3. Results

3.1 Characterisation of the sample

For all editions the survey response rate for companies/organisations was 50% (24 in total of 48), 96.8% (242 in a total of 250) for students, and 97.9% (47 in a total of 48 from P.PORTO) for facilitators.

The characterisation of the companies and the students participating in this project are presented in Figure 1 and Figure 2.



Legend: DGPC - General Directorate for Heritage and Culture

Figure 1. Companies' characterisation and location during the six editions

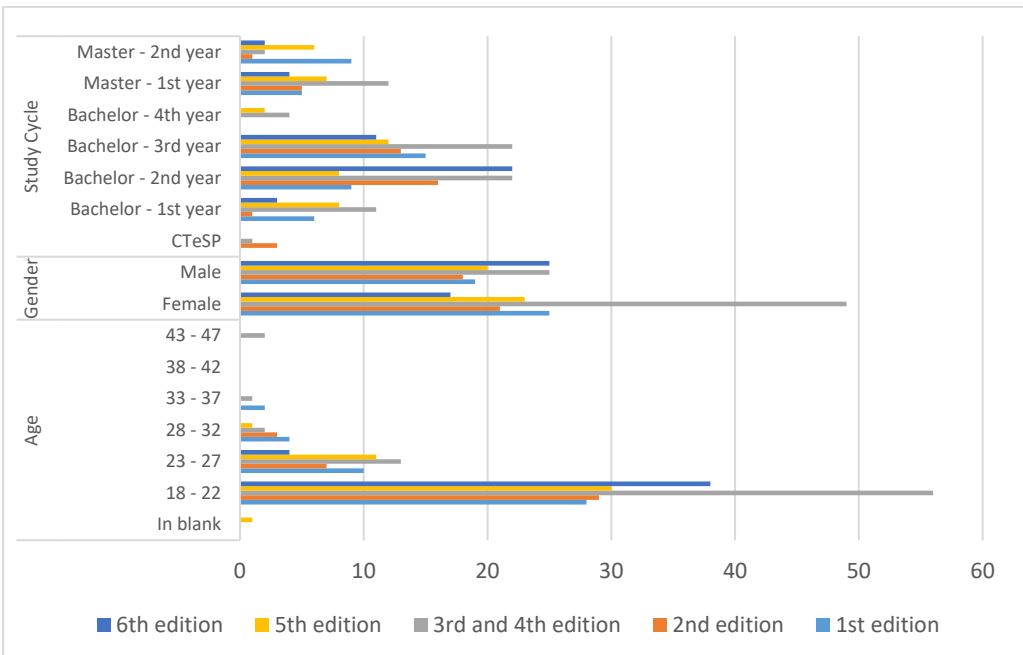


Figure 2. Students' characterisation during the six editions

As seen in Figure 1, only private companies - mostly from Porto County and other neighbouring northern cities - were featured in all editions.

Figure 2, which depicts the characteristics of the students, shows that the representation of males (44.6%) and females (55.4%) is equal by edition, the majority of the students are in their second and third year of bachelor's

degrees, followed by master's degrees, and the majority of them are between the ages of 18 and 22. Ten hours were spent on the project by 64.4% of the students, between ten and twenty hours by 27.7% of the students, and more than twenty hours by 7.9% of the students. shows the characteristics of the students by scientific field.

Table **1** shows the characteristics of the students by scientific field.

Table 1. Students' characterisation by scientific field.

Scientific Field	Percent
Engineering and other technical courses	42.6%
Economics and Business Sciences	21.5%
Arts, Humanities, Languages, and related areas	8.3%
Nursing and other health professions	7.4%
Education	6.6%
Natural and exact sciences	2.5%
Tourism	1.7%
Social Sciences and Law	1.7%
Design	1.2%
Business Communication	1.2%
Accounting and Administration	1.2%
Fashion Business Management	0.8%
Environmental Health	0.8%
Biochemistry in Health	0.4%
Commerce and Fashion Management	0.4%
Industrial and Logistics Management	0.4%
Technology and Management	0.4%
Marketing	0.4%
Multimedia	0.4%

Data shows that more than 50% of the students are from Engineering and Economics scientific field.

3.2 Satisfaction level Analysis

3.2.1 Facilitators

The facilitators that answered the questionnaire were 10 in the first and second edition, 13 in the third and fourth editions (occurred together because pandemic COVID-19), 6 in the fifth edition, and 8 in the sixth edition. In Figure 3 is presented the facilitators' satisfaction level. Most of them have positive levels of satisfaction (42/47).

Overall, the satisfaction level of the facilitators was 89.36%. Concerning the added value of the training programme in innovation co-creation, on average, all considered it relevant, with emphasis on the collaboration and dynamics between facilitators, organisations, and teamwork with students, as well as the project support tools applied (such as Miro, Canva and Problem Tree), the co-creation methodology, internationalisation, the Atlas Platform and Portugal co-creation Chat.

Figure 4 shows the results for satisfaction Level of Pedagogical Innovation in co-creation methodology applied to Facilitators. Besides facilitators from Media & Design school that use design thinking methodology that is similar, all the facilitators worked with the methodology for the first time. The results show that most of the facilitators have positive levels of satisfaction (28 facilitators have satisfaction Levels equal to or higher than 5, corresponding to partially agree (5), agree very much (6), and totally agree (7)).

After Link Me Up program participation, some of the facilitators adopted the use of real challenges developed in co-creation with companies in their curricular units, and the used tools, like MIRO for collaborative working and prototyping tools. In some cases, this methodology of working in co-creation have replaced the practice working based in case studies by the teacher to the students. This was one of the important contributions of the project.

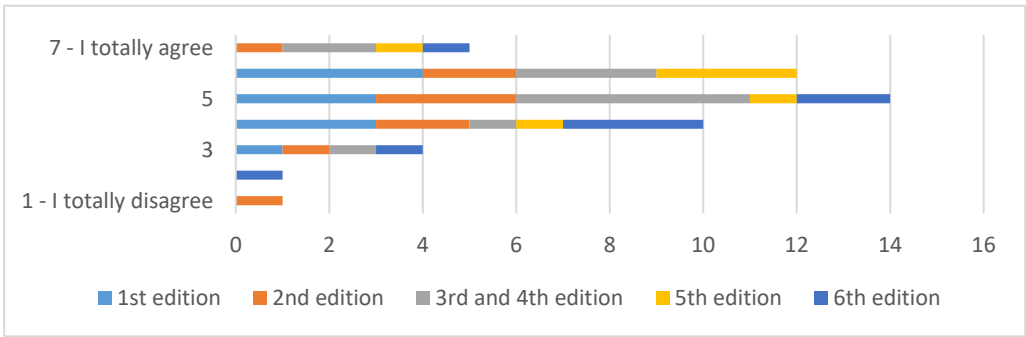


Figure 3. Facilitators' level of satisfaction by edition

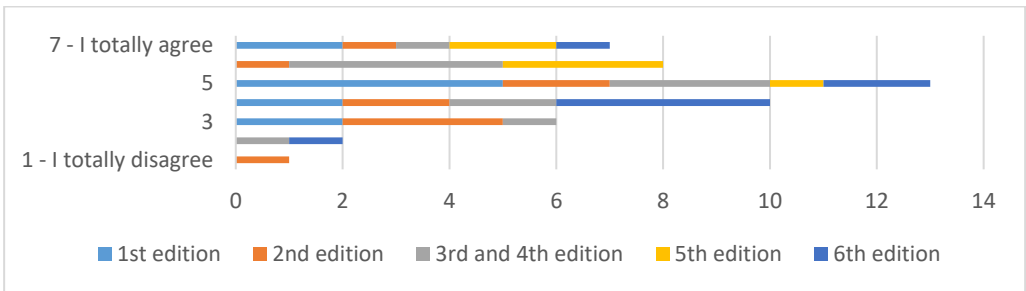


Figure 4. Satisfaction Level of Pedagogical Innovation in co-creation methodology applied to Facilitator

3.2.2 Companies

The Figure 5 represents the type of collaboration between the P.PORTO and the participant companies. As most of the companies are located on the P.PORTO's influence zone, they already knew P.PORTO and had/have collaborations on internships, projects, and services.

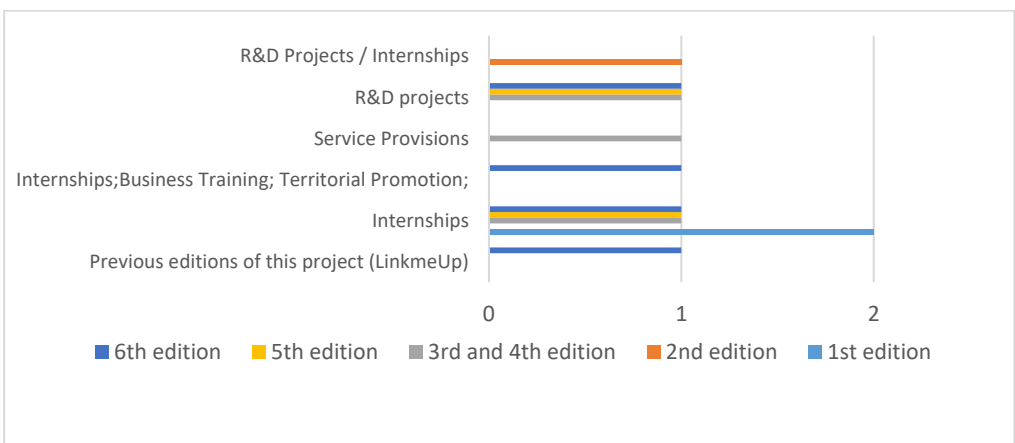


Figure 5. Type of collaboration that the company/organization has with P.PORTO

As shown, the relationship between P.PORTO and the external companies/ organisations are related with students' internship, R&D projects, and service provision. When questioned if there was intention to participate in other innovation co-creation projects again, most of the companies answered yes, (95,8%) considered participating in other innovation co-creation projects, as shown in Figure 6.

Considering if companies recommended participating in this project to other companies only 4,16% do not recommended due to the effort and time involved, see Figure 7 .

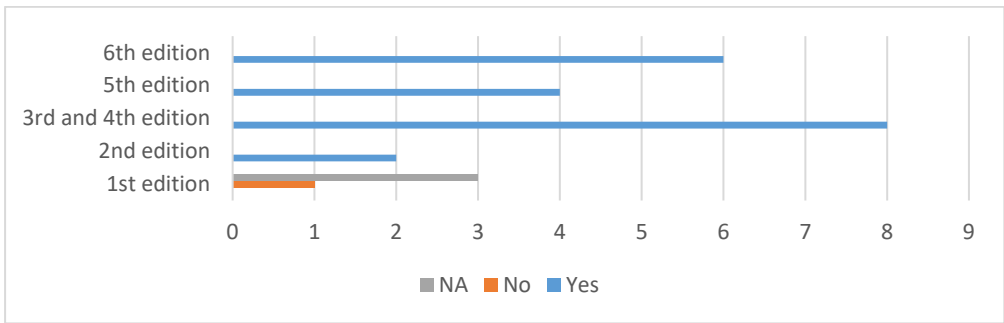


Figure 6. Intention of participating in other innovation co-creation projects again by edition

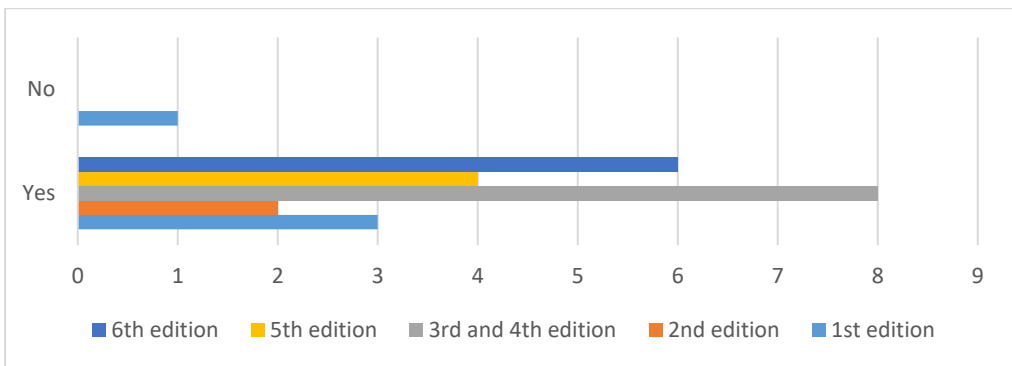


Figure 7. Number of companies that recommended the Link ME UP project participation to other companies by edition

3.2.3 Students

Due to the importance of this programme with an innovative pedagogical methodology working in co-creation, with main goal to promote soft-skills in students, the questionnaire also covered the analysis of soft-skills, students capacitation with the methodology, and the impact of the methods and tools used in this project. A descriptive statistics analysis was done computing the median, mean and stand deviation of the Likert scale (1 to 7), see Table 2 and Table 3.

From Table 2, the results show that the students' assessment median concerning the global level of satisfaction with the project, and with the project's methodology and its support methods and tools is very positive, with median and mean above 5: the relevance of the platform (5), the team working (6), the collaboration with entities and facilitators (6), the relevance of the methodology (6) and the internationalisation (5), and creation capacitation (5) , were high,

most of them considering very much agree and strongly agree, with exception for the mean (4.83) for relevance of the Platform Atlas .

Table 2. Students' perception of the project methodology in all editions (N=242)

	Median	Mean	Std. Deviation
Satisfaction level	6	5.79	1.218
Relevance of the Platform Atlas	5	4.83	1.731
Relevance of teamwork	6	6.03	1.095
Relevance of the collaboration with companies	6	5.62	1.453
Relevance of tools used	6	5.59	1.283
Relevance of the methodology	6	5.69	1.180
Relevance of facilitators mentoring	6	6.03	1.227
Relevance of the international teams	5	5.06	1.664

The same results apply to soft-skills capacitation perception, with exception for creation capacitation with a mean = 4.69, see Table 3.

Table 3. Students' skill capacitation in all editions (N=242)

Skills capacitation	Median	Mean	Std. Deviation
Critical Thinking	6	5.71	1.093
Creativity	6	5.80	1.071
Entrepreneurship	6	5.68	1.257
Leadership	5	5.40	1.276
Communication	6	5.93	1.064
Teamwork	6	5.93	1.229
Digital Competencies	5	5.14	1.432
Research gathering	6	5.82	1.101
Management tools	5	5.23	1.365
Creation Capacitation	5	4.69	1.478

Finally, to the participating students were asked for opportunities of improvement, and most of them claim for more project time, more co-creation time and more teamwork time, although the 8 to 10 weeks project time by edition was part of the methodology. More visits to the involved co-creation company, and more visits to research centres.

A Kruskal Wallis test was used to verify if there were differences between editions (1 to 6), concerning the project methods and support tools (Table 4). The results show that there are statistically significant differences for all methods and tools relevance between editions with exception to relevance of the methodology (p-value=.053).

Table 4. Students' relevance of the methods and tools used on the co-creation process by edition

Methods and Tools Relevance	Kruskal-Wallis (H)	*p-value*
Relevance of the Platform Atlas	34.897	<0.01
Relevance of teamwork	15,209	<0.01
Relevance of the collaboration with companies	20.123	0.004
Relevance of tools used	18.172	0.013
Relevance of the methodology	11.471	0.053
Relevance of facilitators mentoring	9.90	0.041

The same statistical test was applied to analyse differences between editions for satisfaction level and soft-Kills (Table 5). The results show that there were statistically significant differences for satisfaction level and soft skills between the 6 editions (p-value <.05), with exception for "Leadership" skills (p-value=.053) and "communication" skills (p-value =.052).

Table 5. K-independent test for satisfaction level and soft-Kills with grouping variable Edition

	Kruskal-Wallis (H)	*p-value*
Level satisfaction	21.246	<0.01
Critical Thinking	18.536	<0.01
Criativity	15.248	0.004
Entrepreneurship	12.642	0.013
Leadership	9.341	0.053
Comunication	9.407	0.052
Teamwork	10.231	0.037
Digital Competencies	11.977	0.018
Research gathering	20.998	<0.01
Management tools	15.104	0.004

4. Discussion

According to the outcomes of the Link ME UP-1000 ideas project's co-creation axis, some improvements were implemented in P.PORTO with the input of stakeholders, including students, facilitators, and companies. Companies' co-creation experience was productive. Before this project some of them had only worked with P.PORTO for internships, and the majority were willing to cooperate on further co-creation tasks.

With a median response of 6 (significantly agree, totally agree), the Link ME UP - 1000 ideas project had a significant impact on the students and teachers (having participated as facilitators and interns in the methodology and tools used and, simultaneously, carrying out the co-creation process with students and companies). The findings were comparable in terms of the students' capacity and soft-skills development, with a median response of 6 (significantly agree and absolutely agree).

As a result, the project played a pivotal role in the adoption and application of cutting-edge pedagogical techniques throughout the P.PORTO universe. It involved educators and learners from various fields as well as collaborative entities that supported a student-centered learning environment through co-creation using digital platforms for collaborative teamwork. These efforts were in line with the principles of HE4.0, W4.0, and I4.0, as noted by several authors (AlMalki & Durugbo, 2023; Chigbu et al., 2023; Kärkkäinen et al., 2023; Riera et al., 2020). The findings demonstrated that both students and facilitators who were implementing innovative pedagogical approaches for the first time had a high degree of satisfaction with them, with some facilitators even implementing them in their classrooms.

The results from the companies that participated in the Link ME UP project also demonstrated a positive impact between effective knowledge transfer and the implementation and development of co-creation programs that promote the relationship between industry and university as corroborated by several authors (Cai, 2023; Osorno-Hinojosa et al., 2022; Østergaard & Drejer, 2022).

5. Conclusion

In Europe, as in other parts of the world, HEIs have a significant influence on how society is changing. The incorporation of many creative pedagogical approaches is crucial in establishing a student-focused learning milieu that harmonizes with the tenets of Industry 4.0, High Education 4.0, and Work 4.0. The Link ME UP project is an excellent illustration of how to begin putting this intended change into practice. The outcomes of P.PORTO's participation demonstrated how this project can improve the HEI's core activity by altering the internal organizational context. It can also improve the external organizational context by fostering collaboration and better knowledge transfer procedures with Industry 4.0 and Work 4.0.

The project's outcomes and demonstrated impact are exactly in line with the entrepreneurship and innovation promotion

strategy that P.PORTO has been developing for the past ten years. From the establishment of its Knowledge Transfer Workshop (OTIC.IPP) to the founding of the Technology Park (PORTIC) in one of the busiest innovation ecosystems in Europe (Asprela Campus), the P.PORTO has continuously progressed in the development of its action to promote and encourage co-creation, innovation, and entrepreneurship with programmes such as Poliempreende and PPEPP - Entrepreneurship Promotion Program of the Polytechnic of Porto, close to its community and the social and economic agents of his region of influence. Other initiatives include the Porto Design Factory, curriculum adaptation, and increased company collaboration.

The main reasons for this work's limitations were: i) some facilitators did not initially adjust the type of methodology used; ii) team meeting scheduling was not coordinated when foreign participants were involved; iii) in certain instances, the co-creation team (comprised of students, facilitators, and companies) claimed that the challenges would require a few more days of development, even though that was part of the methodology; iv) this activity was linked to obligations pertaining to the regular organization of the academic year; and vi) the projects were implemented in the companies.

This work explores innovative pedagogical approaches and the framework to transfer knowledge, stimulating interest in new or more focused research on co-creation and open innovation.

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