https://doi.org/10.36315/2025v2end102
Education and New Developments 2025

HOW TO FOSTER INTERDISCIPLINARY PROJECT-BASED LEARNING IN DISTANCE EDUCATION: FINDINGS FROM A 24-HOUR DIGITAL HACKATHON

Gianluca Carella[1,2], Marta Conte[1], & Francesco Zurlo[1]
[1]*Department of Design, Politecnico di Milano (Italy)*
[2]*MIT Morningside Academy for Design, Massachusetts Institute of Technology (USA)*

Abstract

Global current challenges such as climate change, public health crises, and technological advancements also require collaboration that transcends disciplinary and cultural boundaries. To cope this scenario, it is necessary to start from education to prepare people for the complexities of the modern environment. Higher education must equip students with essential skills such as critical thinking, adaptability and cross-cultural communication. Alongside traditional teaching methods, more interactive approaches are gradually gaining relevance, as they immerse students in real-world challenges and encourage them to apply their knowledge in practical settings. Interdisciplinary Project-Based Learning (IPBL) addresses these needs by creating opportunities for students to work in diverse teams on authentic problems. Moreover, these paradigms have shifted in recent years due to new technological-driven settings. This paper explores the effectiveness of Interdisciplinary Project-Based Learning (IPBL) in distance learning, using a "digital hackathon" as the learning format. The paper discusses the key challenges that emerged during the hackathon, such as communication barriers and time and resources management. The aim is to provide practical insights and recommendations for managing the online innovation challenges and how it is possible to engage teams, involving higher levels of collaboration, guidance, and empathy to foster IPBL in distance learning. Findings highlighted the potential of IPBL to spark creativity and enhance problem-solving skills when students from diverse backgrounds work together.

Keywords: *Interdisciplinary project-based learning, intercultural collaboration, digital hackathon, distance learning, global challenges.*

1. Introduction and theoretical background

In the context of today's complex and ever-changing society, uncertainty places new demands and challenges on students preparing to enter the working environment. Indeed, the contemporary professional landscape is characterized by multifaceted and ill-defined problems that often cannot be handled by a single individual or monodisciplinary teams but must be tackled systemically through interdisciplinary collaborations (Brassler & Dettmers, 2017; Yusri et al., 2024). It is thus essential for students to develop and strengthen skills such as critical thinking and problem solving, communication, collaboration and team building, creativity and innovation (Brassler & Dettmers, 2017; Stentoft, 2017), all essential to critically and innovatively navigate challenges typical of the 21st century (Yusri et al., 2024).

An approach that has proven effective in providing students with the skills needed to cope with today's work environment is interdisciplinary education, which can be defined as "a process by which learners integrate information, data, techniques, tools, perspectives, concepts, and/or theories from two or more disciplines to craft products, explain phenomena, or solve problems, in ways that would have been unlikely through single-disciplinary means" (Boix Mansilla, 2010; Brassler & Dettmers, 2017). Here, students can manage complex information and combine insights from different areas to generate innovative ideas (Brassler & Dettmers, 2017; Hart, 2019), enabling them to solve problems and answer questions that "cannot be satisfactorily addressed using single methods or approaches" (Klein, 1990) and thus providing them with a comprehensive set of personal and social skills that will make them ready for the contemporary world of work.

Another approach particularly well-suited to prepare students to the complexities of the modern working environment is Project-Based Learning (PBL), a method widely discussed and studied in recent decades (Kokotsaki et al., 2016; Carella & Colombo, 2024; Yusri et al., 2024) that can be described as a student-centered form of education based on context-specific learning, the active involvement of students in

the learning process, and the sharing of knowledge through social interactions among participants (Kokotsaki et al., 2016). PBL encourages students to focus on a realistic project aimed at solving authentic questions and challenges within real world, helping them to collaborate with each other in proactively designing, investigating, making decisions, and ultimately solving problems, usually through the design of a product that addresses the driving question (Blumenfeld et al., 1991; Brassler & Dettmers, 2017; Yusri et al., 2024). By using the project as a learning tool, PBL offers students a more active opportunity to the acquisition and retention of the discipline's core concepts (Carella & Colombo, 2024; Hart, 2019) while also allowing them to develop skills such as creative and critical thinking, problem-solving, communication and self-confidence (Yusri et al., 2024).

When integrated with an interdisciplinary approach, PBL can provide students with a more comprehensive and systemic perspective on the discipline being studied and with the opportunity to develop and exploit a broader range of knowledge and skills (Brassler & Dettmers, 2017; Hart, 2019; Chang et al., 2022). In Interdisciplinary Project-Based Learning (IPBL), the integration of interdisciplinarity into the learning process occurs through the creation of multidisciplinary work teams. The interface between members from different disciplinary areas helps to gain a deeper understanding of the problem and stimulates critical and creative thinking (Chang et al., 2022). By promoting interaction between students and members of other knowledge communities, IPBL facilitates communication across professional languages and encourages students to transcend the boundaries imposed by their respective academic disciplines, thereby enriching their global perspective (Brassler & Dettmers, 2017). This pedagogical approach enables students to develop not only inquiry, knowledge creation, and problem-solving skills (Carella & Colombo, 2024), but also teaches them to understand different perspectives, data, and information, and to apply a variety of context-dependent techniques and tools so as to generate a truly innovative and effective solution to the challenge at hand (Brassler & Dettmers, 2017). Beyond the many benefits of IPBL, it is important to note that teams frequently encounter challenges in managing different perspectives, as well as in establishing the appropriate boundaries and associated knowledge pertinent to the problems at hand (Redshaw and Frampton, 2014; Stentoft, 2017). Disagreements concerning common objectives, unrealistic expectations, and underestimation of the time and effort required may be other relevant barriers to effective IPBL implementation (Repko, 2008; Brassler & Dettmers, 2017).

Another factor that is increasingly affecting education and pedagogical approaches such as (I)PBL is digitalization, i.e. the introduction of digital tools to support and execute activities in a distributed and remote environment rather than in a collocated physical one. Indeed, the ongoing digital transition accelerated by the COVID-19 pandemic resulted in a significant shift toward virtual collaboration in a variety of disciplinary fields (Patricio et al., 2024), fostering the development and diffusion of e-learning and distance learning formats. Despite being theorized for face-to-face interactions, multiple studies describe the benefits of introducing technological means such as collaboration software and digital workspaces in PBL (Carella & Melazzini, 2023). Bringing PBL and IPBL to the online context can indeed enhance student engagement, facilitate information retrieval, analysis and exchange and increase the opportunities for networking and cross-disciplinary and cross-cultural collaboration (Donaldson et al., 2021; Vallis & Redmond, 2021). Furthermore, remote collaboration offers several other advantages over traditional settings, including reduced costs due to minimized travel and material consumption, a potentially higher retention rate of team members due to lower participation effort, and better scalability of formats such as workshops and hackathons due to the lack of space constraints (Donaldson et al., 2021; Patricio et al., 2024). Despite these advantages, some undeniable problems remain: while distance education can increase opportunities for interdisciplinarity by removing spatial barriers, a completely remote context can dampen interaction and discourage active participation, leading to difficulties in project development and flattening creative problem-solving efforts (Carella & Melazzini, 2023).

Despite the abundance of research on (I)PBL and distance learning, the potential of a mixed approach bringing the two together has rarely been investigated. This research aims to fill this gap, focusing on how IPBL can be applied in distance learning. To support this theory, a practical case involving a "digital hackathon" bringing together international students from Politecnico di Milano and MIT is examined.

2. Methodology

This paper is based on a 24-hour hackathon organized by Politecnico di Milano and MIT, bringing together international students from the two academic institutions to design innovative startups.

Forty students, half from Politecnico di Milano and half from MIT, were selected based on their curriculum and competences to create multidisciplinary teams with a balanced mix of skills. The project was carried out in small, interdisciplinary teams composed of two students from the Design School at Politecnico di Milano and two from various disciplines at MIT. The main brief proposed was to design impactful solutions for a rapidly changing climate and urgent societal conditions.

The agenda had to take into account the different time zones of Politecnico di Milano and MIT: in order to allow students to work both synchronously and asynchronously, the activities were carried out using Miro, a digital workspace platform chosen for its flexibility of use and accessibility, and a communication platform of their choice. Because of the short amount of time and the consequent "sprint"-like effort required, four mandatory breaks were also planned to ensure participants' wellbeing.

Digital tools were implemented to facilitate collaboration and guide students through the project, with the recommendation of adapting the proposed process to their specific needs. More in specific, the activities where designed and organized in alignment with the principles of PBL, aiming for a student-centric learning experience capable of fostering active learning through interaction among students, the sharing of knowledge from different disciplines, and the understanding the subject matter through a hands-on approach (Dewey, 1959). A series of templates were designed to guide each team through the following twelve-steps process: Problem Identification; Trend Analysis; Interviews & Need Analysis; Idea Generation; Stakeholders Analysis; Competitive Analysis; Customer Journey; Revenue Model; Roadmap; Final Presentation. Moreover, throughout the 24 hours, students could benefit from the support of experts with vertical skills, available at different timeslots during the whole activity to provide feedbacks and suggestions. The final part of the hackathon was dedicated to final presentations and evaluation of the ideas proposed by each team through a panel of judges, two from Politecnico di Milano and two from MIT.

This paper builds its analysis on a survey distributed among participants of the 24-hour digital hackathon to evaluate the experience in terms of how effectively it supported learning, teamwork and skills development. The questionnaire received 32 responses. Specifically, respondents were administered a questionnaire divided into four sections to verify the most relevant findings emerging from literature. Thus, the sections focused on: Online Workspace & Teamwork, Skill Development & Interdisciplinary Collaboration, Hackathon Format & Schedule and Overall Experience & Suggestions. Both open questions and Likert scale questions were used to measure each area of inquiry and all the answers were collected in an .xls file, which was used for data analysis through descriptive graphs and diagrams (Hays, 1973). The results were analyzed using Excel and the associated data visualizations for each research area and were then discussed by a team consisting of two professors and three researchers.

3. Results

The objective of the survey was to assess different aspects of the digital hackathon based on students' individual experiences, such as the usefulness of specific practices in completing the planned activities, the level of difficulty perceived by the participants and the impact of the activity on the development and reinforcement of specific skills. The open questions allowed to gather qualitative data about the experience, with a specific focus on the impact of interdisciplinarity on the problem-solving process and possible benefits and challenges experienced by participants due to the 24-hours format. The Likert scale questionnaire, with parameters ranging from 1 to 5, allowed to gather some quantitative data. The lowest parameter "1" represented the most negative connotation or the least impact in the IPBL context evaluation, while the highest parameter "5" represented the most positive connotation or the greatest impact.

The first section of the questionnaire aimed to investigate how well digital tools, practices and planned activities supported collaboration and structured teamwork. Upon analysis, findings from this section reveal that the digital tools (Miro, the process templates and the communication platform) had a strong impact on the effectiveness of collaboration within the interdisciplinary team, registering an average score of 4.20/5. Similarly, the support offered by the experts through feedback on specific aspects of the entrepreneurial idea was also evaluated positively, receiving an average score of 4.27/5. On the other hand, the evaluation of the impact of technical problems of various kinds related to the use of technology (e.g., connectivity problems or platform glitches) returned highly variable scores within the sample analyzed, with ratings ranging from 1 to 5 and an average score of 2.27/5.

The second section of the questionnaire aimed to investigate the skills participants developed and/or strengthened during the hackathon and how interdisciplinary teamwork influenced their approach to problem solving. Based on the analysis of the responses provide, the data from this section show that interdisciplinarity within teams helped students in both developing and strengthening skills such as critical thinking and problem-solving (e.g., analyzing complex issues and identifying effective solutions), communication and collaboration (e.g., sharing ideas clearly and working well with team members), creativity and innovation (e.g., generating novel ideas and approaches) and effective collaboration in multidisciplinary teams (e.g., integrating diverse perspectives and expertise).

Moreover, working with peers from different cultural or national backgrounds registered a positive influence on student's approach to problem-solving and innovation as well as on the overall learning experience. With an average score of 4,53/5, participants reported that the interdisciplinary composition of the team enriched problem-solving by merging different ways of thinking. While there were challenges in aligning

perspectives and making decisions, the diversity of backgrounds ultimately led to a more innovative and well-rounded approach to tackling problems.

The third section of the questionnaire aimed to understand how the time-limited structure of the hackathon affected productivity, decision-making, and group dynamics, as well as the impact of collaboration in different time zones. When asked to describe the benefits and challenges experienced due to the 24-hour format, participants reported that the intense time constraint pushed them to make quick decisions and think creatively under pressure. Many valued the opportunity to collaborate with talented peers and receive expert guidance, though some found mentorship access could be improved. Some struggled with rushed decision-making and rigid problem-solving approaches. Despite these challenges, most found the experience enriching and suggested adding team-building activities or extending the event for better idea development.

The fourth and final section of the questionnaire aimed to collect participants' overall thoughts as well as suggestions for improvement, in order to refine the proposed "Distance IPBL" format to better support student collaboration and learning. When asked to provide suggestions to improve the experience, participants emphasized several key areas. Many recommended extending the hackathon duration to allow for longer breaks, more sleep, and deeper engagement with the tasks, while also calling for a clearer and more concise briefing to reduce excess material. Team collaboration improvements were also highlighted, with suggestions to form larger teams or incorporate team-building activities ahead of the event to foster stronger connections. Some participants advocated for pre-defined schedules to optimize organization and reduce load and fatigue. Finally, expanding the range of topics to choose from and ensuring balanced team participation were seen as beneficial for enhancing the overall experience.

4. Discussion and conclusions

The study analyzed the potential of a mixed approach bringing together IPBL and distance learning formats through a practical case involving a "digital hackathon" that gathered international students from Politecnico di Milano and MIT. The results from the 32 students who answered the survey confirmed the positive impact of IPBL in developing personal and social skills such as cross-disciplinary communication, teamwork and collaboration, complex information analysis and management and the ability to innovate by bringing together insights from different fields (Brassler & Dettmers, 2017; Hart, 2019), while also shedding light on some prerequisites necessary for such skills to be developed. In fact, many participants reported that the IPBL experience provided them with a more comprehensive and systemic perspective on the discipline at hand, as well as the opportunity to develop and exploit a broader range of knowledge and skills and to apply context-dependent techniques and tools to generate innovative and effective solutions to the challenge at hand (Brassler & Dettmers, 2017). Moreover, findings from this research are consistent with literature affirming how IPBL facilitates communication across professional languages, promoting empathetic teamwork and encouraging students to transcend the boundaries imposed by their respective academic disciplines in favor of a deeper understanding of interdisciplinary concepts (Brassler & Dettmers, 2017; Stentoft, 2017; Chang et al., 2022). Nonetheless, appropriate time allocation emerged as an essential prerequisite when carrying out IPBL activities in distance learning. It emerges as necessary to give the right time to let students find a collaboration framework and a shared vocabulary optimized for the problems at hand, nor to properly prioritize tasks to complete the assignment, all crucial elements for effective collaboration and skills development (Redshaw and Frampton, 2014; Stentoft, 2017)

Regarding the distance learning format, findings from the analysis allow for multiple reflections. On one side, digital tools were well received by students, most of whom were already familiar with digital workspaces and had already experienced online education due to the COVID-19 pandemic. In line with literature (Donaldson et al., 2021; Vallis & Redmond, 2021; Carella & Melazzini, 2023; Patricio et al., 2024), participants reported that the introduction of the mixed setting (partially physical, partially remote) increased the opportunities for networking and cross-disciplinary and cross-cultural collaboration. On the other hand, while collaboration among students physically in the same space was reported to be consistently effective despite the difficulties imposed by the hackathon format, some participants reported difficulties in maintaining active and consistent collaboration in the digital environment. In fact, mainly due to the different time zones and the underestimation of the effort required by the event, some students developed expectations on the hackathon structure, which led to their partial engagement and, therefore, to hiccups in project development and a flattening of creative problem-solving efforts within the team. Good management of hybrid collaboration, in terms of clear presentation of planned activities, composition of working teams and consistent engagement of all participants, thus emerges as another prerequisite for the success of mixed educational formats such as IPBL in distance learning.

In conclusion, the study demonstrates that a combination of Interdisciplinary Project Based Learning and distance education can remarkably enhance interdisciplinary communication, teamwork, and innovative problem solving. However, the efficacy of this approach is dependent on two key conditions: allowing

sufficient time for meaningful collaboration and effectively managing a hybrid context that balances digital and physical interactions. Ensuring clear communication, realistic time allocation, and active engagement in both contexts is essential to maximize the benefits of this educational format.

Future efforts should focus on exploring alternative time frames and on developing hybrid models that ensure robust participation, even in fully remote settings. By addressing these challenges, educators can harness the full potential of IPBL in distance learning, ultimately creating more inclusive and innovative learning environments that prepare students to tackle complex, real-world problems.

References

Blumenfeld, P. C., Soloway, E., Marx, R. W., Krajcik, J. S., Guzdial, M., & Palincsar, A. (1991). Motivating Project-Based Learning: Sustaining the Doing, Supporting the Learning. *Educational Psychologist*, *26*(3-4), 369-398. https://doi.org/10.1080/00461520.1991.9653139

Boix Mansilla, V. (2010). Learning to Synthesize: The Development of Interdisciplinary Understanding. In R. Frodeman, J. T. Klein, & C. Mitcham (Eds.), *The Oxford Handbook of Interdisciplinarity* (pp. 288-306). Oxford University Press.

Brassler, M., & Dettmers, J. (2017). How to Enhance Interdisciplinary Competence—Interdisciplinary Problem-Based Learning versus Interdisciplinary Project-Based Learning. *Interdisciplinary Journal of Problem-Based Learning*, *11*(2). https://doi.org/10.7771/1541-5015.1686

Carella, G., & Colombo, F. (2024). Teaching Design and actively applying it through project-based learning format: A practical case study of a collaboration between a university course and a company. In *INTED2024 Proceedings* (pp. 2391-2398). https://doi.org/10.21125/inted.2024

Carella, G., Conte, M., Italia, M., & Parolini, F. (2024). How to adopt Strategic Design inside universities: Transforming research in educational formats. In *ICERI2024 Proceedings* (pp. 3927-3936).

Carella, G., & Melazzini, M. (2023). Teaching Design in a Fully Remote Environment: Challenges and Changes in the Pedagogical Approach During the Covid-19 Pandemic. In *ICERI2023 Proceedings: 16th annual International Conference of Education, Research and Innovation* (pp. 3985-3990).

Chang, T.-S., Wang, H.-C., Haynes, A. M., Song, M.-M., Lai, S.-Y., & Hsieh, S.-H. (2022). Enhancing student creativity through an interdisciplinary, project-oriented problem-based learning undergraduate curriculum. *Thinking Skills and Creativity*, *46*, 101173.

Dewey, J. (1959). *The school and society.* University of Chicago Press.

Donaldson, J. P., Choi, D., & Layne, J. (2021). *Online Design Thinking Faculty Development Workshops: A Design-Based Research Study*. https://repository.isls.org//handle/1/7319

Hart, J. L. (2019). Interdisciplinary project-based learning as a means of developing employability skills in undergraduate science degree programs. *Journal of Teaching and Learning for Graduate Employability*, *10*(2), 50-66. https://doi.org/10.21153/jtlge2019vol10no2art827

Hays, W. L. (1973). *Statistics for the social sciences* (2nd Ed.). Holt, Rinehart and Winston.

Klein, J. T. (1990). *Interdisciplinarity: History, Theory, and Practice*. Wayne State University Press.

Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-based learning: A review of the literature. *Improving Schools*, *19*(3), 267-277. https://doi.org/10.1177/1365480216659733

Patricio, R., Dias, J., Carella, G., & Gancho, S. (2024). Managing design innovation challenges in a digital environment. *International Journal of Design Creativity and Innovation*, *12*(3), 139-162.

Redshaw, C. H., & Frampton, I. (2014). Optimising inter-disciplinary problem-based learning in postgraduate environmental and science education: Recommendations from a case study. *International Journal of Environmental and Science Education*, *9*(1), 97-110.

Repko, A. F. (2008). *Interdisciplinary Research: Process and Theory*. SAGE.

Stentoft, D. (2017). From saying to doing interdisciplinary learning: Is problem-based learning the answer? *Active Learning in Higher Education*, *18*(1), 51-61. https://doi.org/10.1177/1469787417693510

Vallis, C., & Redmond, P. (2021). Introducing design thinking online to large business education courses for twenty-first century learning. *Journal of University Teaching and Learning Practice*, *18*(6), 213-234. https://doi.org/10.53761/1.18.6.14

Yusri, R., Yusof, A. M., & Sharina, A. (2024). A systematic literature review of project-based learning: Research trends, methods, elements, and frameworks. *International Journal of Evaluation and Research in Education (IJERE)*, *13*(5), 3345. https://doi.org/10.11591/ijere.v13i5.27875