Entrepreneurship Education Approaches: Hackathon and Project-Based Learning

Ana Miličević, Milica Simić, Zorica Bogdanović, Marijana Despotović-Zrakić, Marko Suvajdžić[**]

Abstract

This study compares the impact of informal education (hackathons) and formal education (project-based learning) on entrepreneurial education. Analysing data on both approaches, gathered through practical experience at the University of Belgrade, the research reveals positive effects on entrepreneurial behaviour and mindset. The study tracks various learning indicators by examining strengths, challenges, and differences in students' intentions, attitudes, and teachers' perspectives. Results show hackathons foster creativity and entrepreneurial skills, while project-based learning excels in subject mastery and soft skill development. Both approaches enhance networking and innovation, but students prioritise hackathons for personal promotion, resulting in varying levels of commitment.

Keywords: Entrepreneurial learning model, Entrepreneurial education, Hackathon, Project-based learning, Sustainable entrepreneurship
JEL Codes: I23 Higher education, L26 Entrepreneurship

1. Introduction

The problem addressed in this article is bridging the gap between academic studies and practical entrepreneurship during studies and offering a unique opportunity for students to gain both formal degrees and experience with real-world challenges, potentially leading to their entrepreneurial careers.

Entrepreneurship education is a complex and fragmented field that is undergoing continuous evolution. Despite the growth of research, consolidation is needed,

** *Ana Miličević*, Senior Associate, Ph.D. Student, Department of Research and Development Center, Faculty of Organizational Sciences, University of Belgrade. E-mail: ana.milicevic@fon.bg.ac.rs. Main research interests: Entrepreneurship, Project-Based Learning, Hackathons, E-Business
Milica Simić, Teaching Assistant, Ph.D. Student, Department for E-Business, Faculty of Organizational Sciences, University of Belgrade. E-mail: milica.simic@fon.bg.ac.rs. Main research interests: E-Business, Blockchain, Artificial Intelligence, Internet technologies, Technology in Education.
Zorica Bogdanović, Full Professor, Ph.D., Department for E-Business, Faculty of Organizational Sciences, University of Belgrade. E-mail: zorica.bogdanovic@fon.bg.ac.rs. Main research interests: E-Business, Internet Technologies, DevOps, Blockchain, Artificial Intelligence
Marijana Despotović-Zrakić, Full Professor, Ph.D., Department for E-Business, Faculty of Organizational Sciences, University of Belgrade. E-mail: marijana.despotovic-zrakic@fon.bg.ac.rs. Main research interests: E-Business, Internet Technologies, Blockchain, Artificial Intelligence
Marko Suvajdžić, Associate Professor, University of Florida. E-mail: marko@digitalworlds.ufl.edu. Main research interests: Digital Art, Blockchain, Game Design, Virtual Reality

especially in pedagogy and curriculum integration. Studies highlight the positive impact of entrepreneurship education on skill development, emphasising pedagogical models of collaboration in technology-rich environments. Common approaches include experiential, problem-based, and project-based learning (PBL), along with methods such as peer assessment, design thinking, formative feedback, and service learning. This diversity emphasises the interdisciplinary nature of entrepreneurship education. While existing research focuses on the outcomes of entrepreneurship education, there is still a lack of emphasis on "education" itself, and its pedagogy is still a black box. Therefore, it is necessary to reconsider the goals, content, teaching and learning methods as assessment strategies (Rodrigues, 2023).

Previous studies have demonstrated the effectiveness of experiential programs in university extracurricular settings. However, there has been inconsistent implementation of Entrepreneurship Education in educational institutions, both within curricula and real-world contexts. Additionally, there has been a lack of promotion for necessary pedagogical innovations in this field (Rodriguez, 2023). European articles dedicated to Entrepreneurship Education exclusively interpret learning outcomes, neglecting the discussion of pedagogical aspects related to the teaching and learning of entrepreneurship (Tiberius & Weyland, 2023).

Entrepreneurial education is a common practice in formal and informal settings, with various models and formats to encourage entrepreneurial thinking and behaviour among students. Its significance is reflected in fostering the idea of entrepreneurship as a career choice and in empowering students to implement entrepreneurial ideas. However, it is still questionable how to ensure a closer engagement between educational theory and pedagogical practice and how educators can manage some educational theories and philosophies to consolidate the adequate provision of quality experiential entrepreneurship education (Bell & Bell, 2020).

One of the ways of bringing formal education closer to the needs of entrepreneurial learning is related to innovations in pedagogical approaches. This includes combining methods, such as PBL and various active learning methods, with traditional assessment approaches. The goal is to overcome the limitations of a standardised educational process and provide flexibility that supports the development of entrepreneurial skills. These innovations allow students to actively participate in learning, apply knowledge to real problems and develop creativity, which is critical to preparing future entrepreneurs.

An alternative approach to making formal education more relevant to entrepreneurial learning is derived from the philosophy of open innovation developed in industry. In this approach, the academic community is included as one of the spirals in the triple, quadruple, or quintuple helix models. (Carayannis & Campbell, 2010). Student competitions and hackathons are used to implement

open innovation in non-formal education, with companies recognising their value in generating ideas and prototypes. However, the limitation of this model is that it exclusively focuses on the innovation capacity of educational institutions or technology transfer and ignores educational goals and learning outcomes. While PBL is a recognised method for fostering innovative competencies, its shortcoming for open innovation lies in translating classroom results to potential investors, consumers or markets (Stojanović et al., 2023).

The research gap is observed in the concrete educational environment at the University of the Belgrade – Faculty of Organizational Sciences (FON), where two different approaches to learning are implemented and practised: PBL in the formal and hackathon in the informal education process. The aim is to examine the contribution of two learning approaches to entrepreneurship education. The analysis of motivational factors refers to the views of PBL and hackathon participants on the contribution of motivational factors to entrepreneurial intention, with the final goal of preparing students to take entrepreneurial action.

The paper is structured as follows: Section 2 reviews the literature on hackathons and PBL in entrepreneurial learning. Section 3 outlines the methodology applied in this research. Section 4 analyses the results, while Section 5 provides discussion and concluding remarks.

2. Literature Overview

In the Literature Review section, we explore the different theories that form the foundation of our research. We also introduce carefully formulated research questions designed to build upon and support the existing theoretical framework. By outlining our research questions here, we aim to emphasise the close connection between our study and the current body of knowledge.

2.1. Bridging the gap to entrepreneurial education through innovative pedagogical approaches

According to the European Entrepreneurship Competence Framework, "EntreComp", developing an entrepreneurial mindset requires skills to generate ideas and recognise opportunities, resources, and actions (García-Castanedo & Corrales-Garay, 2024). Entrepreneurial behaviour refers to the mindset and actions of individuals aimed at creating a positive impact in the workplace. This includes taking the initiative, being innovative and taking calculated risks for success, identifying opportunities and developing creative solutions (Toding et al., 2023). Strategies such as interdisciplinary problem-based learning courses, internships, and teamwork assignments are needed to achieve this. However, entrepreneurship learning strategies in colleges usually apply to a certain level of entrepreneurship training adapted to the early stages, focusing mainly on de-

veloping business ideas or prototypes. While there is no agreement on whether entrepreneurship can be stimulated through education, it is acknowledged that entrepreneurship education positively impacts the development of knowledge and skills and improves entrepreneurial attitudes and intentions (Lina et al., 2019; Muthumeena & Yogeswaran, 2022). An entrepreneurial and innovative Higher Education Institution (HEI) should provide diverse learning opportunities to facilitate innovative teaching and learning across all faculties. Such an institution must encourage innovation and diversity in its approach to teaching and learning across all faculties and departments. Moreover, it should develop entrepreneurial mindsets and skills across all academic programs. Several practices can be implemented to promote the development of an entrepreneurial mindset across the student and teaching staff, including internships, business competitions, case studies, hackathons, games, and simulations. Additionally, teaching staff can receive training to acquire interdisciplinary teaching and research methods that support the development of an entrepreneurial mindset (Marin et al., 2018).

Universities have made significant efforts to incorporate entrepreneurship education into their academic programs. These measures include introducing theoretical courses on entrepreneurship and organising events that promote entrepreneurship (Lina et al., 2019). Despite the large number of existing models of entrepreneurial education, there is currently a lack of adequate models that are applied in higher education institutions and are tailored to help in the establishment of startups (Santoso et al., 2023). There is no coherent framework for entrepreneurship education, although there are frameworks in individual HEIs (Marin et al., 2018). However, the Entrepreneurship 2020 Action Plan proposed by the European Union suggests introducing entrepreneurship education in schools, colleges, and universities, aiming to promote students' entrepreneurship as a driving force for overall social welfare (Simović & Ilić, n.d.). Still, entrepreneurship education faces the challenge of determining the content and methodology (Organ et al., 2022). Another critical factor that can impact the effectiveness of entrepreneurship education is the "fear of failure".

Fear of failure is a psychological phenomenon defined by concern or anxiety over not reaching desired results or goals. Entrepreneurship might show concern about the potential negative repercussions of business failure, such as financial loss, reputational damage, or personal disappointment. Recognising and addressing this challenge within educational frameworks can help institutions better prepare students for the uncertainties of the entrepreneurial environment. (Cacciotti et al., 2016).

In further analysis, we focus on two different pedagogical approaches for improving entrepreneurial education, namely, hackathon-based and project-based

learning approaches, and the outcomes related to students' readiness for an entrepreneurial environment.

2.1.1. Hackathons in Entrepreneurial Education

Hackathons bring together people with diverse skills to solve real-world challenges through collaboration and problem-solving. These events promote cross-disciplinary teamwork, rapid prototyping, practical problem-solving, and effective networking. Hackathons are also great experiential learning opportunities that prioritise user-centric solutions and open collaboration to fuel unexpected innovation. They validate ideas, cultivate an innovation-driven culture, leverage open-source contributions from technical challenges to benefit the wider community, and provide recognition for winning solutions that enhance visibility and attract potential investments. Ultimately, hackathons accelerate open innovation and yield concrete outcomes (Cobham et al., 2017).

A hackathon is a gathering where individuals collaborate to create inventive technological solutions addressing diverse challenges in various industries. This event encourages creativity, problem-solving, and the incorporation of cutting-edge technologies while showcasing a feasible business concept as the proposed solution. Although hackathons were initially centred around programming and exclusively for hackers, they have now transformed into a distinct innovation model with a broader scope, such as finance, food, climate, healthcare, space exploration, music, sports, fashion, and tourism (Lionaite, 2020). Private companies host 48.5 % of hackathons globally, with the academic sector responsible for 30.3 % of these events (HackerEarth, 2017).

Hackathons can enhance performance, drive innovation, and foster intrapreneurship by encouraging creative thinking and risk-taking, promoting cross-functional collaboration, and empowering participants to take ownership of their ideas. They facilitate rapid prototyping and iteration, boost engagement and motivation, and serve as a talent identification and development tool. Ultimately, hackathons create a culture of innovation, foster collaboration, encourage intrapreneurial behaviour, enable quick learning and adaptation, and help identify and nurture potential talent within organisations (Szymanska et al., 2020; Wallwey et al., 2022). Hackathons contribute to entrepreneurial skills and self-efficacy. Effective entrepreneurial learning also significantly improves the ability to identify viable entrepreneurial concepts and launch new ventures (Szymanska et al., 2020).

Communication and collaboration are essential in hackathons. Participants form teams, brainstorm ideas, divide tasks, share knowledge, receive feedback, iterate on their work, and present their projects. Hackathons foster a collaborative environment where effective communication and collaboration are crucial for successful project development, problem-solving, and innovation (Szymanska et

al., 2020). The educational hackathon is an interactive and collaborative learning method that involves students, educational organisations, industry, and society. It fosters multidisciplinary learning and networking (Jussila et al., 2020).

Examples of hackathon usage in academic environments for entrepreneurial learning are numerous, focusing on different aspects, such as training programs and Minimum Viable product generation (Avila-Merino, 2019; Feder, 2021; Temiz, 2021). Minimum Viable Product **(**MVP) is the most basic product version that can be released with the minimum features necessary to satisfy early adopters. The concept is rooted in the lean startup methodology, which aims to validate a business idea by building and launching a simplified product version. By releasing an MVP, startups can gather valuable customer feedback, test hypotheses, and iterate on the product, reducing the risk of investing significant resources into developing features that may not meet market demands (Blank & Bob Dorf, n.d.; Hart, 2012).

The hackathon events held at FON gained much attention from sponsors, partners, companies, and governmental and non-governmental entities over time. By 2010, the hackathon had become a university-wide event. In the following years, hackathons became accessible to all students across Serbia, extending their reach beyond the initial faculty (Naumović et al., 2022). FON student organisation "FONIS" extended hackathons to high school students in 2018. The international hackathon W3 Algorand Hackathon 2023 was hosted at the FON in April 2023, welcoming students at every academic level from the USA and Serbia (Bogdanović et al., 2023; Miličević et al., 2024).

2.1.2. Project-based learning in entrepreneurial education

PBL is an approach to teaching that emphasises active, context-specific learning to equip students with competencies to solve real-world problems. It is widely recognised as an effective method for developing innovation competencies in engineers (Charosky Larrieu-Let, 2021; Cortés et al., 2022; Isomöttönen & Kärkkäinen, 2016). Under the PBL model, students can generate a range of products, from prototypes to commercially viable products, thereby fostering the success of startups (Santoso et al., 2023). The PBL approach emphasises collaborative learning, where teachers and students work together to solve problems and develop projects. It involves students working in groups to share knowledge and skills and encourages effective communication through interactions with peers and teachers. The PBL approach has been found to enhance student engagement, improve learning outcomes, and develop essential skills such as collaboration and communication (Almulla, 2020).

Examples of PBL usage in academic environments for entrepreneurial learning are various. For example, PBL can deliver an entrepreneurial curriculum to software development students (Organ et al., 2022) or for creating startups at

higher education institutions (Santoso et al., 2023). The Department of E-Business at FON has used the PBL approach for a few years. This approach involves students working in multidisciplinary teams to develop business models, digital products and intelligent environments. The teams consist of members with various roles, such as Scrum Masters, Product Development Team, Software Developers, and Testers. DevOps tools are used to facilitate communication and collaboration among the teams. Students actively engage in classes and practical exercises and work on concrete projects for final exams (Bogdanović et al., 2023).

2.1.3. Entrepreneurial readiness in local startup ecosystem: navigating preparedness for professional environments

Specific traits of the local startup ecosystem identified during the previous year indicate that almost 80 % (Ivanovic et al., 2023) of startup founders have a higher education degree. This shows that academia has the potential to contribute to the growth of an entrepreneurial mindset and support entrepreneurial activities. However, *Startup Skener* (Ivanovic et al., 2023; Tomić-Brkušanin, 2022) concluded that the educational system does not motivate and prepare students for future entrepreneurial endeavours and that it does not educate future professionals in areas needed for the development of the digital economy. Lack of relevant knowledge and skills from formal education directly influences the number of startup teams and hinders the employment of new team members in many areas crucial for their growth. Analysis of local support organisations indicates these programs are insufficiently aligned with startup needs.

Entrepreneurship education has a significant positive impact on the performance of established businesses by helping entrepreneurs improve their perceived capabilities and opportunities. These findings extend the current research on the effects of entrepreneurship education on entrepreneurial activities at different stages of development for entrepreneurial businesses (He et al., 2024). On the other hand, it examines design thinking as a method of project-based education used in university-level ideation (García-Castanedo & Corrales-Garay, 2024).

In addition to the above initiatives, many Erasmus, EIT, EIC and HEI projects deal with similar challenges in an international context, e.g., UPM, ELTE, and Universite de Rennes, which provide extensive programs for students with an entrepreneurial orientation. These opportunities involved FON staff and student teams participating in workshops, mentoring programs, and panel discussions. One example of good international practice is the Danube Cup, an international network of universities along the Danube that enhances entrepreneurship education and supports student startups. It brings together student startups with educators, startup ecosystems, and one another to help them succeed in international markets.

Based on the previous analysis and comparison of the hackathon and PBL learning approaches, and having in mind the analysed aspects of the startup environment given in sections 2.1.1, 2.1.2 and 2.1.3, we have formulated three research questions:

RQ1: Does implementing hackathon and PBL approaches enhance students' technological and business knowledge and skills?

RQ2: How do students' perceptions of the impact of hackathons and PBL on their entrepreneurial behaviour reflect the influence of these approaches on their attitudes and actions towards entrepreneurship?

RQ3: Which factors drive students' motivation and active engagement in proposed learning approaches?

2.2. The role of teachers in cultivating stimulating learning environments

Supporting the development of students' entrepreneurial skills requires the special participation and efforts of the teaching staff. The attitude of teaching staff towards entrepreneurship education refers to the way of thinking and behaviour of teachers to create a climate, adopt, apply, and monitor the effects of different approaches (in this case, PBL and Hackathon) for focused learning and supporting entrepreneurial attitudes and behaviours of students. As coaching and mentoring are used to develop students' startup talents, the ability to teach students becomes an enabling factor for action-based learning methods in entrepreneurship education (Somià et al., 2023). Still, the relationship between teacher thinking and creating a student-centred learning environment is underresearched in entrepreneurship education (Santoso et al., 2023; Toding et al., 2023). This study aims to shed light on two different approaches of formal and informal training, the possibility of combining them to achieve influence and encourage entrepreneurial thinking and behaviours of students during their studies at the level of the early phases of development of ideas and solutions. Based on this analysis, the fourth research question was formulated:

RQ4: How do student engagement, learning outcomes, and instructional ease of implementation influence teachers' evaluations of the effectiveness and preferences for different learning methods?

3. Methodology

3.1. Research context

Both approaches (PBL and Hackathon) were considered and implemented within the educational process of the Department of e-business at FON.

Project-based learning occurred in subjects such as the Internet of Things, Digital Marketing, and E-business Risk Management. Students proposed solutions as exam projects without special prizes. The data presented in this article were gathered during the school year 2022–23 (Bogdanović et al., 2023).

The hackathon approach was implemented within the same context but as an informal activity. The Algorand Hackathon 2023, hosted in April 2023, aimed to foster innovation in Web3 projects based on blockchain technologies. Participants proposed e-business solutions across various sectors, guided by a structured program encompassing a blockchain boot camp, design thinking workshops, and a WEB3 hackathon. The hackathon allowed students to apply their knowledge and present their creations to an international jury, earning recognition and prizes from sponsors.

3.2. Assessing the impact of hackathons and project-based learning initiatives: A comparative analysis

To compare PBL, which is incorporated in the classroom, with hackathons, which are typically extracurricular, and to assess their contributions to entrepreneurial learning, the effects of both approaches on students were reviewed using identified indicators and literature reviews.

It is important to emphasise that these two approaches are not directly comparable in an educational context. However, they were evaluated from the point of view of indicators related to learning, project value, career development, professional networks, after-work experiences, and perceived shortcomings, considering factors such as the number of participants, motivation, management model, incentives, collaboration methods, learning outcomes, quality and applicability of solutions. (Avila-Merino, 2019; Bogdanović et al., 2023; Byrne et al., 2018; Garcia, 2023; Miličević et al., 2023).

When assessing the impact of hackathons or PBL initiatives, several critical indicators are considered (Bogdanovic et al., 2023; Butt et al., 2021; Miličević et al., 2024; Nolte et al., 2018; Pe-Than et al., 2018). One of the most important is skills development, which refers to how these initiatives enhance participants' technological skills, soft skills, and problem-solving abilities. Another crucial factor is project value, which includes participants' satisfaction with the challenges and solutions, their overall perception of the experience, and their commitment to advancing the project during hackathons or PBL initiatives.

Additionally, career development plays a crucial role, as participants often view hackathons or PBL initiatives as opportunities to open doors for future jobs or internships. Participants also see these initiatives as a platform for nurturing business ideas with the potential to lead to startup ventures. Networking oppor-

tunities are another critical consideration, as these events allow participants to connect with professionals and like-minded individuals.

Finally, the impact of engagement in post-event activities is considered, along with any perceived drawbacks. These drawbacks may include challenges from the fast-paced environment, issues within team dynamics, or unmet expectations related to mentoring or the event's structure.

3.3. Data collection and Instruments

This study utilised data from surveys conducted after PBL courses and during and after the hackathon. The research and data collection occurred while implementing PBL during the 2022–2023 school year. A survey, titled "Survey Sheet for the Evaluation of Work on the Project," was distributed to gather pertinent information from all students who participated in classes from the e-business department using this learning approach during this period. The survey included six demographic questions, 61 questions about perceived benefits and sacrifices for participation in PBL, and two open-ended questions. Only the questions related to indicators presented in the previous subsection were considered for analysis.

The hackathon data collection was conducted in two stages. The first stage involved initial data collection immediately after the hackathon, focusing on participants' experiences and feedback. Four months later, a follow-up data collection took place, including input from participants and organisers, specifically the teaching staff. To facilitate this research process, three distinct questionnaires were developed: the Participants Survey Hackathon (Survey 1), the Participants Survey Post-Hackathon (Survey 2), and the Teaching Staff Survey (Survey 3).

Survey 1 was conducted immediately after the hackathon, while Survey 2 and Survey 3 were conducted separately for participants and teachers four months later. The research questions focused on the readiness of the participants for new technical knowledge, the initiation of the development of business ideas, and the effects after the hackathon on learning and professional development, while the teachers pointed out which model they see as more suitable in acquiring knowledge, skills and motivation of entrepreneurial thinking and behaviour among students. Survey 2 was designed for participants, aligning with the principles of the initial questionnaire. Specifically, it aimed to capture the perspectives and insights of participants four months after the hackathon's conclusion. Survey 3, designed for the hackathon and PBL teachers, investigated the impact of these methods on pre-entrepreneurial learning aspects, including fostering creativity, enhancing specific knowledge, refining soft skills, promoting an entrepreneurial mindset, and elevating solution quality. Additionally, the survey explored

teachers' openness to adopting hackathons in education and their inclination to enhance formal pedagogical approaches and methodologies.

3.4. Survey participants

In April 2023, Hackathon Survey 1 targeted 34 students from Serbia, representing diverse faculties, primarily with backgrounds in IT. The cohort comprised 16 females and 18 males, including 9 with bachelor's degrees, 13 undergraduates, 9 master's students, and 3 high school students. During Survey 2, which took place four months after the final hackathon, 30 participants from Serbia completed the questionnaire. Survey 3 was conducted exclusively for the hackathon and PBL teaching staff of the FON, and six teachers filled it.

Conversely, the PBL survey involved 111 students from FON, consisting of 44 males and 67 females. These participants actively participated in the PBL learning process and contributed to developing a mandatory project.

4. Results And Discussion

4.1. RQ1: Empowering students with new tech and business knowledge and skills

In analysing *Learning and skill acquisition* indicator based on feedback from PBL and Hackathon participants, students emphasise that both approaches foster knowledge and skill development. PBL notably impacts mastering specific subjects and curriculum knowledge (rated 4.41). Hackathons, scoring an average of 3.87, are highly effective in students' acquisition of technical expertise. PBL significantly contributes to soft skills development alongside subject knowledge acquisition (rated 4.30). According to student perspectives, the implementation of PBL in teaching subjects has a very positive influence on accepting and mastering specific subject knowledge during lessons (see Figure 1). The differences between the two approaches are statistically significant for the tech knowledge aspect: $t(40) = 3.38$, $p = 0.0008$, but not statistically significant for the soft skills aspect.

Furthermore, participants in the hackathon assessed the speed at which they could apply the acquired technical knowledge post-event, giving it an average score of 3.13, indicating a moderate pace with noticeable progress. The level of comprehension of working with technologies after the hackathon was rated at 3.68, representing a satisfactory understanding of how technology operates.

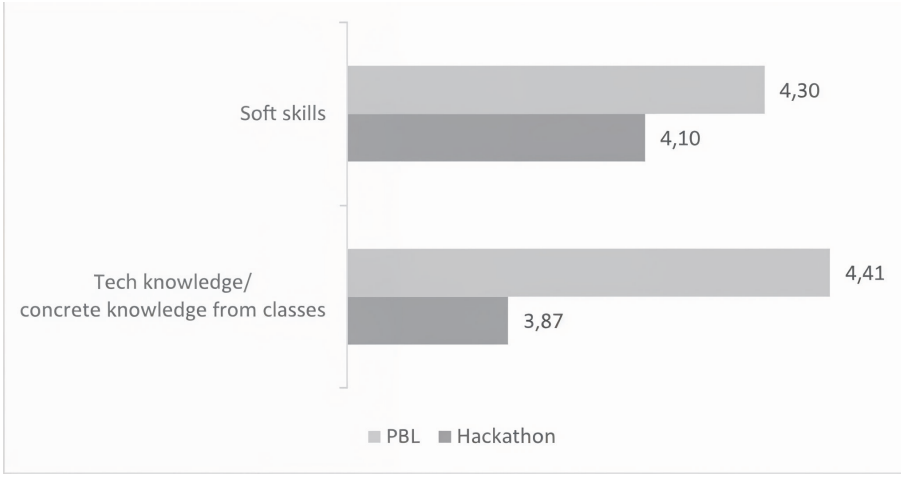

Figure 1. Comparison of average impact approaches of learning and skill acquisition.

4.2. RQ2: Students' perception of the impact of hackathons and PBL on their entrepreneurial behaviour

To perceive and analyse both approaches as forms of entrepreneurial learning, their influence on altering students' thinking and entrepreneurial behaviour was examined. This evaluation encompassed various indicators, including Learning and skill acquisition as problem-solving ability, Project Value in terms of participant satisfaction with the solutions created by the perception of the hackathon or PBL as an opportunity to initiate and inspire business ideas and launch startups, and the assessment of Networking with professionals to expand professional connections and mentorships. Post-project engagement was also considered (see Figure 2). For all three compared aspects, the differences between the intention to continue, start a business idea, and ability to cope with real problems when applying PBL and hackathon approaches are statistically significant, respectively: $t(50) = -2.61$, $p = 0.006$, $t(70) = -3.16$, $p = 0.001$, $t(43) = -7.32$, $p < 0.001$.

How effectively can hackathon participants address actual problems and challenges faced by companies? Students evaluated this capability with a score of 3.83, emphasising that participation in hackathons significantly enhances their readiness to tackle real-world issues and propose solutions. Conversely, PBL participants rated this ability at 2.50, particularly noting challenges in formulating proposed solutions. Hackathon participants, with an average score of 4.60, believed that the hackathon effectively enables students to develop their business ideas. They also noted its role in mastering the fundamentals of entrepreneurship and cultivating a startup mindset. PBL students gave this opportunity a score of 4.26, which is very good. In addition, PBL students

pointed out that they can develop their ideas more easily and quickly by participating in group innovation development projects and acquiring the basics of entrepreneurship and start-ups.

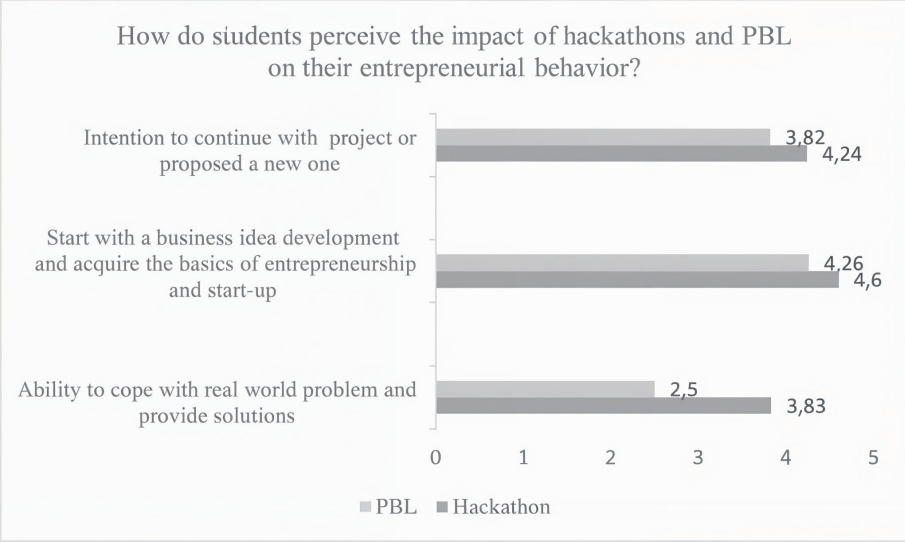

Figure 2. Comparison of the average impact of both approaches on students' entrepreneurial behaviour.

Examining the Post-project engagement indicator, hackathon participants were surveyed on their likelihood of continuing to work on the project. The results showed a grade of 4.24 for hackathon students and 3.82 for PBL students, indicating a positive attitude toward continuing to work on the project.

Additionally, participants were asked to rate the importance of hackathon organisers offering events after the hackathon to support project continuation. Participants expressed strong enthusiasm for this idea, deeming it very important and assigning it a score of 3.97.

A vital benefit of those two learning approaches as entrepreneurial education is transforming entrepreneurial intention into entrepreneurial behaviour. Entrepreneurial intention is essential in entrepreneurship, as it influences actual behaviour. Nevertheless, there are concerns that it may not translate to behaviour. Commitment and internal locus of control provide favourable boundary conditions for an individual to transition from entrepreneurial intention to actual behaviour (Neneh & Dzomonda, 2024).

The mechanism for transitioning from entrepreneurial intention to actual behaviour involves understanding how different learning experiences, such as hackathons and PBL, contribute to this process, especially in fostering partici-

pant commitment and internal locus of control. According to the study results (Kong et al., 2020), the connection of Entrepreneurial intention is positively correlated with entrepreneurial behaviour, while the fear of failure acts as a barrier among students. Having business role models improves entrepreneurial intentions. The study recommends implementing measures to address students' fear of failure and enhance entrepreneurship education to nurture creative talent.

Hackathons offer intensive, hands-on environments where participants face real-world challenges under tight deadlines. They connect intention with action through design, prototyping, and competitive solution presentation. Participants rate the experience highly, attributing it to initial entrepreneurial knowledge that encourages them to participate again. This environment reduces the fear of failure and guides participants with the support of mentors.

PBL involves students in long-term, collaborative projects that delve deeply into complex challenges, where the participants rate the ability to solve real problems with an average score of 2.5. They positively evaluate acquiring basic entrepreneurial knowledge and creating business ideas through their project tasks, which encourages the intention to continue with the baiting project. Long-term engagement with the project enables longer mentoring and guidance through learning and creating solutions, facilitating the fundamental transition from intention to behaviour.

4.3. RQ3: Students' motivation and drivers of active engagement

Both entrepreneurial learning approaches (hackathon and PBL) motivate participants through Project Value, which generates positive emotions, sparks activity, and instils a sense of usefulness by creating innovative solutions. Hackathon students also perceive it positively, grading it by 4.25. The highly positive evaluations for hackathon students 4.12. and PBL students 4.48. indicate that students are motivated by the project's value as they find it gratifying to contribute to developing new innovative services and fulfilling project expectations. Students engaged in PBL conveyed that their curiosity, coupled with addressing real-world problems in PBL projects, motivated them to propose and develop new solutions. They assigned an average score of 4.30 to this mindset, underscoring the significance of curiosity as a motivating factor during project work, an integral component of their educational and examination experience. Enthusiasm and curiosity form essential aspects of the Project Value indicator, reflecting the value students derive from engaging with PBL. Developing innovative solutions is deemed worthwhile and offers a pleasant experience; for the hackathon, students were graded 4.64, and PBL students were evaluated by 4.40 (see Figure 3). There is no statistically significant difference regarding the aspect of curiosity. However, for both feeling useful and enjoyment aspects, there are statistically

significant differences between PBL and hackathon, respectively: t(61) = -2.14, p = 0.02, t(48) = 2.25, p = 0.03.

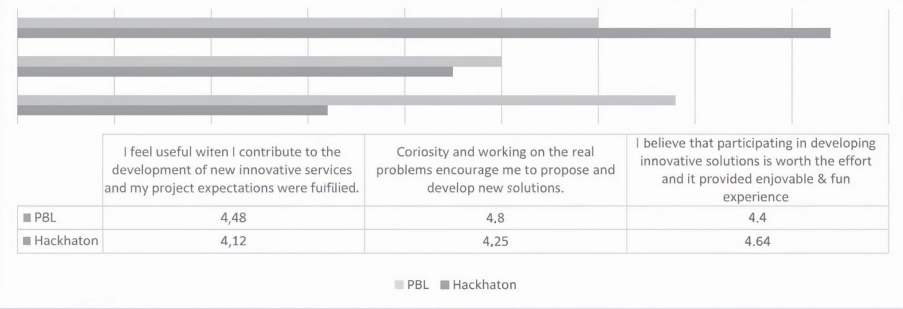

Figure 3. Project Value indicator and impact on Hackathon and PBL students' motivation

Although PBL is a compulsory learning approach integrated into the formal educational process, encompassing task preparation and exam completion, students' attitudes and additional motivations for participation were explored. Students in PBL highly appreciate the experience, viewing it as a valuable addition to their resumes and a beneficial aspect for their future careers. They are motivated by the opportunity to work on real corporate challenges, which enhances their societal recognition and reflects positively on their efforts to contribute to the local community, see Table 1.

Table 1. Motivational Factors for Increasing Student Engagement in PBL

Motivational factors description	AVG	STDEV
Better preparation for the final exam in the course	4.41	0.71
Benefit for further development and career	4.39	0.75
Participation in projects assigned by companies.	4.13	0.91
Contribution to the local community.	4.11	0.94
Individual reputation in society.	3.98	1.01
CV enrichment	3.89	1.21

Table 2 presents the average ratings of various motivational factors influencing participants' decisions to engage in hackathons. Participants were asked to rate the importance of these factors, and the values ranged from the highest-rated factor, having an enjoyable experience, to the least-rated factor, funding a hackathon project (solution), but still highly evaluated, see Table 2.

Table 2. Motivational Factors for Increasing Student Engagement in hackathon.

Motivational Factors for Increasing Student Engagement in hackathon	AVG	STDEV
Have enjoyable experience	4.64	0.49
Improve tech knowledge	4.59	0.5
Connect with professionals	4.57	0.69
Network with like-minded individuals	4.46	0.74
Learn new soft skills	4.27	0.83
Work on real-world problems	4.25	1.11
Employment	4.07	1.11
Internships	4.04	1.19
Validate ideas (business or tech)	3.95	1.05
Win prizes	3.85	1.23
Funding hackathon project (solution)	3.75	1.21
Prizes	3.17	0.49

The average rating for the importance of prizes was 3.17. The score indicates the collective perception among participants regarding the role of rewards, where cash and merchandise prizes, while important, are not central. Additionally, comparing participants' assessments before and after the hackathon, the influence of prizes (both material and monetary) on their decision to participate ranged from 3.85 to 3.23. This suggests that while prizes hold a moderate significance, they are not the primary motivation for students.

Based on the Career Development indicator, students rated the impact of participating in the hackathon as 3.89, indicating that it significantly enhances their chances of securing internships and professional offers. The PBL influence was even higher at 4.33. The Network with Professionals indicator provides insight into the opportunities for students to connect with industry professionals and work on projects assigned by companies. The hackathon received a high average score of 4.57 in this category (see Figure 4). However, only the difference regarding the opportunity to connect is statistically significant: $t(53) = -2.85$, $p = 0.003$.

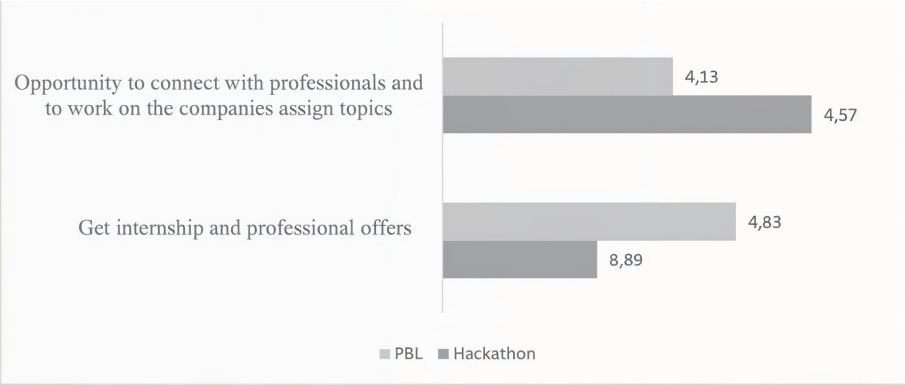

Figure 4. Impact of Hackathons and PBL on Career Development and Network with Professionals.

Additionally, regarding drawbacks such as evaluated attitudes about sharing ideas and opportunities to validate ideas, among the potential disadvantages, hackathon participants reported experiencing a sense of loss and mistrust arising from exchanging ideas. Hackathon students are rated 3.95, meaning they feel that they are not open to sharing ideas, while PBL students showed a neutral attitude about it and evaluated it by 2.66.

4.4. RQ4: Teachers' evaluation

Teachers observed indicators Exploring New pedagogical approaches and Experiential learning outcomes. They emphasised the high importance of innovativeness in student solutions from both approaches, giving it a rating of 5.00. When evaluating Perceived drawbacks and the practicality of learning outcomes, teachers rated the applicability of hackathon solutions to real-world problems higher at 4.00. Teachers who actively engage in hackathons within PBL consider this participation highly significant. It motivates them to enhance teaching methods and experiential learning (see Figure 5). Considering the small sample, we did not examine if there was a statistically significant difference between the samples.

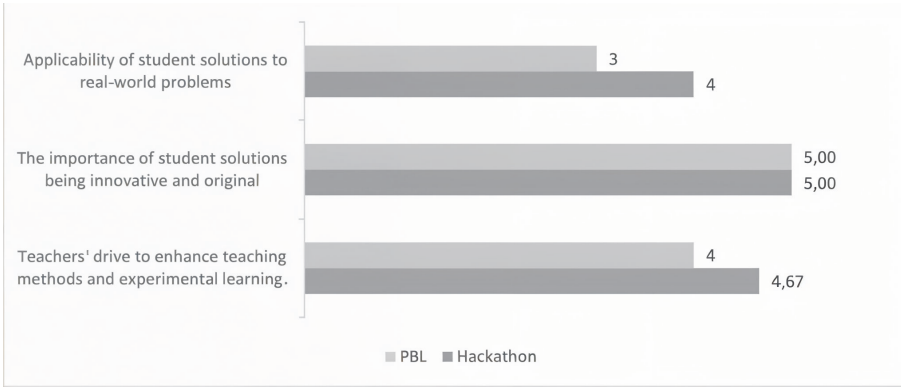

Figure 5. How teachers view the influence of hackathons and PBL as methods for entrepreneurial education on students and enhance teaching methods and experimental learning.

How do teachers compare and evaluate the effectiveness and preference of hackathons and PBL as learning methods? Experienced teachers in both approaches have found that hackathons promote creativity, problem-solving, and an entrepreneurial spirit. On the other hand, PBL focuses on developing concrete knowledge and soft skills. In the case of the hackathon, the development and improvement of the entrepreneurial spirit and behaviour of the students were rated with 100 % preference, with which all participating teachers unanimously agreed. Both learning approaches equip students with the capacity to produce high-quality solutions.

The teachers underscore that the fundamental distinction between these two formats lies in their operational dynamics. PBL is an essential and obligatory element of the formal academic process, requiring mandatory participation throughout study and course completion. On the other hand, the hackathon is an extra, non-compulsory, and informal activity that appeals to participants.

In the realm of higher education, significant transformations in university frameworks and educational settings are essential for fostering critically reflective, inter/transdisciplinary, experiential, and place-based learning. This necessitates a pivotal focus on interdisciplinarity and transdisciplinary within sustainability education, calling for proactive engagement with diverse stakeholders and providing students with opportunities beyond traditional classroom experiences. (Fernando, 2020).

While the teachability of entrepreneurship is debated, schools embrace diverse pedagogical approaches. Contrasting "traditional" and "entrepreneurial" methods reveals a shift from standardized, passive models to active, experiential, and collaborative approaches. This aligns with progressive education and connects entrepreneurship education to various learning concepts, including experiential,

situational, service, problem/project-based, cognitive, and social constructivist learning. The global trend of incorporating entrepreneurship as a distinct course in college and university curricula underscores the evolution of educational strategies (Rodrigues, 2023).

5. Discussion And Conclusion

5.1. Learning and skill acquisitions derived from hackathon and PBL

Analysing students' feedback related to RQ1, it can be concluded that both methods foster knowledge and skill development. Students assert that implementing PBL in teaching subjects positively influences accepting and mastering specific subject knowledge during lessons. Hackathon participants assessed their ability to apply acquired technical knowledge post-event as progressing at a moderate pace. Their understanding of how technology works was deemed satisfactory according to their post-hackathon evaluation.

5.2. Learning outcomes of hackathon and PBL approaches for entrepreneurial behaviour

Examining both approaches concerning RQ2, we can conclude that students' perceptions of the impact of hackathons and PBL were generally positive. The evaluation revealed that hackathon students experienced enhanced readiness, while PBL participants faced challenges in proposing solutions. Hackathon involvement proved highly effective for developing business ideas and mastering entrepreneurship basics. PBL students found value in this approach during group projects. Participants also expressed appreciation for post-project engagement, highlighting the importance of organizers' support in creating opportunities to continue working on their projects.

The study shows that hackathons can be valuable for incubating startups and teaching practical entrepreneurship, provided they are well-designed with clear themes, challenges, and stakeholder goals. Hackathons foster an entrepreneurial mindset and can confirm assumptions about the viability of solutions in pre-incubation stages, encouraging participants to learn startup principles. However, while hackathons are crucial for developing business ideas and fostering entrepreneurial thinking, they may require additional programs and mentoring for more profound, market-tested startup development. Despite market insight and user testing limitations, hackathons still provide valuable learning environments, facilitating the understanding of product/service creation based on specific technologies.

Both hackathons and PBL are vital in translating entrepreneurial intent into action by providing hands-on learning, skill development, and exposure to real-world problems. They complement each other by offering short bursts of

creativity (hackathons) and sustained project engagement (PBL), preparing individuals to pursue entrepreneurial goals effectively.

Hackathons and PBL serve as valuable mechanisms for transitioning from entrepreneurial intention to actual behaviour by providing experiential learning opportunities, fostering skill development, and exposing participants to real-world challenges. They complement each other by offering intensive, short-term bursts of creativity and problem-solving (hackathons) and sustained, in-depth project work (PBL), collectively preparing individuals to act on their entrepreneurial ambitions effectively.

These platforms facilitate dynamic idea exchange, encouraging teams to experiment, iterate, and develop creative solutions collaboratively. Hackathons and PBL foster an entrepreneurial mindset within organisations by emphasising teamwork and open communication, empowering participants to drive innovation forward.

Hackathons are a more effective and efficient model for developing entrepreneurial skills and confidence than traditional semester-long courses. They boost entrepreneurial self-efficacy more rapidly and with fewer resources. Hackathons are a powerful tool for improving entrepreneurial self-efficiency and developing students' skills (Szymanska et al., 2020).

In conclusion, from a collaborative learning and communication point of view learning through PBL and hackathons significantly impacts better performance in innovative environments and being intrapreneurs by enhancing critical thinking skills, fostering creativity, promoting cross-functional collaboration, building intrapreneurial skills, increasing engagement, and enabling rapid prototyping and practical application. These benefits collectively prepare individuals to thrive and drive innovation within organizations.

These collaborative learning methods foster multidisciplinary learning, bridge academia and industry, and prepare students for entrepreneurship by allowing them to apply and enhance their skills in real-life situations. It could be summarized that hackathons and PBL benefit all participants. For participants and team members, it refers to team engagement and teamwork, working together on a project, playing specific roles in a team and a creative way of approaching problem-solving, learning technology together, but also business and management skills. On the other hand, organisers and sponsors realise benefits such as recognition and visibility, a source of innovation, community building and engagement, corporate branding, recruitment, and even IP development (Calco & Veeck, 2015; Pe-Than et al., 2022).

5.3. Motivational forces of student engagement in hackathons and PBL

Regarding the motivational drivers considered in RQ3, both approaches to entrepreneurial learning motivate participants through the value of the project, which is assessed in terms of generating positive emotions, encouraging activity, and instilling a sense of usefulness through the creation of innovative solutions. Although PBL is a compulsory learning approach integrated into the formal educational process, it has been observed that, in addition to gaining practical knowledge and exam requirements, students in PBL highly value the experience itself, viewing it as a valuable addition to their resumes and a useful aspect for their future careers.

Key motivational factors highly esteemed in hackathons include having enjoyable experiences, enhancing tech knowledge, and connecting with professionals and like-minded individuals. Participants collectively perceive rewards, such as cash and merchandise prizes, as important but not central in influencing their decision to engage in hackathons.

Students observed a notable increase in opportunities for internships, professional offers, and connections with industry professionals through both PBL and hackathons. Additionally, they acknowledged the potential to work on projects assigned by companies.

Potential drawbacks of engaging in hackathons encompass the fast-paced and dynamic work environment, challenges arising from hackathon regulations, difficulties in team dynamics, and the absence of teaching or mentoring that may impede team progress. Hackathon participants also voiced concerns about idea loss or imitation during collaborative efforts with team members and other participants.

5.4. Teachers' perspectives

Regarding the teachers' perspectives considered in RQ4, we can conclude that teachers observe that hackathons foster creativity, problem-solving, and an entrepreneurial spirit. At the same time, PBL emphasises concrete knowledge and soft skills development. Hackathons, unanimously rated with 100 % preference by teachers, significantly enhance students' entrepreneurial spirit and behaviour. Both approaches empower students to generate high-quality solutions, motivating teachers engaged in hackathons within PBL to improve teaching methods and experiential learning.

Teachers note that students see the hackathon as an optional chance for personal advancement, motivating them to invest more effort in finding solutions. Conversely, students participate in PBL primarily because it is mandatory, leading to less effort and minimal exam preparation. The key distinction lies in the operational dynamics, with PBL being an essential and obligatory academic

element, while the hackathon is an extra, non-compulsory, and informal activity appealing to participants.

5.5. Future work and challenges

Solving the identified challenges and future work will involve additional efforts in research and establishing an environment for the practical application of realistic entrepreneurial approaches to sustainable learning. To thoroughly understand the lasting impact and value of the ideas and solutions in both approaches, in-depth longitudinal studies are necessary. A research methodology that supports monitoring both approaches while enabling adequate comparisons must be developed for these. Practical evidence is crucial for identifying optimal practices in using formal and informal learning methods in entrepreneurship education. In addition, there is a need to address additional issues related to aspects of intellectual property.

5.6. Implications

The main implications of the research results are directed to teachers and educational institutions that want to improve entrepreneurial education. The research findings could potentially contribute to developing effective pedagogical strategies and educational policies to drive student engagement in these initiatives, thereby enhancing their learning experience. The findings of this study emphasise that if educators want to improve the effectiveness of education focused on developing entrepreneurial skills, it should be implemented in formal education and include blended formal and informal processes based on different entrepreneurial learning formats.

Both hackathons and PBL were highly regarded by students for enhancing their knowledge and skills. Hackathons were preferred for their hands-on, entrepreneurial, and employability experiences. At the same time, PBL students prioritised building team trust and did not express concerns about idea loss or imitation, unlike hackathon participants. Lecturers noted that hackathons foster creativity, problem-solving, and entrepreneurship, while PBL emphasises the development of concrete knowledge and soft skills. The research also delved into students' motivations for participating in hackathons and found that pleasant experiences, technological knowledge, and networking were the top drivers. However, the rewards were significant but not as expected.

In formal education, it is indicated that if teachers want to improve the effectiveness of education aimed at developing entrepreneurial skills, postgraduate programs should be adjusted to students in business and students who are not; accordingly, their basic foundations are entirely different. These approaches to learning affect these two groups differently (Muthumeena & Yogeswaran, 2022).

The findings highlight the significant advantages of hackathon-based learning, showcasing its capacity to enhance educational experiences, stimulate innovation, and motivate students and educators to excel in their roles within academia. These insights contribute to a comprehensive understanding of the benefits and potential of hackathon-based learning in educational settings. The research affirms that hackathons effectively introduce new technologies and IT knowledge, as evidenced by positive feedback from participants without prior experience in technology.

The integration of hackathons into curricula will be explored in future studies, with the expectation that they will become a standard part of the university experience in the "next normal." While there is no universal approach to designing impactful hackathon events, educators are encouraged to experiment with this emerging pedagogy. Following the hackathon concept, there is an opportunity to revolutionise the traditional higher education model, fostering creativity, entrepreneurial thinking, and the development of graduates prepared for the evolving demands of the future workforce.

Assessment is a critical factor in shaping student learning, guiding their approach to a course and supporting the achievement of learning objectives. Evaluation provides essential feedback, helping students close the gap between their current performance and learning goals (Gratchev, 2023). Replacing traditional exams with project-based assessments centred on real-life site investigations leads to higher average grades and enhanced learning experience (Gratchev, 2023). The Faculty of Organizational Sciences has a long-standing tradition of working with students through hackathons, PBL, and solving case studies. It is common for these formats to be used in teaching, and teachers and students are used to their application. However, learning and taking exams through these work formats has not yet become common and widely accepted in the European academic space as a model of knowledge transfer, practical learning and comprehensive assessment of student engagement. FON's experience working with students through hackathon formats and PBL methods is available as a recommendation for considering the introduction of this way of working and testing students at other faculties and institutions of higher education.

Standards-based grading effectively evaluates and conveys student progress, facilitating transparent communication between educators, students, and parents regarding learning objectives and achievements. However, it often leads to a compartmentalised approach to instruction, focusing solely on individual content standards to ensure comprehensive coverage. This isolated teaching and assessment neglects opportunities for interdisciplinary learning and limits student engagement, resulting in passive participation in knowledge-building. Educators need to integrate interdisciplinary, project-based learning into standards-based grading frameworks (Yokom, 2020). This requires the agility and readiness of

academic institutions to improve the standardisation of the educational system, overcome traditional methods of student evaluation, and move to learning and evaluation models based on practical work and delivery of project results. Changing the grading system is crucial to adapt the educational process to the real needs of entrepreneurship, enabling students to acquire the necessary competencies.

In summary, this paper presents results from practical experiences in applying hackathons and PBL, leading to several key conclusions. First, the research highlights that integrating pedagogical strategies such as PBL and hackathons can significantly enhance students' entrepreneurial attitudes and intentions by improving their knowledge and skills while fostering creativity and problem-solving abilities.

Additionally, educational institutions and policymakers are encouraged to adopt blended formal and informal processes in entrepreneurial education, as this integration can effectively engage students and enrich their learning experiences, thus preparing them for both traditional career paths and entrepreneurial ventures. Although this approach is based on one country (Serbia), it can be generalised and implemented in other countries with similar educational systems. Notably, educational systems in many countries in the region, such as Croatia, Montenegro, Bosnia and Herzegovina, and North Macedonia, share a common conceptual foundation. These systems have evolved from similar frameworks, maintaining many of the same practices. This compatibility and minimal language barriers facilitate greater collaboration among students across these nations (Pantić et al., 2011). As a result, regional startup competitions frequently feature teams comprising students from various countries in the region, fostering a collaborative entrepreneurial spirit. Moreover, there is a notable number of competitions and projects within the Danube region, including initiatives like Danube Cap and various Erasmus projects. These programs focus on entrepreneurship and aim to enhance compatibility among educational institutions across borders. Therefore, the results of this research can potentially be applied, with minimal modifications, to other countries in the region. However, it is essential to recognise that the implementation of PBL may vary due to differing educational regulations across countries. While some nations allow for more flexible inclusion of PBL in assessment, the European Union, mainly through programs like Erasmus, provides frameworks supporting such projects' realisation. These frameworks ensure that innovative pedagogical strategies can be effectively integrated into regional educational practices.

Furthermore, hackathons are identified as particularly effective in providing hands-on experiences that enhance students' entrepreneurial skills and employability while also contributing to team trust and fostering creativity and critical thinking. The paper also notes the differential impact of various learning

formats, as PBL tends to emphasise the development of concrete knowledge and soft skills. In contrast, hackathons excel in stimulating innovation and entrepreneurship. This suggests that tailoring educational programs to meet diverse student needs and interests is essential for maximising learning outcomes.

Finally, the study underscores the importance of fostering a genuine interest in entrepreneurship among students; programs designed to enhance entrepreneurial skills should focus on skill development and aim to cultivate students' passion and engagement with entrepreneurship as a viable career path.

The research highlights the transformative potential of integrating innovative pedagogies into entrepreneurial education, emphasising their role in preparing students for dynamic career paths and fostering a culture of innovation within educational institutions.

Acknowledgement

The PBL part of this work was partly supported by the Erasmus+ project

D-PBL: Advancing project-based learning into the Digital Era 2021-1-PT01-KA220-HED-000032011, financed by EU

References

Almulla, M. A. (2020). The Effectiveness of the Project-Based Learning (PBL) Approach as a Way to Engage Students in Learning. *SAGE Open*, *10*(3). https://doi.org/10.1177/2158244020938702

Avila-Merino, A. (2019). Learning by doing in business education. Using hackathons to improve the teaching and learning of entrepreneurial skills. *Journal of Entrepreneurship Education, 22 (1).*, *22*(1).

Bell, R., & Bell, H. (2020). Applying educational theory to develop a framework to support the delivery of experiential entrepreneurship education. *Journal of Small Business and Enterprise Development*, *27*(6), 987–1004. https://doi.org/10.1108/JSBED-01-2020-0012

Blank, S., & Bob Dorf. (n. d.). *The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company by Steve Blank | Goodreads*. Retrieved October 14, 2024, from https://www.goodreads.com/book/show/13557008-the-startup-owner-s-manual

Bogdanovic, Z., Milicevic, A., Stojanovic, D., Labus, A., Despotovic-Zrakic, M., & Radenkovic, B. (2023). Open Innovation Strategies in Engineering Education. In *2023 IEEE 33rd International Conference on Microelectronics, MIEL 2023* (pp. 1–8). IEEE. https://doi.org/10.1109/MIEL58498.2023.10315923

Butt, W. A., Shariff, A., Khan, S., & Mian, A. I. (2021). Global Surgery Hackathons: A Case Study From Pakistan. *Surgical Innovation*, *28*(4), 496–501. https://doi.org/10.1177/1553350621101861 9

Byrne, J. R., Sullivan, K., & O'Sullivan, K. (2018). Active Learning of Computer Science Using a Hackathon-like Pedagogical Model. *2018 Constructionism; Vilnius, Lithuania; Research Council of Lithuania, 138–150.*, *September*. https://www.researchgate.net/publication/327395075

Cacciotti, G., Hayton, J. C., Mitchell, J. R., & Giazitzoglu, A. (2016). A reconceptualisation of fear of failure in entrepreneurship. *Journal of Business Venturing*, *31*(3), 302–325. https://doi.org/10.1016/J.JBUSVENT.2016.02.002

Calco, M., & Veeck, A. (2015). The Markathon: Adapting the Hackathon Model for an Introductory Marketing Class Project. *Marketing Education Review*, *25*(1), 33–38. https://doi.org/10.1080/10528008.2015.999600

Carayannis, E. G., & Campbell, D. F. J. (2010). Triple helix, Quadruple helix and Quintuple helix and how do Knowledge, Innovation and the Environment relate to Each other? a proposed framework for a trans-disciplinary analysis of sustainable development and social ecology. *International Journal of Social Ecology and Sustainable Development*, *1*(1), 41–69. https://doi.org/10.4018/jsesd.2010010105

Charosky Larrieu-Let, G. (2021). Developing innovation competences in engineering education through project-based and challenge-based learning. *TDX (Tesis Doctorals En Xarxa)*. https://upcommons.upc.edu/handle/2117/362127

Cobham, D., Gowen, C., Jacques, K., Laurel, J., & Ringham, S. (2017). From appfest to entrepreneurs: using a hackathon event to seed a university student led entreprise: academic member of staff: doi: 10.21125/inted.2017.0265 undergraduate student. *International Technology, Education and Development Conference INTED2017 Proceedings*, 522–529.

Cortés, D., Ramírez, J., & Molina, A. (2022). *Open Innovation Laboratory to Foster Skills and Competencies in Higher Education*. 281–291. https://doi.org/10.1007/978-981-19-3383-7_22

Feder, T. (2021). Hackathons catch on for creativity, education, and networking. *Physics Today*, *74*(5), 23–25. https://doi.org/10.1063/PT.3.4746

Fernando, F. (2020). Experiential learning in sustainability: Opportunities, building partnerships, and student engagement. *Diverse Pedagogical Approaches to Experiential Learning: Multidisciplinary Case Studies, Reflections, and Strategies*, 93–109. https://doi.org/10.1007/978-3-030-42691-0_7

García-castanedo, J., & Corrales-garay, D. (2024). *The International Journal of Management Education The ideathon as an instrument for entrepreneurial education in university contexts*. *22*(March 2023). https://doi.org/10.1016/j.ijme.2023.100926

Garcia, M. B. (2023). Fostering an Innovation Culture in the Education Sector: A Scoping Review and Bibliometric Analysis of Hackathon Research. *Innovative Higher Education*, *48(4)*, 739–762. https://doi.org/10.1007/s10755-023-09651-y

Gratchev, I. (2023). Replacing Exams with Project-Based Assessment: Analysis of Students' Performance and Experience. *Education Sciences*, *13*(4). https://doi.org/10.3390/educsci13040408

HackerEarth. (2017). *Global Hackathon Report – Trends and insights, HackerEarth*. https://www.hackerearth.com/community-hackathons/resources/whitepapers/global-hackathon-report-trends-insights/

Hart, M. A. (2012). The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful BusinessesEric Ries. New York: Crown Business, 2011. 320 pages. US$26.00. *Journal of Product Innovation Management*, *29*(3), 508–509. https://doi.org/10.1111/J.1540-5885.2012.00920_2.X

He, L., Zheng, L. J., Sharma, P., & Leung, T. Y. (2024). The International Journal of Management Education Entrepreneurship education and established business activities : An international perspective. *The International Journal of Management Education*, *22*(1), 100922. https://doi.org/10.1016/j.ijme.2023.100922

Isomöttönen, V., & Kärkkäinen, T. (2016). Project-based learning emphasising open resources and student ideation: How to raise student awareness of IPR? *Communications in Computer and Information Science*, *583*, 293–312. https://doi.org/10.1007/978-3-319-29585-5_17/COVER

Ivanovic, L., Kurepa, T., & Srbija, I. D. (2023). *Startap skener 2023*. https://www.preduzmi.rs/startap-skener-2023/

Jussila, J., Suominen, A. H., & Rainio, T. (2020). Entrepreneurship Competence Using Educational Hackathons in Finland. *Journal of Finnish Studies*, *23*(2), 32–73. https://doi.org/10.5406/28315081.23.2.05

Kong, F., Zhao, L., & Tsai, C. H. (2020). The Relationship Between Entrepreneurial Intention and Action: The Effects of Fear of Failure and Role Model. *Frontiers in Psychology*, *11*(March), 1–9. https://doi.org/10.3389/fpsyg.2020.00229

Lina, D. M., Ionescu, A. M., & Bedrule-Grigoruta, M. V. (2019). Entrepreneurial Orientation in Romanian Higher Education. *EDULEARN19 Proceedings*, *1*(July 2019), 9864–9872. https://doi.org/10.21125/edulearn.2019.2458

Lionaite, M. (2020). *Hackathons as a tool for learning in the framework of UNESCO learning cities* (Issue June).

Marin, A., Boanță, L. F., Țelinoiu, A., Darie, G., & Din, M. A. (2018). Supporting Entrepreneurship and Innovation in Higher Education in Romania. *ICERI2018 Proceedings*, *1*, 9938–9947. https://doi.org/10.21125/iceri.2018.0844

Miličević, A., Despotović-Zrakić, M., Naumović, T., Suvajdžić, M., & Radenković, B. (2023). Measuring the performance of the innovative potential of the academy on the example of Algorand WEB 3.0 hackathon. *In E-Business Technologies Conference Proceedings (Vol. 3, No. 1, Pp. 217–223)*., 217–223. https://www.ebt.rs/journals/index.php/conf-proc/article/view/195

Miličević, A., Despotović-Zrakić, M., Stojanović, D., Suvajžić, M., & Labus, A. (2024). Academic performance indicators for the hackathon learning approach – The case of the blockchain hackathon. *Journal of Innovation & Knowledge*, *9*(3), 100501. https://doi.org/10.1016/J.JIK.2024.100501

Muthumeena, M. P., & Yogeswaran, D. G. (2022). Entrepreneurship Education Through Successful Entrepreneurial Models in Educational Institutions. *Journal of Development Economics and Management Research Studies*, *09*(14), 13–19. https://doi.org/10.53422/jdms.2022.91402

Naumović, T., Vajagić, B., Cvetković, L., & Proročić, M. (2022). Open innovations and the role of hackathons. *E-Business Technologies Conference Proceedings*, *2*(1), 42–45. https://ebt.rs/journals/index.php/conf-proc/article/view/111

Neneh, B. N., & Dzomonda, O. (2024). Transitioning from entrepreneurial intention to actual behaviour: The role of commitment and locus of control. *International Journal of Management Education*, *22*(2), 100964. https://doi.org/10.1016/j.ijme.2024.100964

Nolte, A., Pa, E., Pe-Than, P., Filippova, A., Bird, C., Scallen, S., & Herbsleb, J. D. (2018). *You Hacked and Now What? – Exploring Outcomes of a Corporate Hackathon. Proceedings of the ACM on Human-Computer Interaction, 2(CSCW), 1–23.*

Organ, J., O'Neill, S., & Shanahan, B. W. (2022). Development of Social Technology Entrepreneurial Ventures: A challenge project-based learning approach. *IFAC-PapersOnLine*, *55*(39), 181–186. https://doi.org/10.1016/j.ifacol.2022.12.050

Pantić, N., Wubbels, T., & Mainhard, T. (2011). Teacher competence as a basis for teacher education: Comparing views of teachers and teacher educators in Five Western Balkan countries. *Comparative Education Review*, *55*(2), 165–188. https://doi.org/10.1086/657154

Pe-Than, E. P. P., Nolte, A., Filippova, A., Bird, C., Scallen, S., & Herbsleb, J. (2018). *Designing Corporate Hackathons With a Purpose. The future of software development. Ieee Software, 36(1), 15–22.*

Pe-Than, E. P. P., Nolte, A., Filippova, A., Bird, C., Scallen, S., & Herbsleb, J. (2022). Corporate hackathons, how and why? A multiple case study of motivation, projects proposal and selection, goal setting, coordination, and outcomes. *Human-Computer Interaction*, *37*(4), 281–313. https://doi.org/10.1080/07370024.2020.1760869

Rodrigues, A. L. (2023). Entrepreneurship Education Pedagogical Approaches in Higher Education. *Education Sciences*, *13*(9). https://doi.org/10.3390/educsci13090940

Santoso, R. T. P. B., Priyanto, S. H., Junaedi, I. W. R., Santoso, D. S. S., & Sunaryanto, L. T. (2023). Project-based entrepreneurial learning (PBEL): a blended model for startup creations at higher education institutions. *Journal of Innovation and Entrepreneurship*, *12*(1). https://doi.org/10.1186/s13731-023-00276-1

Simović, V. I. ekonomskih nauka, & Ilić, M. I. ekonomskih nauka. (n. d.). *Digitalno preduzetnistvo*. https://www.library.ien.bg.ac.rs/index.php/monog/article/download/1416/1156/

Somià, T., Lechner, C., & Pittaway, L. (2023). Assessment and development of coachability in entrepreneurship education. *The International Journal of Management Education*, *UR*(Last round). https://doi.org/10.1016/j.ijme.2023.100921

Stojanović, D., Radenković, B., Bogdanović, Z., Miličević, A., & Barać, D. (2023). Crowed-based open innovation: model, challenges, and trends. *6th International Scientific Conference on Digital Economy DIEC 2023*, 45–71. https://ipi-akademija.ba/file/diec-6-online/189

Szymanska, I., Sesti, T., Motley, H., & Puia, G. (2020). The effects of hackathons on the entrepreneurial skillset and perceived self-efficacy as factors shaping entrepreneurial intentions. *Administrative Sciences*, *10*(3), 1–15. https://doi.org/10.3390/admsci10030073

Temiz, S. (2021). Open innovation via crowdsourcing: A digital only hackathon case study from Sweden. *Journal of Open Innovation: Technology, Market, and Complexity, 7(1), 39.*, *7*(1), 39. https://doi.org/10.3390/joitmc7010039

Tiberius, V., & Weyland, M. (2023). Entrepreneurship education or entrepreneurship education? A bibliometric analysis. *Journal of Further and Higher Education*, *47*(1), 134–149. https://doi.org/10.1080/0309877X.2022.2100692

Toding, M., Mädamürk, K., Venesaar, U., & Malleus, E. (2023). Teachers' mindset and attitudes towards learners and learning environment to support students' entrepreneurial attitudes in universities. In *International Journal of Management Education* (Vol. 21, Issue 1). https://doi.org/10.1016/j.ijme.2023.100769

Tomić-Brkušanin, B. (2022). *Startap skener 2022*. https://www.preduzmi.rs/startap-skener/

Wallwey, C., Longmeier, M. M., Hayde, D., Armstrong, J., Kajfez, R., & Pelan, R. (2022). Consider "HACKS" when designing hackathon challenges: Hook, action, collaborative knowledge sharing. *In Frontiers in Education (Vol. 7, p. 954044). Frontiers Media SA.*, *September*. https://doi.org/10.3389/feduc.2022.954044

Yokom, H. B. (2020). *IMPLEMENTING PROJECT-BASED LEARNING WITHIN A STANDARDS-BASED GRADING SYSTEM*. https://digitalcommons.hamline.edu/hse_cp/489