

BUILDING AN INNOVATIVE ECOSYSTEM: GAMIFICATION AND HACKATHONS IN INDUSTRIAL MANAGEMENT EDUCATION

Milena Rajić¹ Peđa Milosavljević² Zorana Stanković³

Abstract: This paper analyses the integration of gamification and hackathons as innovative pedagogical tools in industrial management education. Addressing the skill gaps in creativity, problem-solving, and teamwork, it explores how these methods can bridge the divide between theoretical knowledge and practical applications. By analysing case studies and existing literature, the study highlights the potential of gamification to improve student engagement through motivational elements and hackathons to support experiential learning via collaborative, real-world problem-solving. Challenges such as resource constraints and resistance to change are discussed alongside proposed frameworks for scalable and adaptable implementation. The findings show the importance of creating an innovative ecosystem in education, aligning academic practices with modern industry demands, and preparing students for a competitive global workforce. This research contributes to advancing higher education by offering practical strategies to improve learning outcomes and support innovation.

Key words: gamification, hackathons, innovative ecosystems, industrial management education, problem-solving

1. INTRODUCTION

Industrial management education is confronting constant challenges due to the demands of the workforce specifically the engineering field. Employers increasingly seek professionals who show high skills in technical knowledge, creativity, problem-solving, and teamwork. However, a notable skills gap persists in these areas. For instance, a study highlighted that 85% of professionals consider creative thinking important for problem-solving in their work, yet less than 30% feel expected to be creative at work [1]. Similarly, problem-solving skills are in high demand. A survey by the American Management Association found that critical thinking and problem-solving are among the top skills necessary for employees, with 72% of executives identifying these competencies as essential [2]. Teamwork is another important competency. Research indicates that effective collaboration is necessary for organizational success, yet many graduates lack adequate teamwork skills. A study on employability skills found that employers often perceive graduates as deficient in teamwork abilities, important for workplace integration and productivity [3]. To address these skill gaps, innovative educational strategies are being implemented. Gamification involves incorporating game design elements, such as points, badges, and leaderboards, into educational contexts to improve engagement and motivation. Studies have shown that gamification can improve student engagement and learning outcomes. For example, research indicates that gamified learning environments can lead to increased motivation and participation among students [4]. On the other hand, hackathons are intensive, time-bound events where participants collaboratively solve problems or develop new products. In educational settings, hackathons provide experiential learning opportunities that support creativity, teamwork, and practical problem-solving skills. A systematic literature review found that hackathons serve as effective informal learning platforms, promoting active engagement and skill development among students [5]. An innovative ecosystem in education should refer to a collaborative environment that integrates various stakeholders: students, educators, and industry partners, to promote creativity, critical thinking, and real-world problem-solving. Such ecosystems encourage the application of interdisciplinary knowledge and the development of skills for the modern workforce. A scoping review emphasized the importance of innovation culture within the education sector to improve learning outcomes and better prepare students for future challenges. In the context of education, gamification refers to the application of game design elements, such as points, badges, leaderboards, and challenges, to non-game educational settings to improve student engagement, motivation, and

¹Assistant Professor, Department of Management in Mechanical Engineering, Faculty of Mechanical Engineering, University of Niš, Aleksandra Medvedeva 14, Niš, Serbia, email: milena.rajic@masfak.ni.ac.rs

²Assistant Professor, Department of Management in Mechanical Engineering, Faculty of Mechanical Engineering, University of Niš, Aleksandra Medvedeva 14, Niš, Serbia, email: zorana.stankovic@masfak.ni.ac.rs

³Professor, Department of Management in Mechanical Engineering, Faculty of Mechanical Engineering, University of Niš, Aleksandra Medvedeva 14, Niš, Serbia, email: pedja.milosavljevic@masfak.ni.ac.rs

learning outcomes. This approach provides the motivational aspects inherent in games to make learning experiences more interactive and enjoyable. Research [6] found that incorporating gamification into active learning setups positively affected skill development, academic achievement, and student satisfaction, aligning educational experiences with the competencies demanded by the digital society of the twenty-first century. Hackathons, on the other hand, represent intensive, time-constrained events where participants collaborate to develop solutions to specific problems, often through coding or project-based work. In educational settings, hackathons serve as informal learning platforms that promote active engagement, creativity, and practical problem-solving skills. Research [7] analysed the role of hackathons in education and found that, while no standardized setup exists for promoting and assessing learning outcomes, these events are used to support learning and innovation. An innovative ecosystem in education refers to a collaborative environment that integrates various stakeholders, students, educators, industry partners, and policymakers, in order to promote and encourage creativity, critical thinking, and real-world problem-solving.

The primary objective of this paper is to explore how innovative pedagogical tools like gamification and hackathons can address the limitations of traditional teaching methods in industrial management education. This paper aims to analyse their potential to improve student engagement, improve learning outcomes, as well as the development of technical but also soft skills such as creativity, problem-solving, and teamwork. Another goal is to examine the effectiveness of integrating gamification and hackathons into existing curricula. The paper seeks to evaluate how these tools can simulate real-world challenges, allowing students to practice interdisciplinary collaboration and apply theoretical knowledge in practical contexts. Also, the paper aims to propose a framework for integrating gamification and hackathons into industrial management education. The focus will be on creating scalable, adaptable models that institutions can adopt to improve educational quality and better align academic outcomes with industry needs. In order to achieve these objectives, the paper contributes to the ongoing transformation of higher education in industrial management, ensuring that graduates are equipped to adapt to an increasingly complex and competitive global landscape.

2. GAMIFICATION AS A TEACHING METHOD

Traditional teaching methods in industrial management education, such as lectures and textbook-based learning, often fail to fully engage students or prepare them for the dynamic demands of modern industries. These methods typically emphasize passive learning, where students act as recipients of knowledge rather than active participants. Research [8] shows that passive learning approaches result in retention rates as low as 5%, compared to 75% for experiential and active learning models (Fig.1).

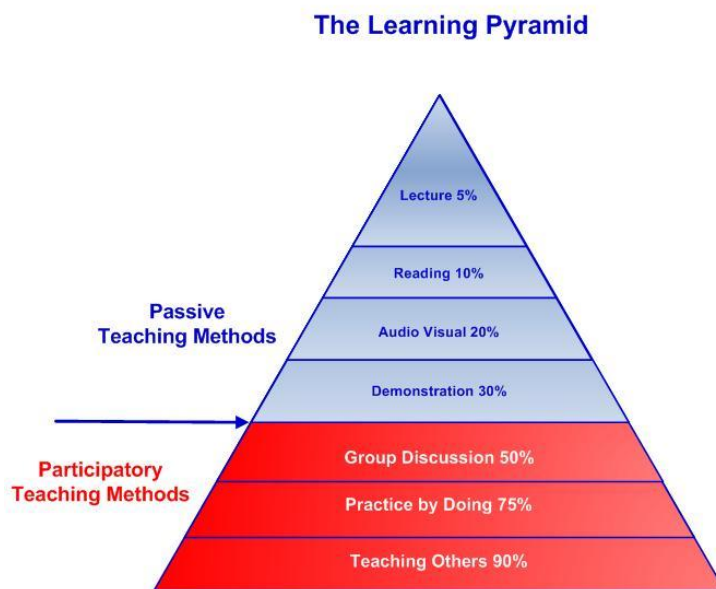


Figure 1 – Learning pyramid [8]

Furthermore, traditional methods often overlook the development of essential skills like creativity, problem-solving, and teamwork, which are critical for navigating real-world industrial challenges. Industrial management, as a discipline, requires students to integrate technical expertise with managerial and collaborative skills. However, conventional curricula rarely offer opportunities to practice these competencies in realistic scenarios. For instance, a 2019 survey of engineering graduates revealed that 62% felt unprepared to address complex, interdisciplinary problems in professional environments [9]. This highlights the gap between academic preparation and industry expectations. Another limitation is the lack of adaptability in traditional teaching models. These approaches often fail to keep pace with technological advancements and changing industry needs. As industries embrace automation, digitalization, and innovation, educational practices must evolve to prepare students for roles that demand agility, innovation, and interdisciplinary collaboration. Without reform, graduates risk entering the workforce underprepared for its complexities. The primary objective of this paper is to analyse how gamification and hackathons can address limitations in traditional teaching methods, improve student engagement, and develop skills such as creativity, problem-solving, and teamwork in industrial management education. The study aims to analyse the effectiveness of these tools through existing literature and to propose a practical framework for integrating them into curricula. The significance of this study lies in its potential to improve educational outcomes by bridging the gap between theoretical knowledge and real-world applications.

3. CASE STUDIES AND PRACTICAL APPLICATIONS OF HACKATHON-DRIVEN INNOVATION

Hackathons have proven to be effective platforms for supporting innovation and developing practical solutions across industries. The good example is the "Hack for Travel" hackathon, organized in response to the COVID-19 pandemic's impact on the tourism sector [10]. This event promoted collaboration among participants to generate innovative business ideas aimed at revitalizing tourism. The study analysing this hackathon identified six key processes that effectively organized the event and encouraged cooperation and knowledge sharing among participants, leading to the development of innovative solutions. Another significant case is the "HacktheCrisis" hackathon in Sweden, conducted entirely online during the COVID-19 pandemic [11]. This digital-only hackathon aimed to address challenges posed by the pandemic by bringing together diverse participants to develop solutions. The event resulted in growth in the digital health community in Sweden, demonstrating the feasibility and impact of virtual hackathons as open innovation methods. In the corporate sector, a multiple case study of two large-scale agile organizations revealed that internal hackathons improved developers' satisfaction and well-being, strengthened company culture, and improved communication and collaboration [12]. These events led to the rapid development of ideas and prototypes, contributing to organizational innovation and productivity.

An important case study that should be highlighted is the "Ideas of March" hackathon, which follows a project-based learning model [13]. In this event, local non-profit organizations, educational institutions, and small businesses propose projects requiring mobile applications to address their specific needs. This approach not only provides participants with real-world problems to solve but also benefits the community by delivering practical solutions. The hackathon emphasizes collaboration, reflection, and group skills, aligning with educational objectives to improve student learning experiences. Research [14] examined the use of hackathons to support sustainable product innovation within a company. The research highlighted that while hackathons are effective in generating innovative ideas, there is a challenge in sustaining and developing these projects post-event. The study emphasized the importance of organizational support and structured follow-up processes to ensure that the innovative solutions conceived during hackathons are effectively implemented and contribute to the company's product development pipeline. Another case study explored the design and execution of a hackathon through university-industry collaboration [15]. This event transformed a real-world workplace problem from an enterprise into a hackathon challenge for college students, sponsored by a technology vendor. The study demonstrated that such collaborations not only provide students with valuable experiential learning opportunities but also offer companies fresh perspectives and potential solutions to their operational challenges. The success of this hackathon was attributed to careful

planning, clear problem formulation, and effective facilitation of idea development. These examples show the effectiveness of hackathons as platforms for innovation, education, and community engagement. By bringing together diverse participants to tackle real-world problems within a constrained timeframe, hackathons stimulate creativity, improve collaborative skills, and often lead to the development of important solutions that extend beyond the event itself.

4. DISCUSSION

The integration of gamification and hackathons into industrial management education has significantly contributed to building an innovative ecosystem. This ecosystem supports collaboration, creativity, and continuous learning by connecting students, educators, and industry stakeholders in a dynamic environment. The findings indicate that hackathons provide a structured yet flexible platform for students to address real-world challenges, apply interdisciplinary knowledge, and develop innovative solutions. The gamification elements further improve this ecosystem by motivating participants through competition and rewards, driving engagement, and sustaining interest. The combination of these tools creates a culture of innovation where students are encouraged to think critically and work collaboratively. This culture extends beyond the classroom, embedding innovation into the broader educational and professional landscapes. Despite the successes, several challenges were encountered during the implementation of these interventions. Resource constraints were a recurring issue, particularly in organizing hackathons, which often require significant logistical and financial investment. For example, ensuring access to adequate technology, mentorship, and physical or virtual spaces was a challenge for some institutions. Another obstacle was participant resistance, particularly among students unfamiliar with the intensity of hackathons or sceptical of gamified learning approaches. Resistance from faculty members accustomed to traditional teaching methods also hindered the seamless adoption of these strategies. Limitations in the study design included a lack of longitudinal data to assess the long-term impact of these interventions on student learning outcomes and career readiness. Many studies relied on self-reported data from participants, which, while insightful, may introduce biases. Furthermore, the scalability of these approaches across different educational and cultural contexts remains an open question, requiring further investigation.

The findings of this study have important implications for educational practices and institutional policies. Integrating gamification and hackathons into curricula can provide students with practical, hands-on experiences that improve their readiness for the workforce. Institutions should prioritize embedding these tools into their programs by providing training for educators, allocating dedicated budgets, and establishing partnerships with industry stakeholders. Policies that encourage collaboration between universities and industries can further strengthen these ecosystems, creating opportunities for students to work on real-world projects and gain exposure to professional environments. Curriculum design should also reflect the dynamic nature of these interventions, incorporating flexible, interdisciplinary approaches that allow for iterative learning. Policymakers should consider these findings when drafting guidelines for educational reform, emphasizing active learning strategies that promote creativity, critical thinking, and innovation. By addressing the challenges and scaling these practices effectively, institutions can build robust innovative ecosystems that not only improve educational outcomes but also drive broader societal and industrial advancements.

5. CONCLUSION

This study explored the integration of gamification and hackathons as innovative pedagogical tools to address the limitations of traditional teaching methods in industrial management education. The findings demonstrate that these approaches significantly improve student engagement, support critical skills such as creativity, problem-solving, and teamwork, and create an environment conducive to experiential learning. Gamification, through its use of motivational elements like leaderboards and rewards, successfully increases participation and sustains interest, while hackathons provide intensive, real-world problem-solving experiences that bridge the gap between theoretical knowledge and practical application. The case studies analyzed in this paper highlight the effectiveness of these tools in various contexts, including university-industry collaborations and community-based initiatives.

They underscore the importance of structured planning, interdisciplinary collaboration, and post-event support in ensuring the sustainability of hackathon-derived solutions. Furthermore, the research reveals challenges such as resource constraints, resistance from participants and educators, and the need for scalable implementation models, emphasizing the importance of institutional commitment and policy support. Future research should focus on longitudinal studies to assess the long-term impact of these interventions, particularly their influence on career readiness and industry adaptability. Additionally, exploring the application of these tools across different cultural and educational contexts will provide valuable insights into their scalability and adaptability. This study contributes to the ongoing transformation of higher education, offering practical solutions to improve the quality and relevance of industrial management education in the 21st century.

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