

A promising methodology. Assessing the pedagogical value of hackathons

Active Learning in Higher Education

1–15

© The Author(s) 2025



Article reuse guidelines:

sagepub.com/journals-permissions

DOI: 10.1177/14697874251330793

journals.sagepub.com/home/alh**Katharina Resch** 

University for Teacher Education Upper Austria, Austria

University of Vienna, Austria

Sabine Freudhofmayer 

University for Teacher Education Vienna, Austria

María-Jesús Martínez-Usarralde

University of València, Spain

Abstract

Hackathons have become increasingly popular in higher education, although prior research about their use in the higher education sector is limited in scope and does not link the new pedagogy to learning theories. In contrast to the main literature in this field, our research adopts a conceptual rather than an empirical focus and is built on two comparative analyses. The first of these is a placement of hackathons within learning theories, in particular inquiry-based learning, experiential learning, challenge-based learning, problem-based and project-based learning. The second is a comparative analysis of hackathons with other community-based methodologies, that is, service-learning, challenge-based learning and community-based research, with which many educators already identify. Hence, our study lays the ground for assessing the pedagogical value of hackathons in higher education and provides a methodological comparison for educators, who aim to use this type of pedagogy in their applied coursework.

Keywords

challenge-based learning, community-based research, comparative analysis, hackathon, higher education research, learning theories, service-learning

Introduction

A lack of practical learning opportunities in the field of study is generally regarded as a bitter quality deficit of a study programme in higher education. There are numerous forms of applied coursework which connect theory and practice, thereby fostering collaboration between the higher

Corresponding author:

Katharina Resch, Institute for Secondary School Education, University for Teacher Education Upper Austria, Huemerstrasse 3-5, Linz A-4020, Austria.

Email: katharina.resch@ph-ooe.at

education institution, educators, students and community partners and providing benefits for all sides (Rutti et al., 2016). While some forms of applied coursework, such as community-based learning or service-learning, have a broad evidence base for their effectiveness and student learning outcomes (Felten & Clayton, 2011; Gama et al., 2023; La Lopa, 2012), others lack a basic or advanced assessment of their pedagogical value. One such pedagogy is the hackathon, a methodology that has become increasingly popular in higher education yet for which an evidence-based assessment is still missing.

Hackathons originate from the technology sector and have been gradually transferred to the educational context in recent years (M. B. García, 2022; T. M. García & Menéndez, 2021; Jussila et al., 2020; Suominen et al., 2019) to promote experiential learning opportunities that combine creativity, problem-solving and teamwork skills (M. B. García, 2023). A hackathon is a contest method in which teams of students develop solutions in a set period of time and which typically end with an award or prize for the winning solution. Over the last 20 years, hackathons have become popular in the IT sector, where they have been used in the development of technological solutions (Porrás et al., 2018). However, they have rarely been adapted to the field of higher education (Rys, 2021). Accordingly, and as is also the case with other community-based methodologies, the pedagogical potential of hackathons clearly needs to be explored as they offer students the chance to collaborate with community partners and to develop ideas with them that produce a valuable output for the community. In the framework of applied coursework, students meet the respective needs of the community partners involved. In hackathons, students hone their problem-solving skills and benefit from experiential learning in a more authentic environment which connects theory with real needs and thus enhances traditional classroom learning (Helker et al., 2024; Kitsios & Kamariotou, 2023).

To date, the hackathon methodology seems to have been applied most frequently in the computer science, social sciences and engineering disciplines (M. B. García, 2023; Komssi et al., 2015). A recent systematic review (Chau & Gerber, 2023) identified ten science and humanities disciplines in which research on hackathons is being conducted. While the computer science perspective still dominates the field, perspectives from educational science, innovation and entrepreneurship, science and technology studies, organizational studies, health and medicine, gender studies, design, arts, and library and information science also have a significant standing to date. In the social sciences in particular, civic hackathons have been receiving increasing attention in the last years (Baack et al., 2020; Berg et al., 2021) even in the form of online civic hackathons (Förschler & Decuypere, 2024; Hershkovitz & Lahav, 2023) as a novel variation of conventional hackathons that address community needs. Nevertheless, it remains unclear in hackathon research how and in which form learning takes place for different student groups and disciplines. While hackathons have become more refined in methodological terms through prior research, the theoretical approaches that inform the underlying empirical work remain in the background: they are under-elaborated, and lack pedagogical assessment. Specific literature on hackathons in education is still very limited, and further research is needed to gain a better understanding of the hackathon methodology, its value compared to other applied coursework methodologies and its pedagogical potential. Considering new and meaningful methodologies in the field of education appears essential for closing the theory-practice gap and for training educators to implement applied methodologies in their coursework.

What is a hackathon?

A hackathon is a methodology used to tackle complex and interdisciplinary problems for which there is no simple solution. The term itself is a combination of ‘hack’ and ‘marathon’ (O’Riordan & Gormley, 2023). In practice, a challenge is presented, and participants work in small groups to develop a solution in as short time as possible. Usually, the hackathon ends with the groups

presenting their results to all participants and an evaluating jury (Kohne & Wehmeier, 2020). The group with the most suitable solution wins the prize. There are accounts of hackathons being implemented in the United States in the late 1970s as well as in Canada in the late 1990s (Chau & Gerber, 2023). At these specific events, like-minded participants gathered, usually for not longer than 48 hr, to develop computer programs. In 2006, the internet company Yahoo organized one of the first large-scale hackathons as a competition with a prize and sponsors. Thus, innovation development in hackathons happens rapidly and intensively (Lawrence, 2016). Most of them last between 24 and 36 hr and take place in open working spaces so that the participants or teams can see what others are developing (Wallwey et al., 2022). Rys (2021) distinguishes between three types of hackathons: (1) the classic IT hackathon, which is attended by participants from the IT industry, (2) the free hackathon, which has no predefined target groups or topics and (3) the mixed hackathon, which is currently a popular form that requires an IT element in solution development.

There are usually three phases to a hackathon (Heller et al., 2023): (1) the *preparation* phase in which a detailed plan for the hackathon is drawn up, (2) the *practice* phase in which the actual hackathon event takes place and (3) the *follow-up* phase in which the innovation is expanded to product development or another form of implementation (Kohne & Wehmeier, 2020). For educators, the preparation phase is usually the longest and most intensive phase, as the ‘challenge’ needs to be defined, students invited and a reliable cooperation established with the community partner(s). In this sense, hackathons encourage collaboration and are a catalyst of collaborative innovation (Chernov et al., 2024). The core element of the hackathon event is the ‘challenge’. Creating a hackathon challenge is a task that takes time, since all participants must be given the same parameters and the same resources. In the preparation phase, educators can choose between (1) selective or open hackathon recruitment, (2) competitive or collaborative hackathons and (3) physical, virtual or hybrid hackathons (Pe-Than et al., 2022) depending on their specific objectives. Civic hackathons do not necessarily involve an IT element (Förschler & Decuypere, 2024; Hershkovitz & Lahav, 2023), but may focus on policy making or even crafting (O’Riordan & Gormley, 2023). Wilson et al. (2019), for example, report on a hackathon with 27 students who attended a one-day event involving expert panels, rapid iteration and solution pitches on the topic of community homelessness. This homelessness hackathon was organized by an interdisciplinary steering committee made up of 13 members of faculty, staff and the community. It met for over four months to plan the agenda for the event and design promotional materials (Wilson et al., 2019, p. 739). The one-day event itself started off with welcome remarks, followed by a team-building exercise to enable the participants to get to know one another and a brief presentation on homelessness in the area by a community expert. The teams then engaged in a structured brainstorming activity designed to help them identify the problem they wanted to address and the possible solutions. While developing the solutions, they consulted in turn with a number of invited experts. Finally, the teams were instructed to prepare pitch presentations lasting no more than 3 min.

State-of-research in education

Assessing the value of hackathons from a pedagogical perspective requires an analysis of the state-of-research in higher education and an assessment of the available empirical evidence for their pedagogical value and effectiveness for student learning.

We distinguish research *with* hackathons and research *on* hackathons, classifying our own study as the latter (a field of research that only emerged in 2013). According to a review of the literature published in the last decade (Olesen & Halskov, 2020), research on hackathons in the *teaching and learning* context makes up only about 11.5% of the available publications. These underline the benefits of the peer learning processes in hackathons, of working in interdisciplinary teams and of

engaging with community partners (Olesen & Halskov, 2020). In terms of diversity in participation, however, women and minority students seem to participate less frequently. Chau and Gerber (2023) go even further and provide a systematic review of hackathons based on 111 publications between 2013 and 2022. Their findings show that hackathon research can be categorized into four themes: (1) the purpose of the hackathon (innovation, learning and collaboration), (2) the hackathon processes, (3) the outcomes of the hackathon and (4) the critical reviews of hackathons. Studies from a *teaching and learning* perspective make up 32.4% of the publications in this review, a percentage that is higher than that of Olesen and Halskov (2020) but still low compared to publications in other disciplines (e.g. computer science). Heller et al. (2023) provide a systematic review of hackathons based on 87 publications between 2007 and 2022. Their content analysis is comprehensive and contains evidence and recommendations for the *preparation*, *practice* and *follow-up* phases. According to Chau and Gerber (2023), the vast majority of data on hackathons stem from empirical studies with students (Bonilla et al., 2020; Gama et al., 2018; Nolte et al., 2020), which almost exclusively focus on participants' experiences and what participants do in hackathons (Jones, Semel & Le, 2015). Other topics of research include measuring the differences between modified and standard forms of hackathons, studying the experiences of minority participants (Paganini & Gama, 2020) or exploring the sustainability of hackathons, in particular with regard to the short-term and long-term continuation of ideas (Nolte et al., 2020).

Various benefits for students are reported for hackathons in higher education. They meet the needs of students by promoting hard and soft skills, fostering collaborative work essential for later working life and encouraging students to take responsibility for real problems in society (O'Riordan & Gormley, 2023; Porras et al., 2018). Students are given the opportunity to network and connect with stakeholders in a professional field and develop entrepreneurship competences (Jussila et al., 2020). During a hackathon, students engage in hands-on, experiential learning opportunities in which they can develop creativity and problem-solving skills and learn how to best collaborate with others to reach a certain result in a given period of time. Hackathons require students to engage, investigate, and act (O'Riordan & Gormley, 2023), just like challenge-based learning (Sukacké et al., 2022). Hackathons are 'collective experiences' (Jussila et al., 2020, p. 65) in which all students are equal 'experts' in solving a challenge (Membrillo-Hernández et al., 2019). They experience 'the feeling of belonging' (T. M. García & Menéndez, 2021, p. 58) to a group that is striving to achieve a common goal. Civic hackathons have the additional potential to reduce the stereotyping of population groups less familiar to students (Kitsios & Kamariotou, 2023) and place the specific social groups affected by the solutions at the core of the methodology (Faludi, 2023). In this sense, they can potentially reduce prejudice and empower individuals to engage in change processes (Förschler & Decuypere, 2024; Hershkovitz & Lahav, 2023).

But hackathons also have disadvantages such as the difficulty in recruiting participants with the appropriate professional background, the costliness and challenge of organizing hackathon events, the fact that most technologies cannot be developed quickly and the over-focus on technological development rather than educational quality in technology-oriented hackathons (Heller et al., 2023). From a social perspective, attention needs to be paid to the focus of the hackathon event to avoid an accidental erosion of its social innovation character, since corporate sponsorship and investor participation may shift the focus of participants towards economic or corporate objectives rather than those affected by the solution (Faludi, 2023).

Assessing the pedagogical value of a hackathon

We begin by taking stock of the relevant learning theories as a first step to ground hackathons in educational theories. We then conduct a comparative analysis of hackathons and other community-based methodologies in order to benchmark similar approaches.

Framework for placing hackathons in learning theories

First and foremost, if hackathons are even to be understood as a pedagogy, they must be grounded in learning theories. For this reason, we developed a framework on the basis of a review of higher education literature focusing on hackathons, searching for direct reference to learning theories (first step). Inquiry-based learning (IBL) and experiential learning (EL) were identified as learning theories in this step. Then, we analysed the literature again to understand the concrete methodologies students learn with in hackathons (second step). In this step, collaborative learning, problem-based learning (PBL), project-based learning (PrBL) and challenge-based learning (CBL) were added. A later analysis revealed the relevance of community-based methodologies, namely Service-Learning (SL) and community-based research (CBR), which were then subjected to a comparative analysis (see below).

Figure 1 places hackathons in the centre of the framework – showing their key features. The learning theories (IBL, EL and CBL) were arranged on the left as a theoretical framework for educators who plan hackathons. Useful applied methodologies for the implementation of a hackathon were positioned on the right: collaborative learning in teams, topic-centred methodologies (PBL and PrBL), and community-centred methodologies (SL, CBR and CBL). All methodologies share distinct key features with hackathons, and differ at the same time. The position of CBL in the framework is delicate as it was identified as both a learning theory and a methodology.

Hackathons are rooted in specific learning theories which can be a helpful guidance for educators, who plan hackathons: *inquiry-based learning (IBL)*, *experiential learning (EL)* and *challenge-based learning (CBL)*, (Gallagher & Savage, 2020; Towhidi & Pridmore, 2022). These three learning theories share common features such as learning through discovering contents in practice-based settings by working on a real need or challenge. During a hackathon, students work on a real challenge and collaborate with others to find new solutions. According to EL (D. A. Kolb, 1984; A. Y. Kolb & Kolb, 2005), learners should be actively engaged in solving problems, pose questions, experiment, assume responsibility for the task and construct meaning from the practical learning experience. Students learn from trial-and-error attempts (Wurdinger & Allison, 2017). They engage physically, cognitively and socially (Morris, 2020) – all key components of a hackathon. In IBL (Kienzler & Fontanesi, 2017), student teams typically focus on a central and authentic challenge that guides their student-centred inquiry process. CBL requires students to work with educators and experts from the community to solve real-world problems and to deepen their subject knowledge in parallel (Membrillo-Hernández et al., 2019). The core element of CBL is the real-world challenge, like in a hackathon or in IBL. By engaging in the development of their own solutions to the challenge in a hackathon, students move from learning to discovering content more effectively.

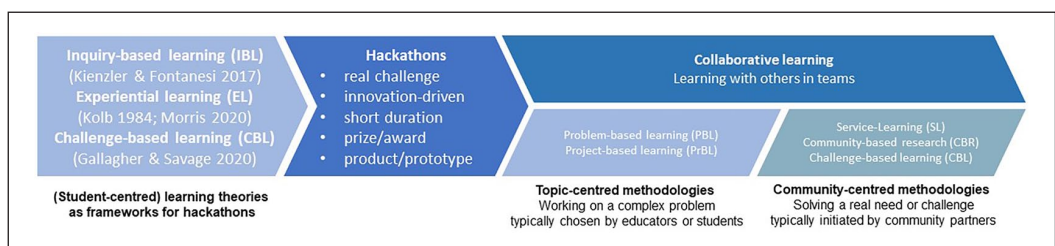


Figure 1. Framework (authors' own compilation).

When educators implement a hackathon, they apply methodologies associated with *problem-based (PBL)* and *project-based learning (PrBL)*, – both of which are topic-centred pedagogies (M. B. García, 2022, La Place et al., 2017). While both methodologies encourage students to actively explore problems, PBL ‘encourages knowledge construction by starting each learning experience with a complex real-life problem that is typically presented to a small group of students in a tutorial setting’ (Spronken-Smith & Harland, 2009, p. 138). In this sense, PBL means investigating and solving complex problems for which there is no one correct solution (an increasingly important aspect given the complexity of the world’s problems and of cross-curricular work). This requires students to build connections between knowledge blocks, work collaboratively and apply appropriate learning resources in their teams (Sukackè et al., 2022). PBL is an especially compelling pedagogical practice that is conducive to student learning across disciplines. However, interdisciplinary learning can only take place if the interdisciplinarity of the problem is explicitly addressed by the educator (Stentoft, 2017). PBL is rooted in self-directed learning, and it is contextual and constructive (Sukackè et al., 2022). One challenge with problem-based and project-based learning is that problems may be hypothetical and predefined, thus leading to controlled situations in which solutions might already exist in advance (Membrillo-Hernández et al., 2019). PrBL (Roessingh & Chambers, 2011) can entail working on a topic for a longer period of time, going through the phases of conceptualising and implementing a project, and applying multiple perspectives on the topic (Lange, 2020; Rengstorf & Schumacher, 2013). Developing solutions for complex problems requires the use of project management elements such as dividing tasks into work packages, allocating these packages to small groups or deciding on a timeline.

Without *collaborative learning*, hackathons could not take place, so collaborative learning is conceptualized as a feature of overriding importance in a hackathon. Participating in a hackathon is a ‘collective experience’ (Jussila et al., 2020, p. 65) that fosters cooperative learning (Cwikel & Simhi, 2022, Porras et al., 2018). Hackathons enhance collaborative, group-based and networked learning, often even in an interdisciplinary context (Kettunen et al., 2013). Students learn by building on their own experiences and those of others. They learn through dialogue, group discussions and joint reflection to create new ideas and solutions to the challenge posed (Wilson et al., 2019). Cooperative learning is rooted in the early democracy conceptions of Dewey (1916/1993), which also promote critical thinking, community learning and social responsibility.

Comparative analysis

In this section, we take our analysis one step further by focussing on the community-centred methodologies that add additional value to understanding hackathons: service-learning (SL), community-based research (CBR) and challenge-based learning (CBL). CBR is a research-driven activity in which students develop a research-based solution for a community need in the framework of applied coursework. CBL is a student-centred methodology which requires students to solve a real-world challenge together with educators and community partners (Membrillo-Hernández et al., 2019). In SL, students provide an organized service activity in the community (*service*) and reflect on this experience in parallel in class (*learning*). SL thus emphasises civic learning (Resch & Schrittmesser, 2021), which is also the case in CBL (Cruger, 2017). While hackathons also provide solutions to challenges posed by a community partner, they follow different learning principles. With this more detailed comparison of community-centred methodologies, we emphasise the importance of identifying a real challenge or real need in a hackathon, in CBL, and SL – as common features of community-centred methodologies. They all focus on learning with a community partner, either a business partner, school, association, or the like, to solve the key challenge or need (M. B. García, 2022; Membrillo-Hernández et al., 2019), thus a comparative analysis may add value to understanding the pedagogical potential of hackathons. Table 1 summarizes the main

Table 1. Comparative pedagogical value within community-centred methodologies (authors' own compilation).

Dimensions of comparison	Comparing community-centred methodologies			
	Hackathon	Service-learning	Community-based research	Challenge-based learning
Orientation	Innovation-driven	Service-driven	Research-driven	Innovation-driven
Main aim	Typically develop a product or prototype	Develop and implement a service to the community	Develop a research-based solution for a community need	Develop a solution for a real need or challenge
Service	No direct service to the community	Direct or indirect service to the community	No direct service to the community	Direct or indirect service to the community, call to action
Discipline(s)	Interdisciplinary approach	Monodisciplinary approach	Monodisciplinary approach	Multidisciplinary approach
Duration	Intensive days (1–3 days)	One semester or longer	One semester or longer	One semester or longer
Basic problem	Real challenge	Real need	Real need	Real challenge
Digitalisation	Digitalisation as core activity	Optional digitalisation in e-service-learning	No digitalisation	Optional software development process
Social learning arrangements	Collaborative learning in small groups	Collaborative learning in small groups	Collaborative learning in small groups	Collaborative learning in small groups
Distinguished form of learning	Digital learning	Civic learning	Methodological learning	Civic learning, digital learning
Learning environment	Learning at university	Learning at university and in the community	Learning at university and in the community	Learning at university
Reflection	No mandatory reflection	Mandatory reflection	No mandatory reflection	Reflection as evaluation
Role of the educator	Teacher as facilitator	Teacher as facilitator and instructor	Teacher as instructor and facilitator	Teacher as facilitator, mentor and co-designer
Recognition	Prize or award provided by sponsors	No prize or award	No prize or award	No prize or award
Credit valorisation	Typically non-credit-bearing	Credit-bearing when integrated in a course	Credit-bearing when integrated in a course	Credit-bearing when integrated in a course

similarities and differences. While this differentiation aims to make the similarities and differences between these methodologies more explicit and understandable, we are also fully aware that there are various forms, variations, combinations and hybrids thereof.

When comparing the methodologies (hackathons, SL, CBL and CBR), basic categories can be applied that help to guide the comparative analysis, namely orientation, main aim, service, discipline(s), duration, origin of the basic problem and digitalisation. In the subsequent advanced comparison, criteria are applied which show the nature of hackathons in a pedagogical context more extensively, namely social learning arrangements, distinguished forms of learning, learning environment, reflection as part of the learning experience, the role of the educator and recognition and credit valorisation.

Comparison of key attributes

As can be seen above, the four community-centred methodologies have more differences than similarities. Hackathons are innovation-driven (M. B. García, 2023) and aim to develop a product or prototype (depending on the discipline maybe also a policy or another product) within a limited amount of time. SL is service-driven with a direct or indirect service delivered to the community to meet a specific and real need. It connects theory and practice by allowing students to participate in a service that corresponds to the needs of the community and at the same time reflect on the experience in class in order to gain an enhanced sense of civic engagement (Bringle et al., 2006). CBR is research-driven and aims primarily to develop a research-based solution for a community need. To reinforce the connection between theory and practice, educators often use CBR in their courses to strengthen the research orientation in their study programme. This form of practitioner research (Cochran-Smith & Lytle, 2009) encompasses forms of research in which students and community partners work together to systematically investigate topics related to community needs with the aim of producing knowledge for application in practice. CBR is seen as a distinctive methodology that is based on partnership and full, equal engagement between researchers, students and community partners. One of the main differences in the approaches is the connection between their main aim and their service character. While hackathons provide a product for a real challenge, they might not necessarily provide a service to community members (as is the case for SL, where a direct or indirect service is rendered to community members). Like hackathons, CBR also does not deliver a direct service but rather an analysis or exploration of a real need, which may then be solved in the community itself. While hackathons are usually an interdisciplinary endeavour (Suominen et al., 2019), SL and CBR are usually designated to a specific study programme and are thus monodisciplinary. CBL is usually also interdisciplinary (Perna et al., 2023). The four methodologies also vary in duration. Hackathons are the shortest, lasting from one to three days, while SL, CBL and CBR can last for one semester or longer. While the basic problems that lie at the centre of all methodologies is the challenge that is posed in a hackathon and the real need that is addressed in SL, CBL and CBR, the differences are, however, only linguistic in nature. In hackathons (with the exception of civic hackathons), the digital component is a core category that typically involves coding, prototyping or programming. SL, in contrast, is more concerned with transforming students into ‘engaged citizens’ (Sliwka & Klopsch, 2012) – this is also the case in CBL – than developing a digital product or prototype. While SL and CBR do not traditionally involve a digital element, e-service-learning does (Waldner et al., 2012). Gallagher and Savage (2020) identified common characteristics of CBL in higher education in an extensive literature review, which mirror some of the key characteristics of SL, CBR and hackathons. These characteristics are: global themes, real-world challenge, collaboration of students with community partners, challenge definition and technology. A defining feature of all four methodologies is the real-world challenge, which addresses a global theme such as sustainability or health. Usually, community or business partners present the challenge to students in SL and hackathons, however in CBR and CBL usually educators define the main challenge (Gallagher & Savage, 2020). In all methodologies, students collaborate with community partners to define challenges, and identify, develop and present solutions. Technology involves the use of virtual learning environments and online communication, but even more so in hackathons and e-service-learning a digital solution.

Advanced comparison on a pedagogical level

Common to all four methodologies is the use of specific learning arrangements in which students learn together, namely collaborative learning in small groups. In these groups, a service is provided (SL), a research design implemented (CBR), a solution to a grand challenge developed (CBL), or a product or prototype is developed (hackathon). The level of student involvement in CBR varies depending on the focus and impetus of the research. In most cases, students are centrally involved in CBR activities, but less intensively than in hackathons, CBL, or SL. All approaches involve the active engagement of students in solving real-world needs. In contrast to hackathons, SL focuses on both the organised service activity provided by the students (*service part*) and the parallel reflection in class (*learning part*), thus combining academic and civic learning (Rutti et al., 2016). Hackathons, in turn, swap the reflective component for a competitive one, as the groups of students compete against each other for the final award or prize. Hackathons have great potential when it comes to digital or entrepreneurship learning or when creativity is needed to solve or present a problem, similar to CBL. This is not the case in SL and CBR, where the former strengthens personal growth through the rendering of a service in the community, and the latter empowers students in developing their methodological competences. The real-world challenge is the core element of all four methodologies: In SL, CBL and hackathons these needs are urgent and thus need solutions now, while in CBR the real need might not be as urgent (Gallagher & Savage, 2020).

The learning environment also differs. Hackathons and CBL are usually held only at the university, which means that students do not move out of their comfort zone and familiar place of learning. In SL and CBR student learning also occurs in the community, that is, outside the university. However, in hackathons, community partners do still actively engage with the student teams, albeit within the university setting (Heller et al., 2023; Rys, 2021).

Learning in higher education, especially in credit-bearing formats, involves mandatory reflection such as that used in SL. In hackathons, CBL and CBR, reflection is optional. Students are usually assessed on the basis of their presentations, products, or activities. Sometimes this involves self-assessment and peer feedback (Sukackè et al., 2022). In hackathons, feedback is given by sponsors through the awarding of the prize. SL provides students with a greater opportunity to practice mandatory and systematic reflection and adaptive and flexible behaviour in a real-life setting while rendering the service.

The role of the educator changes most in hackathons, where the teacher becomes a facilitator of learning and plays an instructional part only in the beginning of the hackathon. In SL, the teacher also becomes a facilitator while students render their services in the community and may, in addition, instruct them in specific issues. In SL, educators take on instructive, supporting and communicator roles (Resch & Schrittmesser, 2021). Teachers may give instructions at the beginning of the course and then increasingly withdraw from this instructive role in order to promote autonomous learning during the service experience. In the communicator role, teachers act as a 'link person' who establishes and maintains contact to community partners on behalf of their students (Boland, 2014, p. 188). There might be role similarities in hackathons and SL, especially when students are inexperienced with hackathons, then teachers instruct them in the beginning, like in SL, and then step-by-step turn into facilitators once small groups are running. In CBR, teachers remain instructors of the research methodology and shift their role when students conduct research in the community to guide them through the process of proficiently applying research methods in a community setting. It is crucial for the successful implementation of CBR and CBL that students are not simply 'parachuted' into a community but are instead instructed by educators to ensure that they are fully aware of the socio-cultural environment in which they will be working and receive clear information on the purposes of the activity. In CBL, 'the teacher serves as mentor and facilitator, but must resist temptation to either define the problem or find 'good' solutions for their students'. (Cruger,

2017, p. 89). The teacher becomes a co-designer of the solution in the learning process (Membrillo-Hernández et al., 2019; Sukacké et al., 2022).

Last but not least, an advanced comparison must also look at aspects of recognition and credit valorisation. In hackathons, the sponsors provide a prize or award for the winning team, which is not the case in SL, CBL and CBR. However, SL, CBL and CBR are credit-bearing activities in which students do receive formal recognition of their efforts (Resch et al., 2022). In extreme cases, students even have to take time off from work in order to participate in a hackathon, without receiving credits like in SL, CBL, or CBR. The fact that hackathons are much shorter in duration is a further reason why they are non-credit bearing. However, there have been attempts to place hackathons within course structures to make them credit-bearing (Moro, 2024).

Discussion

Two main trends have affected the rise of the hackathon methodology in higher education (Heller et al., 2023). First, societal issues have become increasingly complex, and universities play a main role in providing interdisciplinary solutions to the challenges faced. Second, the innovation imperative has now also reached the higher education sector, and both academics and higher education management need to integrate innovation into their everyday work. This requires universities to search for methodologies to promote innovation in extracurricular and curricular settings (such as hackathons). Our study places hackathons within the educational literature and looks at how to describe their pedagogical value. For this reason, we carried out multiple assessments and comparative analyses, namely a placement of hackathons within learning theories and a comparative analysis of hackathons with community-based methodologies (SL, CBL, CBR). In contrast to the main block of literature in this field, which is empirical, our study has a conceptual focus.

The first analysis shows that there are a range of learning theories that apply to the main attributes of hackathons. In *inquiry-based*, *experiential* and *challenge-based learning* (Towhidi & Pridmore, 2022) students discover contents by working on a real need or challenge in an open-ended process. Their learning processes are in the foreground. In *problem-based* and *project-based learning* – topic-centred methodologies – students develop projects or explore problems which are complex and multi-faceted and require interdisciplinary solutions, but may have been predefined or solved in advance (Spronken-Smith & Harland, 2009). As our advanced assessment shows, hackathons can be counted as part of the body of community-based methodologies. The inconsistent terminology regarding the methodologies (e.g. problem vs. issue vs. challenge vs. situation) has been acknowledged as a limitation in comparative studies (Sukacké et al., 2022) and we must certainly admit that a comparison of hackathons and community-based research is delicate since community-based research has a different focus of activity, longer duration and a research purpose. However, unlike their counterparts, hackathons are innovation-driven events in which students develop a product, prototype, or another product. This working on innovation is a challenge of the hackathon and CBL methodology as it requires communication and the identification of connections between disciplines that finally lead to an innovation phase or product (Wallwey et al., 2022). Furthermore, the duration of the hackathon as the main learning event is the shortest of all the methodologies. From the learning perspective, we need to be attentive to and critical of the short duration of hackathons, since completing the entire experience in one, two or three days requires dedication and exposes students to high levels of stress and exhaustion (Rys, 2021).

Unlike SL and CBR, hackathons do not usually form part of curricular activities, which makes the recognition of student efforts and achievements more difficult. In the hackathon, only one group of students wins the prize or final award, and hence receives formal recognition, but the others do not. Apart from not being part of formal learning in the curriculum, another difficulty

from an educational perspective is the lack of mandatory reflection on the learning process. Students can take part in hackathons without any form of reflection taking place with the educators. Other methodologies such as SL have identified reflection on action as a key attribute of applied coursework (Resch, 2023). Hackathons, hence, need well-planned follow-up exercises, which could even be part of academic coursework. Hackathons have also been criticised for not being sustainable, for example by not involving any follow-up or further development, installation, implementation or maintenance of any solutions, software or products developed (Decker et al., 2015). Making hackathons sustainable and providing further attention and institutional support by higher education institutions (e.g. entrepreneurship support) would serve to prolong the learning processes of students. Critics also note that the product of a hackathon could become a secondary outcome, while attending the actual event as a student might be designated the primary objective, thus contributing to the development of civic attitudes, social responsibility and solidarity in society (Kienzler & Fontanesi, 2017).

One recommendation is to widen the scope of the stakeholders who are involved in bringing about and organizing the main hackathon event (Chau & Gerber, 2023). Research on hackathons needs to be seen as a wider educational practice which involves not only educators and students but also administrative staff from the university and the community partners. Their perspective on learning within a hackathon event has received little attention to date.

Our study emphasises the importance of identifying and adopting a learning theory when studying hackathons, as most literature on them is empirical (Nolte et al., 2020) and refers to the main attributes of a hackathon in the preparation, practice and follow-up phase yet does not necessarily apply a learning theory and ask *who* learns *what* and *in which form* in these three phases. Indeed, hackathons are difficult to observe from a research perspective as there are many things happening at the same time (Rys, 2021). Without the application of a learning theory, there is a risk of losing track of the pedagogical value of the methodology. We also acknowledge the limitations of our study and its comparison of methodologies with a focus on community-centred methodologies. The study illustrates that there are still a number of open questions and threads that need to be taken up, above all the fact that at least two types of hackathons also feature digital learning (Rys, 2021), namely the classic IT hackathon and the mixed hackathon, which requires an IT element in solution development. Placing hackathons in digital learning theories is still outstanding. Educators thus still need to mine the full potential of existing learning theories and conceptual frameworks for hackathons in the future.

Conclusion

This discussion shows that there are multiple possibilities for relating hackathons with learning theories and that the full potential of applying learning theories to hackathons has not yet been exploited. If theories in general shape the way that social phenomena are perceived, an insufficient theorisation of hackathons may ultimately give rise to inappropriate policy and practice recommendations. Our study thus contributes to a theoretical framework of hackathons in learning theories by providing a specific analysis of hackathons in higher education and acting as a stepping stone for future research on hackathons from a learning perspective.

Data availability

Not applicable

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship and/or publication of this article: This project was supported by the European Commission [grant agreement number 2021-1-DE01-KA220-HED-000031186].

Ethical considerations

Not applicable

Consent to participate

Not applicable

Consent for publication

Not applicable

ORCID iDs

Katharina Resch  <https://orcid.org/0000-0002-5532-8105>

Sabine Freudhofmayer  <https://orcid.org/0000-0003-3794-565X>

References

- Baack, S., Djeflal, C., Jarke, J., & Send, H. (2020). Civic Tech: ein Beispiel für Bürgerzentrierung und Bürgerbeteiligung als Leitbild der Verwaltungsdigitalisierung. In T. Klenk, F. Nullmeier, & G. Wewer (Eds.), *Handbuch Digitalisierung in Staat und Verwaltung* (pp. 337–345). Springer VS. Authors removed for peer review.
- Berg, S., Clute-Simon, V., Freudl, R. L., Rakowski, N., & Thiel, T. (2021). Civic Hackathons und der Formwandel der Demokratie. Eine repräsentationstheoretische Analyse von #WirVsVirus. *PVS Politische Vierteljahresschrift*, 62, 621–642. <https://doi.org/10.1007/s11615-021-00341-y>
- Boland, J. A. (2014). Orientations to civic engagement: Insights into the sustainability of a challenging pedagogy. *Studies in Higher Education*, 39(1), 180–195.
- Bonilla, R., Granda, R., & Lozano, E. (2020, April 27–30). *Effects of a hackathon on the motivation and grades of CSI students* [Conference session]. IEEE Global Engineering Education Conference (EDUCON), Porto, Portugal. (pp. 773–778). <https://doi.org/10.1109/>
- Bringle, R., Hatcher, J., & McIntosh, R. (2006). Analyzing Morton's typology of service Paradigms and integrity. *Michigan Journal of Community Service Learning*, 13(1), 5–15.
- Chau, C. W., & Gerber, E. M. (2023, April 23–28). *On hackathons: A multidisciplinary literature review* [Conference session]. Human Factors in Computing Systems – Proceedings, Hamburg, Germany (pp. 1–21). ACM. <https://doi.org/10.1145/3544548.3581234>
- Chernov, I., Elsler, M., Maillart, T., Cacciatori, C., Tavazzi, S., Gawlik, B. M., Vystavna, Y., Anastasaki, A., DuBois, C., Warner, S., Neely, M. B., Muziasari, W., Christ, K., Abrate, T., Salyani, A., & Sullivan, T. (2024). Innovative solutions for global water quality challenges: Insights from a collaborative hackathon event. *Frontiers in Water*, 6, Article 1363116.
- Cochran-Smith, M., & Lytle, S. L. (2009). *Inquiry as stance*. Teachers College Press.
- Cruiger, K. M. (2017). Applying challenge-based learning in the (feminist) communication classroom: Positioning students as knowledgeable change agents. *Communication Teacher*, 32(2), 87–101. <https://doi.org/10.1080/17404622.2017.1372602>
- Cwikel, J., & Simhi, M. (2022). Using the hackathon model in social work education. *Social Work Education*, 41(8), 1563–1576.
- Decker, A., Eiselt, K. and Voll, K. (2015) Understanding and improving the culture of hackathons: Think global hack local. *IEEE Frontiers in Education Conference*, 1–8.

- Dewey, J. (1916/1993). *Democracy and education: An introduction to the philosophy of education*. Macmillan.
- Faludi, J. (2023). Hack for impact—sociomateriality and the emergent structuration of social hackathons. *Journal of Organizational Ethnography*, 12(2), 223–241.
- Felten, P., & Clayton, P. H. (2011). Service-learning. *New directions for Teaching and Learning*, 128, 75–84. <https://doi.org/10.1002/tl.470>
- Förschler, A., & Decuyper, M. (2024). Where are we heading? Hackathons as a new, relational form of policymaking. *Journal of Education Policy*, 39(4), 519–540.
- Gallagher, S. E., & Savage, T. (2020). Challenge-based learning in higher education: An exploratory literature review. *Teaching in Higher Education*, 28, 1135–1157. <https://doi.org/10.1080/13562517.2020.1863354>
- Gama, K., Gonçalves, B. A., & Alessio, P. (2018, July 2–4). *Hackathons in the formal learning process* [Conference session]. 23rd Annual ACM Conference on Innovation and Technology in Computer Science Education (ITiCSE 2018), Larnaca, Cyprus (pp. 248–253). Association for Computing Machinery. <https://doi.org/10.1145/3197091.3197138>
- Gama, K., Valença, G., Alessio, P., Formiga, R., Neves, A., & Lacerda, N. (2023). The developers’ design thinking toolbox in hackathons: A study on the recurring design methods in software development marathons. *International Journal of Human–Computer Interaction*, 39(12), 2269–2291.
- García, M. B. (2022). Hackathons as extracurricular activities. Unraveling the motivational orientation behind student participation. *Computer Applications in Engineering Education*, 30(6), 1903–1918.
- García, M. B. (2023). Fostering an innovation culture in the education sector. A scoping review and bibliometric analysis of hackathon research. *Innovative Higher Education*, 48, 739–762.
- García, T. M., & Menéndez, F. A. (2021). University hackathons: New ways of educational and social innovation. The experience of the University of Salamanca. *Journal of Higher Education Theory & Practice*, 21(7), 56–62.
- Heller, B., Amir, A., Waxman, R., & Maaravi, R. (2023). Hack your organizational innovation literature review and integrative model for running hackathons. *Journal of Innovation and Entrepreneurship*, 12(6), 1–24. <https://doi.org/10.1186/s13731-023-00269-0>
- Helker, K., Bruns, M., Reymen, I. M., & Vermunt, J. D. (2024). A framework for capturing student learning in challenge-based learning. *Active Learning in Higher Education*. Advance online publication. <https://doi.org/10.1177/14697874241230459>
- Hershkovitz, A., & Lahav, O. (2023). Promoting innovation via a university-organized online hackathon. *International Journal of Teaching and Learning in Higher Education*, 35(2), 32–43.
- Jussila, J., Suominen, A. H., & Rainio, T. (2020). Entrepreneurship competence using educational hackathons in Finland. *Journal of Finnish Studies*, 23(2), 32–73.
- Jones, G. M., Semel, B., & Le, A. (2015). “There’s no rules. It’s hackathon.” Negotiating commitment in a context of volatile sociality. *Journal of Linguistic Anthropology*, 25(3), 322–345.
- Kettunen, J., Kairisto-Mertanen, L., & Penttilä, T. (2013). Innovation pedagogy and desired learning outcomes in higher education. *On the Horizon*, 21(4), 333–342.
- Kienzler, H., & Fontanesi, C. (2017). Learning through inquiry. A global health hackathon. *Teaching in Higher Education*, 22(2), 129–142. <https://doi.org/10.1080/13562517.2016.1221805>
- Kitsios, F., & Kamariotou, M. (2023). Digital innovation and entrepreneurship through open data-based platforms: Critical success factors for hackathons. *Heliyon*, 9(4), 1–11.
- Kohne, A., & Wehmeier, V. (2020). *Hackathons. From idea to successful implementation*. Springer VS.
- Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Prentice Hall.
- Kolb, A. Y., & Kolb, D. A. (2005). Learning styles and learning spaces: Enhancing experiential learning in higher education. *Academy of Management Learning & Education*, 4(2), 193–212.
- Komssi, M., Pichlis, D., Raatikainen, M., Kindstrom, K., & Jarvinen, J. (2015). What are hackathons for? *IEEE Software*, 32(5), 60–67.
- La Lopa, J. (2012). Service-learning: Connecting the classroom to the community to generate a robust and meaningful learning experience for students, faculty, and community partners. *Journal of Culinary Science & Technology*, 10(2), 168–183.

- La Place, C., Jordan, S. S., Lande, M., & Weiner, S. (2017, June 24–28). *Engineering students rapidly learning at hackathon events* [Conference session]. ASEE Annual Conference and Exposition, Conference Proceedings, Columbus, Ohio, (pp. 1–14). <https://doi.org/10.18260/1-2-28260>
- Lange, D. (2020). *Pedagogical Booklet. Project-based learning in non-formal education*. https://lehrerinnenbildung.univie.ac.at/fileadmin/user_upload/p_lehrerinnenbildung/Arbeitsbereiche/Didaktik_der_Politischen_Bildung/LEAP/LEAP_IO1_Final.pdf
- Lawrence, A. (2016). *What is a hackathon? A newbie's guide to collaborative coding*. Rasmussen University.
- Membrillo-Hernández, J., Ramírez-Cadena, M. J., Martínez-Acosta, M., Cruz-Gómez, E., Muñoz-Díaz, E., & Elizalde, H. (2019). Challenge based learning: The importance of world-leading companies as training partners. *International Journal on Interactive Design and Manufacturing*, 13(3), 1103–1113. <https://doi.org/10.1007/s12008-019-00569-4>
- Moro, A. S. (2024). A concrete recipe to reinvent and innovate the bachelor's program: Free choice of courses and hackathon-based teaching. *Human Arenas*, 7, 722–730.
- Morris, T. H. (2020). Experiential learning. A systematic review and revision of Kolb's model. *Interactive Learning Environments*, 28(8), 1064–1077.
- Nolte, A., Chounta, I. A., & Herbsleb, J. M. (2020, August 26). *What happens to all these hackathon projects? Identifying factors to promote hackathon project continuation* [Conference session]. ACM on Human-Computer Interaction 4 (CSCW2), Tallinn, Estonia (pp. 1–26). <https://doi.org/10.1145/3340481.3342735>
- Olesen, J., & Halskov, K. (2020, July 6–10). *10 years of research with and on hackathons* [Conference session]. DIS 2020 – Proceedings of the 2020 ACM Designing Interactive Systems Conference, Eindhoven, Netherlands (pp. 1073–1088). <https://doi.org/10.1145/3357236.3395543>
- O'Riordan, F., & Gormley, C. (2023). Running a hackathon for academic staff: A case study from DCU. *Irish Journal of Academic Practice*, 11(1), 3. <https://doi.org/10.21427/F3KM-FC33>
- Paganini, D., & Gama, K. (2020). Female participation in hackathons: A case study about gender issues in application development marathons. *IEEE Revista Iberoamericana de Tecnologías del Aprendizaje*, 15(4), 326–335. <https://doi.org/10.1109/>
- Perna, S., Recke, M. P., & Nichols, M. (2023). *Challenge based learning. A comprehensive survey of the literature*. The Challenge Institute. https://www.challengeinstitute.org/CBL_Literature_Survey.pdf
- Pe-Than, E. 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.
- Porras, J., Khakurel, J., Ikonen, J., Happonen, A., Knutas, A., Herala, A., & Drögehorn, O. (2018, June 8). *Hackathons in software engineering education. Lessons learned from a decade of events* [Conference session]. International Workshop on Software Engineering Education for Millennials (pp. 40–47). <https://doi.org/10.1145/3194779.3194783>
- Rengstorf, C., & Schumacher, C. (2013). Projektunterricht in Lehrerbildung und Bildungsdiskussion. [Project-related teaching in teacher education and educational policy] In C. Schumacher, F. Rengstorf, & C. Thomas (Eds.), *Projekt: Unterricht und Professionalisierung in Lehrerbildung und Schulpraxis* [Project: Teaching, Project-related Teaching and Professionalization in Teacher Education and School Practice] (pp. 19–39). Vandenhoeck & Ruprecht.
- Resch, K. (2023). Formative assessment of e-service learning using learning diaries and group reflections. In Hummel, S. and Donner, M.T. (eds.), *Doing Higher Education. Student Assessment in Digital and Hybrid Learning Environments*. (pp. 378–400). Wiesbaden: VS Springer. https://doi.org/10.1007/978-3-658-42253-0_13
- Resch, K., Knapp, M. and Schrittemser, I. (2022). How do universities recognize student volunteering? A symbolic interactionist perspective on student engagement recognition in higher education. *European Journal of Higher Education*, 12(2), 194–210. <https://doi.org/10.1080/21568235.2021.1919170>
- Resch, K. and Schrittemser, I. (2021). Using the Service-Learning approach to bridge the gap between theory and practice in teacher education in Austria. *International Journal of Inclusive Education*, 27(10), 1118–1132. <https://doi.org/10.1080/13603116.2021.1882053>

- Roessingh, H., & Chambers, W. (2011). Project-based learning and pedagogy in teacher preparation: Staking out the theoretical mid-ground. *International Journal of Teaching and Learning in Higher Education*, 23(1), 60–71.
- Rutti, R., LaBonte, J., Helms, M., Hervani, A., & Sarkarat, S. (2016). The service learning projects: Stakeholder benefits and potential class topics. *Education & Training*, 58(4), 422–438.
- Rys, M. (2021). Invention development. The hackathon method, knowledge management. *Research & Practice*, 21(3), 499–511. <https://doi.org/10.1080/14778238.2021.1911607>
- Sliwka, A., & Klopsch, B. (2012). Service learning and school development in German Teacher Education. In T. Murphy & J. Tan (Eds.), *Service-learning and educating in challenging contexts* (pp. 89–104). Continuum.
- Spronken-Smith, R., & Harland, T. (2009). Learning to teach with problem-based learning. *Active Learning in Higher Education*, 10(2), 138–153. <https://doi.org/10.1177/1469787409104787>
- Stentoft, D. (2017). From saying to doing interdisciplinary learning: Is problem-based learning the answer? *Active Learning in Higher Education*, 18(1), 51–61. <https://doi.org/10.1177/1469787417693510>
- Sukackė, V., Pereira de Carvalho Guerra, A. O., Ellinger, D., Carlos, V., Petroniene, S., Gaižiuniene, L., Blanch, S., Marbà-Tallada, A., & Brose, A. (2022). Towards active evidence-based learning in engineering education: A systematic literature review of PBL, PjBL and CBL. *Sustainability*, 14(21), 1–31. <https://doi.org/10.3390/su142113955>
- Suominen, A. H., Halvari, S., & Jussila, J. (2019). World heritage meets smart city in an urban-educational hackathon in Rauma. *Technology Innovation Management Review*, 9(9), 44–53.
- Towhidi, G., & Pridmore, J. (2022). Hackathons for experiential learning in IS higher education. *Issues in Information Systems*, 23(1), 293–305.
- Waldner, L. S., McGorry, S. Y., & Widener, M. C. (2012). E-service-learning: The evolution of Service-Learning to engage a growing online student population. *Journal of Higher Education Outreach and Engagement*, 16(2), 123–150.
- 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. *Frontiers in Education*, 7, Article 954044. <https://www.frontiersin.org/articles/10.3389/educ.2022.954044>
- Wilson, J., Bender, K., & DeChants, J. (2019). Beyond the classroom: The impact of a university-based civic hackathon addressing homelessness. *Journal of Social Work Education*, 55(4), 736–749. <https://doi.org/10.1080/10437797.2019.1633975>
- Wurdinger, S., & Allison, P. (2017). Faculty perceptions and use of experiential learning in higher education. *Journal of e-Learning and Knowledge Society*, 13(1), 27–38.

Author biographies

Katharina Resch is an educational sociologist and professor for educational science at the University for Teacher Education Upper Austria and a researcher at the University of Vienna. Her work focuses primarily on teaching and learning, innovative didactics, social and educational inequalities, diversity, inclusion and higher education research. She is a member of the EERA Higher Education Research Network.

Sabine Freudhofmayer is an educational scientist at the University for Teacher Education Vienna. Her research focuses on teaching and learning, student research and professional development in teacher education. She has contributed to several European projects on student civic engagement and is currently studying transformative learning in inter- and transdisciplinary teaching contexts.

María-Jesús Martínez-Usarralde is professor of comparative and international education at the University of Valencia in Spain. Her work focuses on comparative and international education and cooperation for development as well as on educational innovation, university social responsibility and methodologies such as service learning. She is vice-president of the SEEC – Society of Spanish Comparative Education.