Use of Hackathons in Engineering Curriculum: Best Practices

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Abstract*. Hackathons are increasingly more integrated into the higher education system as a form of a pedagogical approach, as their benefits are becoming more recognised. This work builds on a previously presented framework for introducing hackathons in engineering curriculum with an additional presentation of related works, gathered with a preliminary literature review of two digital databases. Seven best practices are presented from the reviewed literature and from our experience with the organisation of hackathons in one master's level academic course at the University of Maribor over four academic years. The best practices we recognised are introducing additional stakeholders, a short timeline with enforced downtime, a hackathon as an exam, preparing communication channels in advance, adjusting the level to participants, offering additional prizes for the best projects, and preparing students by teaching Design thinking concepts before the event and Intellectual property protection afterwards.*

Keywords. Hackathon, academic curriculum, active learning, engineering curriculum

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1 Introduction and motivation

Incorporating hackathons into the engineering curriculum represents a dynamic approach to fostering active learning and practical skill development. Hackathons are highly engaging, continuous events centred around a key theme where participants in small groups create working software prototypes in a set amount of time, usually within 1-3 days [1]. In education, they are viewed as helpful tool to extend the core content without unnecessarily inflating the curriculum [2]. Previous studies on hackathons have recorded many advantages to introducing hackathons into the curriculum: (i) helping to solve industry-based challenges, (ii) fostering cooperation and cooperative learning, (iii) developing industry-specific skills, and (iv) engaging in informal and practical learning [2][3]. Lessons learned in a decade of organising code camps and hackathons for engineering students were reported in [2] along with a proposed taxonomy for hackathons and guidelines for using them in the graduate curriculums. A positive view of this pedagogic approach from educators (on a sample of 162 teachers) was reported by Mehta et al. [3]. The main stakeholders recognised in educational hackathons are **students**, **higher education institutions**, **industry representatives**, **society and citizens** [4]. University's Business Incubators and Knowledge and Technology Transfer Offices were also recognised as important stakeholders in our previous work [5].

This work builds on our previously published framework for introducing hackathons as a form of pedagogical approach to engineering curriculum [5]. This paper presents further insight into our approach. The main contributions of this work are i) a preliminary systematic literature review of related work with ii) analysis and overview of existing best practices in the field, and iii) an additional presentation of best practices from the organisation of yearly hackathons in four consecutive years as a part of the observed Master level course.

2 Background and method

We conducted a preliminary systematic literature review (SLR) to observe hackathons that have already been included in the engineering curriculums and answer the research questions:

- RQ1: How many students were included in the hackathon?
- RQ2: At what higher education study level were they introduced?
- RQ3: How was hackathon included in a course?
- RQ4: How long were hackathons?
- RQ5: What stakeholders were included?

The SLR was conducted in two digital databases, IEEE Xplore and ACM Digital Library, on 28. 8. 2023. The following query was used to search through titles, abstracts and paper metadata:

"hackathon" AND "curriculum" AND "engineering"

The search was limited to journal and conference publications in English. Only studies focused on higher education students (exclusion criteria or EC1) and with a presented case of hackathon implementation (EC2) were retained. Six papers were obtained from IEEE Xplore and one from ACM. After EC1 was implemented, five papers were retained (4 from IEEE Xplore and 1 one from ACM).

3 Results

The results of preliminary SLR are presented in Table 1. Hackathons were included in engineering curriculums in various countries; one of them was conducted as an international event. The number of participating students varied greatly, from 18 up to 260 per event. They were introduced at the bachelor and master level of education. Most of the observed papers documented hackathons related to software engineering (SE), Data Science or SE management. They were introduced as a part of the curriculum and graded as such, for example, as a part of the final project (in [6]) or were introduced as a volunteering part of the course and graded with bonus points (in [7]). Two examples of volunteer hackathons (i.e. outside of mandatory curriculum) in the form of engineering days' events (in [8]) and summer school (in [9]) were also introduced. The latter measured somewhat lower attendance. The length of hackathons was, in most cases, limited to a few days, with the exception of an eight-hour hackathon [7] and a weekly event [6].

Table 1. Overview of hackathon papers gathered with SLR.

Ref.	Country	Student nr.	Study level	Curriculum fit	Duration	Stakeholders
[8]	Israel	18 per event, together 700	bachelor	Annually, 40 workshops between semesters	3 days	Students, teachers
[10]	Canada	48-260 per event, multiple events	bachelor	engineering design days, various courses	2-4 days	Faculty, teachers, students
[6]	Brazil	Two events, 22 and 34 students	bachelor	Hackathon as a final project	weekend hackathon	Students, teachers, mentors
[9]	Online, international	39 international students	bachelor, master	Erasmus+ Summer school	1 week	Students, industry, academic board
[7]	Russia	34 students	master	Volunteer part of course	8 hours	Students, industry (as customer), researchers

3.1 Best practices

Extracted best practices combined with our experience presented in [5] are summarised in the following points, completing the lessons learned that were already recognised in the literature [2].

3.1.1 Introducing additional stakeholders

Introducing industry stakeholders allows students to get in touch with possible future employers, while participating in the project-oriented workflow, which is more related to the industry workflow. Introducing mentors from the industry and academia allows students to improve their solutions, while introducing other university offices (i.e., Incubators, Technologiy Transfer Offices) allows the presentation of entrepreneurial initiatives available to students. Nevertheless, the mentioned stakeholder have also their own benefits, like ideating support for their challenges, insight into perspective employees, etc.

3.1.2 Short timeline with enforced downtime

Execution of the hackathon within a few days allows students to retain their focus on the course at hand and avoid scheduling issues with other study and work obligations of students. Event dates should also consider other events close to major assessments in the term, such as final exams, as those reduce student attendance and attention [10]. Hackathon culture often involves overnight work. However, in our experience [5] and in [6], enforcing the downtime to keep the students rested and avoid health concerns and sleep deprivation proved effective. Some students might continue their work outside the official schedule, though they are not forced to do so by the design. Compliance with the educational law and university schedule policies should also be taken in advisement.

3.1.3 Hackathon as an exam

Using hackathon as a final project in a course to keep students' motivation is shown in [6] and in our experience [5]. This allows for the demonstration of knowledge and skills of each student [2], while also pushing students towards participation. The organization of hackathons outside the mandatory curriculum has a lower participation rate [7]. Fair and balanced grading within a group is a recognized challenge.

3.1.4 Preparing students by teaching Design thinking and Intellectual property protection

To successfully integrate hackathons into the curriculum, students need to understand design thinking and the basics of business planning. After the event, students should be presented with the options to develop their projects further. This includes familiarizing them with topics of innovation, intellectual property, and technology readiness level. The university’s business accelerator hub and local business hubs should also be presented after the event, if they are available to students [5].

3.1.5 Preparing communication channels in advance

The development of effective communication skills is one of the competencies required from engineering graduates [2]. To support effective communication in hackathons, we found it best to prepare communication channels in advance, specifically channels for communication between groups and mentors from the industry. In the case of our hackathons, MS Teams groups and shared calendars of meetings with mentors were created [5], while [9] prepared Zoom, cloud file share and miro boards as base collaboration tools for groups in online hackathons.

3.1.6 Adjusting the level to participants

Hackathons can be used at different levels of education and should be adjusted to the skillset of participant. Porras [2] recommends focusing on skills and competencies for first-year bachelor students and building skills for understanding new technologies in higher levels of studies. In our experience, the adjusted level should also impact stakeholders; companies are more interested in collaborations with students who have already developed basic skills and are capable of independent problem-solving. Therefore, they might not be a suitable partner for a hackathon targeted at freshmen students.

3.1.7 Additional prizes for best projects

Our experience with hackathons showed that students are more motivated to prepare and present better solutions if an additional reward is presented. This can be organised with the collaboration of industry partners or other sponsors, as described in [5][10].

4 Discussion

Hackathons are becoming a widely accepted pedagogical approach in higher education curriculums as a method of teaching creative thinking, decision-making skills, problem-solving, solution development, teamwork, use and expansion of skill and innovation. Most of the literature focused on introducing hackathons into the SE curriculum, while other engineering disciplines were less represented, though they could similarly benefit from them. A wider adoption is still in the process, and therefore, sharing best practices and lessons learned can positively impact the adoption rate, quality of organized events and their integration into engineering curriculums. This work builds on our previously published paper [5] where a framework for introducing hackathons in curriculums was presented, presenting recognized best practices from the literature and our lessons learned.

5 Conclusion

With the annual organisation of hackathons in the observed Master level course, broader literature review of alternative implementations and wider promotion of this pedagogical approach, we aim to gather further success stories and lessons learned to enable a swift and easy inclusion of hackathons in engineering curriculums. The knowledge and expertise accumulated through the organisation of hackathons hold the potential for implementation within the wider ATHENA university network. By sharing our experiences, insights, and best practices, we aspire to foster further use of this pedagogical approach. Implementing hackathons within the ATHENA testbed combined with lessons learned from related approaches (e.g., Praxis and BIP) can foster international and multidisciplinary environment cooperation models suitable for obtaining micro-credentials for students and cross-border industry involvement.

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