Hackathons as a Part of Software Engineering Education: CASE in Tools Example

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Abstract. Software engineering programs intend to connect with the industry practices to provide the most relevant up to date knowledge to the students. Students tend to pay more attention and attach more credibility to the academic knowledge when they see the endorsement of the program by the industry. For various reasons, faculty finds it difficult to connect to the industry, while as we noted those relations are essential both for education and research. Companies, while generally keen for recruitment of fresh graduates, may experience difficulty to convey their needs in terms of required capabilities and to influence education programs. We address this issue by introducing a Hackathon as a part of the software engineering program curriculum and proposing a particular setup of this event. Incorporating educational hackathons into software engineering programs will ensure a connection between academic educational programs and current industrial practice.

Keywords: Hackathon, Education, Software Engineering.

1 Introduction

Co-located with the Tools 50+1 conference, the CASE in Tools hackathon [1] joined students, companies, and researchers to experiment together with all kinds of tools for Software Engineering (SE). This event intended to help to gather expertise and new ideas on interesting practices, expose students to various business domains and modern challenges in Software Engineering. The overall goal was to open a dialogue among companies, researchers and students on hot topics in Software Engineering supported by hands-on experiments delivered in an entertaining manner in a time-boxed brainstorming format. As faculty, we designed this event to enhance the course on Management of Software Development in order to motivate and encourage students.

In this paper, we provide a brief literature review of hackathons in education, present our specific design of a hackathon that increases the outcomes for all stakeholders, discuss our experience of implementing the hackathon - both success and challenges, and present the results evaluated with a survey. We believe that this approach will be interesting to a wide audience of instructors in Software Engineering.

2 Literature review

The hackathons have been applied in education for over a decade, Porras et al [2] describe the history, discuss challenges and benefits of hackathons in various forms. They report that hackathons are a means to teach soft skills to engineers and improve the engagement of students with the course material. In particular, the hackathons provide a stimulating environment to practice teamwork, leadership, communication, presentation skills. Hackathons expose students to business domains, "customers" requirements and expectation management, that way encouraging awareness about end-users' preoccupations. Overall, hackathons represent a gamification of the education process that may positively impact learning outcomes. In the same paper, Porras et al give a basic taxonomy of hackathons with 24-hours events, week-long code camps, hacks as an exam, competitions and industry hacks. The goals may differ from a fast track to a new topic or a technology, to testing skills in a real project or emphasizing innovation and creativity in a context given by a customer.

Nandi and Mandernach [3] looked at hackathons from the informal learning standpoint and emphasized the benefits from informal peer learning that helps participants to acquire new skills. Anslow et al. [4] proposed datatons - data analytics hackathons as a way to boost the software engineering curricula. At datatons the students and data scientists explore together "customers" datasets. In [5] Decker et al. proposed a community-based format for hackathons - Think Global Hack Local (TGHL) to alleviate the intimidating culture of hackathons and make hackathons more fun and inclusive. They successfully run two TGHL events with students helping non-profit organizations.

Researchers admit that in education hackathons are helpful to extend core content without overstressing the curriculum [2]. Instructors obtain new means to evaluate students' skills and teach soft skills in a real environment. Students learn faster, get appreciation and acknowledgment for their contributions by their peers, companies, and community. Hackathons augment hiring perspectives as students and companies closely collaborate in work-related areas. Companies further benefit from crowdsourcing for new creative product ideas and solutions.

Nevertheless, researchers indicate that hackathons may also have negative effects. They require significant additional effort by faculty on top of their regular duties. The intensity of hackathons and associated stress may affect participants' study-life balance and in worse cases be harmful to health. When evaluating the group work, it is difficult to cope with the "free rider" problem. Finally, the outcomes for companies are uncertain since they depend on many factors that are hard to control or unify such as the team's qualification and experience with a particular technology.

3 Proposed Design of Hackathon for SE education

While teaching a Master's program at Innopolis University we faced several challenges that led us to apply the hackathon approach. In this section we discuss the teaching challenges, the goals for the educational hackathon and the particular hackathon setup that we designed in order to maximize the benefits and alleviate the risks mentioned above.

3.1 Specific Challenges on Example of MSD course

The CASE in Tools hackathon was designed for students of Masters programs at Innopolis University, as a part of the "Managing Software Development" (MSD) course. This course, originally created by David Root and Eduardo Miranda from Carnegie Mellon University, is focused on such aspects of software development as processes, planning, people management, etc. The course is organized as follows: 2 lectures per week, individual assignments (reading questions, essays), and group assignments (case studies). Overall, the course has a high workload: twice as many lectures as in the regular course; heavy home assignments requiring much writing resulting in up to 20 hours weekly working effort.

The course is taught for the students of two master's programs: Software Engineering and Data Science. The enrollment requirements for these programs differ significantly: The Software Engineering program requires 1+ years of industrial experience, while the Data Science program does not have such a requirement. Lack of industrial experience causes difficulties in understanding of the concepts and techniques taught in the course. Another challenge comes from the theoretical set-up of the course: although the course is packed with the practical assignments, they are built around the papers that were written years ago, and discussing some case studies on a paper; lack of real-life practice decreases students' motivation and makes it harder to convey the relevance of the course.

3.2 Overall Goals for Educational Hackathon

While designing hackathon as a part of the "Managing Software Development" (MSD) course, we set the following goals:

Expose students to various business domains. Students need to get acquainted with various business domains so that they can find a sphere of their interest and aspiration.

Force soft skills development. Participation in the hackathon facilitates the development of creativity, critical thinking, teamwork, leadership, communication and presentation skills.

Maximize communication with real "customers". Facing a real customer provides students with a deeper understanding of the importance of communication in software development and the issues that it brings along.

Expose students to modern challenges in Software Engineering. Customers bring real problems that represent a state of practice in software engineering.

Maximize benefits to "customers". The event was intended to bring tangible benefits to the "customers", such as the connection of students with potential future employees, insights on technical challenges, promotion of the company and its technologies

Re-enforce Faculty-Industry communication. Communication with the industry, even though perceived by the faculty as important and beneficial, is often insufficient due to the busyness of the faculty members or lack of soft skills. The hackathon induces the researchers to connect and communicate with people from the industry and face pertinent issues in software development.

3.3 Education "Hackathon" Process

The authors of the current paper designed and successfully conducted four specialized hackathons to boost collaboration in a large research project as reported in [6]. We intended to transpose our experience to the education domain as many characteristics were deemed extremely relevant. First, the hackathon was restricted to 8 hours of intensive work that limited the effort required by the organizers, students, and companies. Second, the customer was an essential part of the team - that maximized the collaboration between students, companies and faculty. The "Homework" - preparation activities by the teams before the hackathon, - helped to diminish stress, effectively plan Hackathon day and maximize the outcomes. Third, entertainment was the necessary part to stimulate creativity, facilitate communication and induce positive experience for all participants. Finally, we opted for a frugal administrative approach to limit the load of organizers. That was to choose the simplest and the most affordable options for the registration, coffee breaks, lunch, rooms and presentation equipment.

In the table below we compare the main characteristics in comparison with a "Traditional" hackathon - the most frequent form of a hackathon as summarized from the literature review above.

Table 1. Comparing hackathon approaches.

Properties	**"Traditional" hackathon**	**CASE in Tools**	**Intended benefits**
Duration	From 24 hours	8 hours - intensive work, Several days of "homework"	Less stress, Better work-life balance, Individual pace, Maximizing the outcomes through shaping the topics
Teams	Students only	Students, Customer	Extensive communication and working relations:

		representative, Mentor from Faculty	- Student-Customer - Faculty-Customer
Topic	Product prototype	Focused experiment	More predictable outcomes to companies
Evaluation	Jury	All participants, audience favorite	Better participation, Students learn from other teams' results
Awards	Monetary	Symbolic goodies, Course grades	Less stress, Less control needed, Less burden on event budget

With regards to the process and timeline, the CASE in Tools was designed in four stages as depicted in fig. 1:

- **Stage 1: Call for topics** - starting three months before Hackathon Day. Sourcing potential customers and defining a topic: a focused experiment feasible within 4-6 hours.
- **Stage 2: Team forming** - a preparation stage, starting three weeks before Hackathon Day. Topics announcement is followed by students' registration and gathering their interest in a particular topic. The teams are formed and they have about two weeks to organize the first meeting with a customer, ask questions about the topic, prepare a technical environment and get familiar with the concepts.
- **Stage 3: Hackathon day** - 8-hours event with lunch and 2 coffee-breaks. The day starts with topic pitches, presented by customers. Then the teams' forming is finalized and they spread in various locations to work together.
- **Stage 4: Demo time** - presentations of the teams' results at the end of Hackathon day. Evaluation of the technical progress, business impact and entertainment level of the final demonstration. Award ceremony with symbolic prizes for participants and winners, followed by an afterparty.

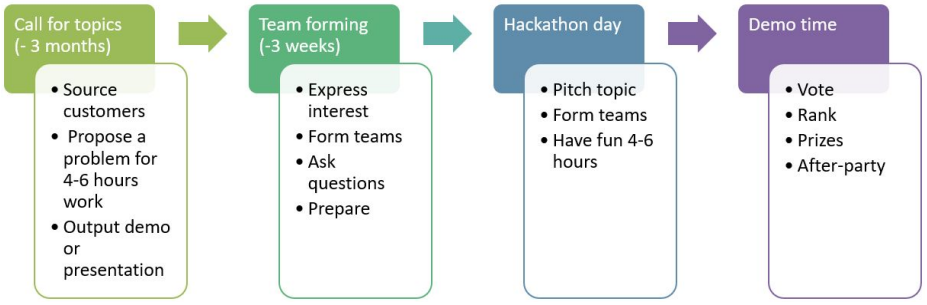

Fig. 1. Four stages of the CASE in Tools hackathon.

4 CASE in Tools in Practice

The hackathon design presented in the previous section was implemented at the TOOLS 50+1 Conference. In this section, we discuss our experience with regards to implementation, organizational challenges. Finally, we elaborate on the hackathon outcomes based on the evaluation survey.

4.1 Implementation

We started sourcing customers 3 months before Hackathon day. We used direct connections and mailing to the Innopolis University network. It was hard to convey benefits for potential customers: only direct connections worked, we have not received answers to cold emails. Nonetheless, we managed to find eight customers paying for participation in the hackathon. We conducted interviews with each customer to discuss the potential benefits of participation, explain the process and organization and define a feasible scope of a proposed challenge. The duration of the interviews ranged between 1 and 3 hours. The outcome of this stage was the challenge topics that we published on Hackathon website.

The next stage was team formation. The students of MSD course were offered additional points for Hackathon participation, which accounted for 10% of the final grade. As a result, 34 out of 44 MSD students took part in the event. We used an online poll to collect students' preferred projects - they marked the challenges of their 1st, 2nd and 3rd choice. Organizers allocated students to teams according to the preferences collected. Some challenges attracted more interest than the others, so manual balancing was required, and there were challenges that were not the first choice of any of its participants. A mentor from the academic staff was added to each team.

The preliminary work stage started 2 weeks before Hackathon day. During this stage, the teams had to organize at least one meeting with the customer and to collect all the necessary information. Mentors were expected to track this process. During this stage, 4 out of 8 customers conducted a tutorial so that the hackathon participants could get acquainted with the technology to be used in a respective challenge. We controlled teams to ensure that they started to work by checking the status with online polls.

Hackathon day was the core part of the hackathon. After the opening speech delivered by organizers, the customers presented their challenges. The teams had 4 hours, excluding lunch and coffee breaks, to provide a solution for their challenge and prepare a presentation. A customer and a mentor worked together with their team, providing guidance when necessary. The final presentations were evaluated on a

5-point scale by the hackathon participants including mentors and customers based on the criteria presented in fig.2. The winner was defined by the highest average score.

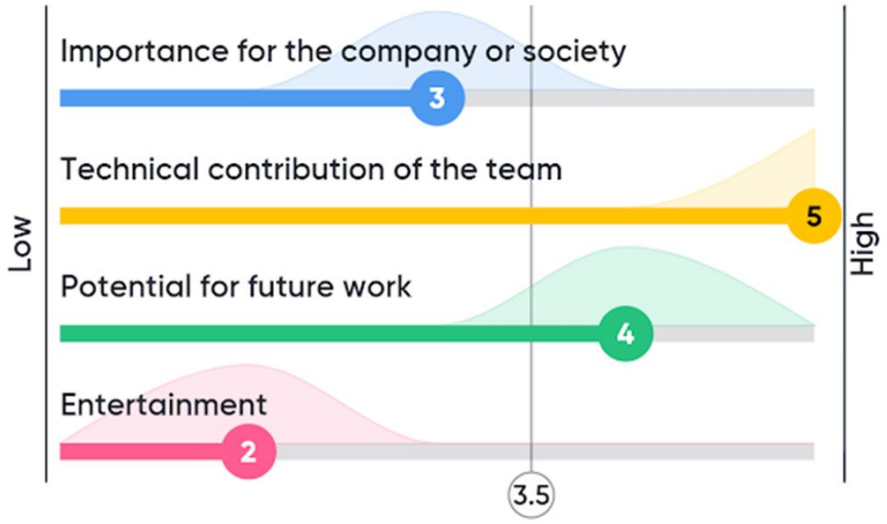

Fig. 2. Example of the voting process. The average score is 3.5.

4.2 Organizational Challenges

The main challenge in the organization was sourcing customers that would be interested in participating in the educational hackathon. Few companies responded to our multiple invitations, few who responded were our personal contacts. Among those few, several would have difficulty understanding their professional benefits in participating in this event. Few would challenge the organizers with pre-composed assumptions on students' qualifications and ability to solve business problems. Several would find it difficult to formulate a compact business problem and define its scope so that students would solve it in such a limited time. The interviews and workshops between organizers and customers helped to bootstrap that process. Overall, there was always a possibility to extract the right problem with an effort of a 2 hours' workshop.

The soft skills learning and much of knowledge transfer about the business domain rely on the involvement of customers in teamwork. We had a team with a remote customer due to travel restrictions. While the team and the customer reported overall satisfaction with the process and the event in general, our observations showed a limited success for the team, since the team would have had difficulty to convey the business impact of their findings. Another customer sent a representative, who had limited expertise in the topic and lower personal engagement since he was not

involved in the preparation workshop. That presumably harmed the team's learning outcomes and ultimately chances at the final presentations contest.

Managing an international event required an unintended amount of administrative effort, for example ordering branded hand-outs, badges, collecting registration fees, controlling the budget receivings and spendings. While we received important help from volunteers and the Innopolis University administrative staff, this represented an important unplanned distraction and added up on top organizers' regular daily duties.

We hoped that the voting process, when the audience evaluated each presenting team would stimulate attention to the final presentations and would help all the participants to learn from each other's experience. These hopes were not fully realized due to several reasons. First, the available project equipment was not adequate for a large space. The presenters had very different presentation skills. The audience was overly tired after a stressful day of intensive work. The presentations took twice as long as it was planned. It was difficult to constantly maintain the focus due to a large number of highly technically dense and diverse topics. As a consequence, the participants reported their overall frustration with the evaluation process. This all prevented the audience from getting maximum from presentations. Finally, we may conclude that the scalability of the event is rather limited since the time needed for final presentations grows with the number of teams. Thus, the evaluation may take an unreasonable amount of time after a long working day.

Nevertheless, we were quite pleased to witness that our main goals were met. The customers presented a variety of business challenges that were quite relevant to the curriculum. The students and customers actively communicated on the task-related topics. That had a positive impact on learning outcomes for students and improved the outcomes for the customers. Both groups reported high satisfaction with the event. We also observed a higher motivation by students to attend sessions specific to their challenges at the TOOLS conference.

4.3 Survey results

We conducted a survey to evaluate the outcomes. The dataset collects replies of 28 out of 34 student participants and 5 out of 7 participating customers and all 9 mentors from researchers and faculty. Although the dataset is not representative enough to draw definite conclusions, the results may give interesting insights about the appropriateness of the hackathon for education purposes.

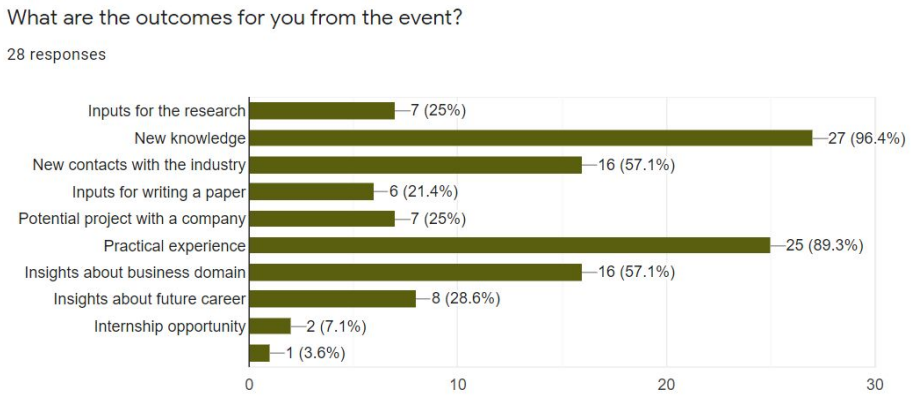

Fig. 2. Example of students' responses on the hackathon outcomes.

The majority of students reported acquiring new knowledge and practical experience. More than half of students report contacts with industry and insights about the business domain as an outcome. A minor part of students reported that they obtained inputs for their research, potential projects for the company and insights for their future career.

With regards to the Hackathon objectives, we can conclude that they were mostly meet:

Expose students to various business domains. 57% of students reported that they obtained insights into the business domain.

Force soft skills development. The hackathon stimulated students to practice creativity, critical thinking, teamwork, leadership, communication and presentation skills. In particular, 78% of students indicated that teammates' contribution was adequate. Moreover, our observations after the hackathon made us believe that the distance within the teams significantly diminished.

Maximize communication with real "customers". 89% of students reported that the customer provided all necessary information and feedback. 4 of 5 customers reported that all team members were engaged in the work.

Expose students to modern challenges in Software Engineering. 96% of students reported an exposure to new technologies and 89% reported to obtain practical experience.

Maximize benefits to "customers". All customers reported that their expectations from the hackathon were met. 2 out of 5 reported that the value of the outcome was 3 times higher than the registration fees. 3 out of 5 customers expressed a wish to participate in the next edition of the hackathon. All customers will recommend the hackathon to a colleague.

Re-enforce Faculty-Industry communication. 77% of researchers reported getting new contacts with the industry. 55% reported obtaining inputs for their research. 33% indicated a possibility for a follow-up project with a customer.

All in all, we can safely claim that the event was very successful. Students were exposed to different advanced subjects in software engineering, while companies

could explore the solution for their problems with the help of students and researchers. Overall the ambiance at the event and after made us believe that we were on the right track for improving the education process.

As a concluding remark, we would like to cite one of the students: *"Mr. Sadovykh, thank you for organizing this Hackathon. It was really inspiring for me and I am happy to have one more wonderful day in my life. At first, I was doing it for the grades but it turned out much more than that. I* ***learned so much*** *from it."*

5 Conclusions

Hackathons have become an important means for educational purposes. The gamification aspect of hackathons promotes faster learning of new technologies, encourages the practice of soft skills and engagement with curricula. Students get exposed to the business domain and technology challenges of companies in real-life settings in an entertaining and stimulating environment. In the meantime, hackathons may reveal certain drawbacks such as associated stress, time and administrative effort as well as uncertain outcomes to the participating companies.

The connection between academic educational programs and current industrial practice is valuable for faculty, students and industry, yet not easy to implement. Based on our experience with collaborative research hackathons, we designed a specialized educational hackathon to accelerate learning and promote collaboration between faculty, industry and students in a time-boxed event.

The hackathon setup has the following distinct features. First, the hackathon is restricted to 8 hours of intensive work that limits the effort required by the organizers, students, and companies. Second, the customer is an essential part of the team - that maximizes the collaboration between students, companies and faculty. Third, we introduce a set of preparation activities before the hackathon day, such as meeting with a customer and tutorials, to help to diminish stress, effectively plan the hackathon day and maximize the outcomes. Fourth, entertainment was the necessary part to stimulate creativity, facilitate communication and induce positive experience for all participants. Finally, we propose a frugal administrative approach to limit the load of organizers.

The hackathon organization revealed a number of challenges, such as difficulty to find paying customers and define a feasible scope of a proposed topic, high administrative effort of the organizers on top of their regular duties, shortcomings of Demo time organization. The discussion of these issues lays the foundation for a more efficient organization of future hackathons.

Despite the challenges mentioned above, the event was very successful. Students were exposed to different advanced subjects in software engineering, while companies could explore the solution for their problems with the help of students and researchers. The outcome of the hackathon is evaluated based on a survey completed by students, mentors and customers after the event. All groups reported high satisfaction with the event. Students reported that they obtained insights about the business domain (57%), exposure to new technologies (96%) and practical experience

(89%). Researchers reported getting new contacts with the industry (77%), obtaining inputs for their research (55%), obtaining a possibility for a follow-up project with a customer (55%). All customers reported that their expectations from the hackathon were met. The results make us believe that hackathons should become a part of the curriculum.

6 Acknowledgments

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