

## Promoting Innovation via a University-Organized Online Hackathon

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This article presents a study of a full-day, university-organized, online hackathon that aimed at designing solutions to problems raised in remote learning and teaching. The event, with about 80 participants, was carried out during the COVID-19 pandemic when many schools were closed and shifted to emergency remote teaching. The hackathon participants were challenged to design innovative solutions to authentic problems that have been raised during this situation. Using an online questionnaire, to which 28 of the hackathon participants responded, we quantitatively and qualitatively examined how the event had affected them. Findings suggest that participating in the hackathon mostly contributed to the participants' recognition of the importance of collaboration, and their thinking about academy–society relations. These contributions were driven by the way the hackathon was designed and handled, and the fact that it was held online enabled some of its unique contributions. We also show that online, shorter-than-usual hackathons still have a meaningful, multi-faceted contribution to their participants, and conclude with recommendations for planning such events.

Due to the spread of the COVID-19 pandemic, new educational setups were established quickly. Teaching and learning in these settings have raised many difficulties for various education stakeholders—students of all ages, educational teams within schools and higher education institutes, parents of young-age students, supporting staff at all levels, and policymakers, among others. As in many cases, this extreme situation had caused many around the globe to ponder both short- and long-term solutions to the various difficulties the educational system faced (Gyimah, 2020; Parker et al., 2020; Sunita, 2020). It is from such stressful situations that innovation often arises (Gross & Sampat, 2020; Vesci et al., 2021).

As education researchers, we believed that it was our duty to respond to the situation and to do so in a way that will leave a mark outside the academic milieu. As we have been aware of the importance of collaboration among heterogeneous groups for the promotion of innovative, creative ideas (Lauretta McLeod & Lobel, 1992; Mostert, 1997; Zhao & Hou, 2009), we decided to organize a full day of brainstorming, involving both students and non-students, with the main goal of designing innovative solutions to the previously mentioned problems. Due to epidemiological restrictions, the event had to be held online. We saw the glass half full and appreciated the opportunity to have as broad participation as possible and to use digital platforms to support the expected collaboration. Therefore, we structured the event as a 'hackathon.'

Hackathons have served for many years as means for promoting innovation, as a result of bringing together people from different backgrounds to solve a problem in a time-restricted setting (Flores et al., 2018; Rosell et al., 2014). However, besides their mere outcomes, hackathons may have some important contributions to their participants, in terms of their perceptions of the topics discussed during the problem-solving event as well as of problem-solving at large. This is why

hackathons have been suggested—and implemented—as pedagogical tools (Brown et al., 2018; Jussila et al., 2020; Kienzler & Fontanesi, 2017; Porras et al., 2019; Silver et al., 2016). Still, we have recognized a gap in the literature regarding the understanding of how organizations could harness such events to contribute to their members and a broader community.

To bridge this gap, we set up the following research question: How did participation in a hackathon contribute to participants regarding the following aspects?

1. Strengthening the sense of belonging to an academic community.
2. Understanding of teaching and learning in the digital age.
3. Thinking about solving problems.
4. Collaborative design and learning.
5. Enhancing the sense of involvement between academia and society.

### **Design Process as a Problem-Solving Tool**

At the beginning of the 20th century, John Dewey developed a general strategy for problem-solving that was based on reflective thinking and on a series of questions to be asked. This strategy was based on five stages: defining the problem; analyzing the problem and searching for relevant information; determining criteria for an optimal solution; proposing multiple solutions; and, finally, evaluating the solutions and choosing the optimal one (Dewey, 1910). The process, which explicitly refers to problem-solving as a cognitive skill, also emphasizes the importance of information organization, and helps improve it significantly.

Following this notion of problem-solving, the design process has served as a framework to solve problems or needs. It is a mental model, which is based on the heuristic approach (Schon, 1984), and describes a

cycle of building and rebuilding solutions throughout a meaningful learning process (Schoenfeld, 1987). The model helps in creating an inner representation of the real world that will allow the student to acquire cognitive and meta-cognitive skills that enable the student to solve problems independently (De Miranda, 2004).

As a learning tool, the design process has served in technology education, borrowing from engineering education. One of the main goals of technology education is to experience activities of problem-solving. Therefore, the design process, as a problem-solving tool, allows students to develop sensitivity to, and awareness of, the interrelationships between various components of the problem, hence providing them with an organizational and logical framework. The design process relates to the thinking process, which relates to planning with intentions and goals, as opposed to a random execution process. Understanding the design process model enables supporting students in understanding the problem-solving process, which can further be transferred to diverse problem-solving situations (McCade, 1990). Wrigley and Straker (2017) explored a variety of higher education courses that included the design process as content. They found that these courses were successfully taught within higher education contexts across multiple disciplines, with collaborative work which involved students from a variety of disciplines—such as engineering, social sciences, medicine, and education—to solve complex problems. Similar results were found by Razzouk and Shute (2012).

Design process models which were used for technology are all cyclic and contain four main actions: 1) identifying the problem, including defining desired solution; 2) exploring materials, mechanisms, and processes; 3) developing solutions; and 4) evaluating the solutions (Johnsey, 1995; Mioduser, 1998).

### **Theoretical Framework for Studying Hackathons and Learning**

A hackathon is a themed, time-bounded (usually 24–48 hours) event in which participants with diverse expertise work in teams to solve problems. Hackathons have served as meaningful educational platforms, as they establish and promote domain knowledge in a real-life context, and help develop multiple skills, such as collaboration, presentation, innovation, and problem-solving. Indeed, the promotion of such knowledge skills has been repeatedly realized, while involving students in an authentic, engaging, hands-on experience (Awuni Kolog et al., 2016; Cwikel & Simhi, 2021; Mtsweni et al., 2015; Porras et al., 2019).

Focusing on educational hackathons that are organized by academic institutions, we recognize five main goals that serve as the framework of our research.

### **Domain knowledge**

Hackathons usually function as a novel pedagogical tool that enables students to gain conceptual and practical knowledge (Byrne et al., 2017, 2018; Kienzler & Fontanesi, 2017; Medina Angarita & Nolte, 2020; Tandon et al., 2017). This is achieved by implementing constructionist ideas, either by developing artifacts or ideas (Byrne et al., 2017; Kienzler & Fontanesi, 2017).

### **Problem-Solving Skills**

At their very core, hackathons are organized to solve problems. Participation in hackathons may solidify participants' problem-solving skills, which are not often acquired or practiced in traditional post-secondary education (Cwikel & Simhi, 2021; Nandi & Mandernach, 2016; Sakhumuzi & Emmanuel, 2017).

### **Collaboration**

Collaboration is also key to the design of hackathons and is often an outcome of such events (Medina Angarita & Nolte, 2020). The opportunity to collaborate with people with different expertise than one's own in long, intensive brainstorming sessions is often appreciated by hackathon participants (Babaian et al., 2017; Bell et al., 2019; Mhlongo et al., 2020; Wang, Roy, et al., 2018; Wilson et al., 2019).

### **Learners' Community**

Consisting of the learners and their interactions with each other, a learners' community is aimed to satisfy the learning-related goals of its members, by increasing social cohesion and knowledge gaining (Rovai, 2002). As hackathons are issue-oriented and intensively engage participants in authentic problem-solving experiences, they often cultivate a strong sense of belonging to the places and contexts in which they operate (Decker et al., 2015; DiSalvo et al., 2014; Pe-Than & Herbsleb, 2019). Indeed, university-organized hackathons succeeded in increasing students' sense of a learners' community, (Kienzler & Fontanesi, 2017; Munro, 2015).

### **Academic–Society Relationship**

Universities, through their dual research and teaching endeavors, are part of a complex process of producing successful knowledge and a better society. Hackathons may serve as a means to strengthen such relationships by involving non-academicians as either participants or mentors (Chang & Rieple, 2013; Mtsweni et al., 2015; Nandi & Mandernach, 2016; Wang, Roy, et al., 2018). Involving people from outside the university brings a valuable perspective that enhances participating

students' skills and improves their hackathon products (Chang & Rieple, 2013; Wang, et al., 2018).

### Methods

We took a mixed-method approach in the design of this study. In this section, we will first describe the research population; then, we will define the research variables and present the research tool; finally, we will describe the research process.

#### Research Field

This study was carried out in Israel, where the education system is mostly public and centralized. As in most of the world, the COVID-19 pandemic outbreak has dramatically impacted the education system in Israel. For a few months—toward the end of the 2019–2020 school year and the beginning of the 2020–2021 school year—schools across the country were closed, due to national lockdowns, and teaching and learning were done remotely. Our hackathon and the data collection were carried out when many schools were still operating remotely.

The studied hackathon was a full-day online event (9 am–7 pm) organized by the authors, as part of extracurricular activities being held in the Technology & Learning graduate program at the School of Education, Tel Aviv University (Israel). The event was open to the public with free participation. Planning the hackathon, using the tips given by McGowan (2016), we first considered the main goal we strive to achieve (i.e., tackling authentic problems that had risen during COVID-19 days of teaching and learning), the participants who might find it useful, potential sponsors, supporting judges and mentors, and the overall structure of the event. The hackathon planning roughly followed the recommended timeline suggested by Nolte et al. (2020). The main goal, theme, and general structure of the hackathon were decided upon about 4 months prior to the hackathon day, and the hackathon and its preceding panels (see details that follow) were publicized over the 3 months prior to the hackathon day. This information was sent out via various platforms, including professional and personal mailing lists, relevant professional and personal profiles, pages, and groups on Facebook, WhatsApp groups, and event pages on the department and the university websites.

Non-student participants had various interests in educational technology, either because they were education stakeholders—students, teachers, principals, or parents—or because they were associated with product design and development (or both). Registration was closed about a week before the day of the event, to allow participants time to communicate and form groups based on mutual interests (see Pre-Hackathon Group

Forming section). We now detail the main design considerations for, and components of, the studied hackathon. Most of them echo the design aspects identified in Medina Angarita and Nolte's literature review (2020).

#### Pre-Hackathon Panels

Prior to the hackathon, we organized two panels to discuss the difficulties and affordances of learning during COVID-19. In these panels, we hosted education stakeholders who presented the audience with their perspectives on the situation. Most of the panel members held a position that allowed them to have a broader view of what was happening in the field beside their own experience.

From what we heard in these panels, we compiled a list of difficulties that had served as the basis for the hackathon. This list was posted prior to the event, and the hackathon participants were required to choose one difficulty that most interested them. Table 1 presents the list of difficulties and reports on the difficulties that were selected by the hackathon groups.

#### Pre-Hackathon Group Forming

The week before the hackathon, after close of registration, was dedicated to communication among the registrants. They formed groups, based on mutual interests. The full list of registrants, with some relevant background information, was made available through a secured website. A dedicated WhatsApp group was opened for the registrants, in which they presented themselves and their interests and discussed possible connections. A shared Google Sheet document was also set up for documenting the forming groups. This way, the day of the hackathon opened with a few groups already set up, some of whom had begun meeting and brainstorming their ideas. Eventually, nine groups were formed and had operated during the hackathon day, involving about 80 participants.

#### Design Process Model Canvas

Prior to the event, the participants were also presented with a design process model canvas, which served as a unified framework for idea development. The canvas was our adaptation of the popular Lean Canvas (Osterwalder & Pigneur, 2010), and was used for the development, organization, and evaluation of ideas. It has six blocks: 1) problem: What are the main issues that frustrate your users? 2) users: Clearly define the characteristics of your users; 3) existing alternatives: What do your users do today to address the problem? 4) solution: What are your solutions? How do they refer to the unique requirements of your users with regard to the

**Table 1.**  
*The List of Addressees and Their Difficulties*

Addressees	Difficulty
Students	<ul style="list-style-type: none"> <li>• Organizing learning, in terms of physical space, time management, and technology use (1)*</li> <li>• Self-directing learning and motivation toward remote learning (1)*</li> <li>• Being in a negative socio-emotional situation, a result of the long stay at home, away from peers, and of the uncertainty of what would come next (1)*</li> <li>• Handling remote learning for students with special needs (1)*</li> </ul>
Teachers	<ul style="list-style-type: none"> <li>• Lacking intimacy in online synchronous classes, due to lack of physical proximity and students not opening their webcams (1)</li> <li>• Adjusting pedagogy to the new conditions for bringing students to meaningful learning</li> <li>• Increasing students' interest and motivation (3)*</li> <li>• Assessing students in a remote setting, specifically conducting remote exams (1)*</li> <li>• Keeping boundaries between work and home while working from home</li> <li>• Dealing with the situation emotionally</li> </ul>
School and local authority personnel	<ul style="list-style-type: none"> <li>• Dealing with COID-19-related limitations and with ever-changing Ministry of Education regulations for operating schools</li> <li>• Dealing with students who got fully disengaged with school</li> <li>• Dealing with digital gap among teachers</li> <li>• Organizing and pooling school-wide or city-wide resources to optimize learning settings</li> </ul>
Parents	<ul style="list-style-type: none"> <li>• Organizing learning of children at home, in terms of technology infrastructure and time management</li> </ul>

*Note.* \*The challenges chosen by the hackathon participants, number of groups working on this difficulty is in parenthesis.

problem? In what ways are they better than the existing alternatives? What are the criteria to choose the preferred solution? Present one solution; 5) system design: What are the technological characteristics of the system (hardware, software, interfaces, user experience)? Build some mockups, review them, and request improvement suggestions from potential users; and 6) future development: What are the expected costs and revenues and how would you access your users? Which administrative and ethical aspects are relevant to promoting your product? How would you make sure that your product really solves the problem? An additional block included a checklist of tasks to complete during the hackathon day.

### The Hackathon Day

Following an opening welcome session, three 15-minute presentations were given to the participants to help participants get to the end of the day with well-developed ideas (no actual development of a prototype was required); these presentations discussed

transforming an idea into a product, building up a product demonstration, and making an effective presentation.

Then, groups convened separately—each in its own Zoom room—for about 2 hours of brainstorming, after which all of the participants assembled in the main Zoom room for 3-minute presentations of their ideas. Following that, and after a lunch break, the groups convened again in separate rooms for almost 4 hours, to fully develop their ideas and to prepare for the final presentations. Throughout their brainstorming and working sessions, the groups could have used the help of mentors; we had 12 mentors with different backgrounds and experiences.

The final session of the event was open to the public and indeed was participated in by over 100 people. During it, each group gave a 5-minute presentation of their idea. The presentations were evaluated by a group of 12 judges who were faculty at our School of Education, EdTech entrepreneurs, and some of the participants in the pre-hackathon panels. Overall, the hackathon groups presented a varied set of solutions,

among which were: a virtual character that assists students to manage their learning; a Zoom add-on that will depict students' emotional state to teachers; an online social network in which students of the same classroom will get connected based on mutual interests; virtual reality-based tours for better engaging students; an AI-based personalized virtual learning space that allows students to research based on their own topics of interest; an online space for self-assessment on multiple dimensions; a fully virtual school that will allow rich learning activities and a personalized look.

Following the presentations, the judges convened to discuss their decision of the winning group. While doing so, the audience was polled for their favorite group. The event was concluded by announcing the judges' and the audience's choices; members of the chosen teams were awarded prizes with a total worth of \$2000 USD.

### Research Population

We got 28 responses to the online questionnaire, of which 16 were males and 11 were females; one participant preferred not to disclose their gender. Nine of the participants were students in our program (five males and four females). Participants were between 14 and 62 years old ( $M = 37.1$ ,  $SD = 14.1$ ,  $N = 28$ ). Twenty of the participants (71%) were various education stakeholders, including high school students, higher education students, high school teachers, instructors, developers of educational content, and an educational entrepreneur. Five of the participants (18%) were working in the high-tech industry, in either development or managerial positions and three of the participants (11%) were product designers.

### Research Variables

We collected some background information about the participants, including gender, age, and whether or not they were students in our program. Dependent variables were defined to capture the contribution of the hackathon to the participants on five dimensions: (a) sense of a learners' community (relevant only to the participating students); (b) understanding of the teaching and learning process; (c) understanding of problem-solving processes; (d) recognizing the importance of collaboration; and (e) thinking about academy–society relations. Each of these variables was measured on a 4-point Likert scale, with options labeled "Not at All," "To a Little Extent," "To a Medium Extent," and "To a Large Extent."

### Research Tools

We used an online questionnaire to collect background information—gender, age, profession, and

whether the participant was a student in our program—and self-evaluation of the contribution of the hackathon. The latter consisted of five parts, each for a different dimension of our framework. Each part presented a 4-point Likert-type item, referring to one of the dependent variables: "Participating in the hackathon contributed to my [dimension]." (The item about the sense of a learners' community was presented only to the participating students, based on their answer to a previous question, "Are you currently a student in the Technology & Learning program?") Those who chose either "To a Medium Extent" or "To a Large Extent" as a response to a given question, were directed to a follow-up section. In this follow-up question, participants were asked to rank the contribution of each of the seven hackathon components to that dimension on a 3-point Likert scale ("Not at All," "To a Medium Extent," "To a Large Extent;" we also included a "Not Relevant" option). The seven components were: resources (event website and collaborative spreadsheet to manage groups), WhatsApp group, design process model canvas, meetings with mentors, group activity, the event being a competition, and the event being held online. We also included an open-ended question, in which participants were encouraged to bring examples from their experience during the hackathon that support their ranking.

### Data Analysis

Quantitative analysis was based on common statistical tests, conducted in open-source statistics program, JASP. Qualitative data (responses to open-response questions) was analyzed using the conventional (inductive) data analysis approach, that is, in a bottom-up manner, with the researchers immersing themselves in the data independently to allow new insights to emerge (Hsieh & Shannon, 2005). Coding—and then organizing the codes into main categories—was conducted jointly by the two authors, over a few brainstorming sessions, until full agreement achieved.

## Findings

### Overall Contribution of Participation in the Hackathon

Examining the contribution of the hackathon, we found that participants ( $N = 28$ ) mostly contributed to the recognition of the importance of collaboration, with high values ( $M = 2.43$ ,  $SD = 0.92$ ) (0–3 scale). The second highest contribution, with relatively high values, was in making them think about academy–society relations ( $M = 2.00$ ,  $SD = 1.09$ ). The contribution of participation to the understanding of problem-solving processes ( $M = 1.79$ ,  $SD = 1.10$ ) and teaching and learning at large ( $M = 1.75$ ,  $SD = 1.08$ ) was medium. Referring to the

participating students ( $N = 9$ ), the contribution of the hackathon to their sense of a learners' community was medium ( $M = 1.78$ ,  $SD = 1.20$ ). Findings are summarized in Table 2.

Running a Repeated Measures ANOVA—omitting the measuring of sense of a learners' community, due to its small sample—we found that the differences between the contributions were overall significantly different from each other, with  $F = 5.95$  ( $df = 3$ ), at  $p < 0.001$ . Post-hoc comparisons revealed two pairs of values with a significant difference. The contribution to recognizing the sense of collaboration was higher than the contribution to the understanding of teaching and learning, with  $t = 3.75$ , at  $p < 0.01$ , as well as from the contribution to understanding problem-solving, with  $t = 3.56$ , at  $p < 0.01$ . It was also marginally significantly higher than the contribution to thinking about academy–society relations, with  $t = 2.37$ , at  $p = 0.08$ .

We found no evidence of associations between the contributions to participants' gender, or age, as reported in Table 2.

### Contribution of Each of the Hackathon Components

Following the previous analysis, we checked which of the hackathon components helped in contributing to participants. Each of the seven components was tested against each of the five contributions. Overall, we found that group activity was the strongest single contributor in every dimension, with very high values of 1.72 or higher (0–2 scale).

Interestingly, the second highest contribution was attributed differently across the different contributions. For creating a sense of community, it was attributed to both mentors and competition ( $M = 1.75$ ,  $SD = 0.50$ ,  $N = 4$ , for both). Mentors were also the second highest contributor to the understanding of problem-solving ( $M = 1.39$ ,  $SD = 0.70$ ,  $N = 18$ ) and to thinking about academy–society relations ( $M = 1.44$ ,  $SD = 0.73$ ,  $N = 16$ ). The design process model was the second highest contributor to the understanding of teaching and learning ( $M = 1.53$ ,  $SD = 0.64$ ,  $N = 15$ ). Finally, the WhatsApp group was the second highest contributor to recognizing the importance of collaboration ( $M = 1.59$ ,  $SD = 0.59$ ,  $N = 22$ ). Findings are summarized in Table 3.

### The Ways in Which the Hackathon Components Contributed to Participants

We analyzed participants' responses to a set of open-ended questions in which they were asked to elaborate on the overall contribution of the hackathon participation to each of our studied dimensions. These questions were prompted to participants who ranked this contribution as medium or high (3 or 4 on a 4-point Likert scale) and were presented after ranking the contribution of each of

the hackathon components to this dimension (as was reported in the previous section). Overall, there were 37 responses from 15 participants. After coding the responses, we decided to group them into three main categories: group-external resources, group-internal activities, and event structure. Following is a description of the three main categories, along with how they were referred to in the participants' responses. Findings are summarized in Table 4.

### Group-External Resources

Under this category, we grouped responses that were related to the event website; the collaborative spreadsheet that was used to organize the group activity before and during the hackathon; the two panels that took place prior to the hackathon and laid the conceptual foundations for the solutions designed throughout it; the opening presentations; the design process model; and the discussions with the mentors during the hackathon.

Resources-related responses were coded mostly under the dimensions of understanding teaching and learning and understanding problem-solving. Participants stated that “the opening presentations” (P9), “the pre-event panels” (P13), “a mentor who helped us building a conceptual basis to our idea” (P23), and “the event website that held all of the information” (P28) had helped them to better understand teaching and learning. Regarding the understanding of problem-solving processes, they explicitly mentioned the design process model, “following which we first thought of the problem and then of ways of solving it” (P1), and that “made us actually practice problem-solving” (P12); also, problem-solving was promoted by “collaborative platforms” (P13, P28) and “an educator mentor who was familiar with the problem” (P23).

### Group-Internal Activities

Under this category, we grouped responses that were related to group formation (starting prior to the hackathon day), discourse within the groups, collaboration between the groups, and heterogeneity among the group members.

This category appeared across all dimensions. Among the participating students, “working with other program peers, as a group” (P12) had helped them to increase the sense of a learners' community; one of the participants elaborated on this issue:

Sharing knowledge together with my program peers in front of the non-student group members made me realized that I feel confident to explain about phenomena and processes about which I was exposed in lessons during the semester. (P2)

**Table 2.***Contribution of Hackathon Participation to Participants' Promotion in Difference Aspects<sup>1</sup>*

	N	M	SD	Correlation w/Age (Spearman's $\rho$ )	Gender Differences
Sense of a learners' community	9	1.78	1.20	0.12 (p = 0.76)	t(7) = 0.06 (p = 0.96)
Understanding of teaching and learning	28	1.75	1.08	0.22 (p = 0.26)	t(25) = 1.53 (p = 0.14)
Understanding of problem-solving	28	1.79	1.10	0.25 (p = 0.20)	t(25) = 0.59 (p = 0.56)
Recognizing the importance of collaboration	28	2.43	0.92	0.14 (p = 0.49)	t(25) = 0.14 (p = 0.89)
Thinking about academy–society relations	28	2.00	1.09	0.15 (p = 0.43)	t(25) = 0.82 (p = 0.42)

<sup>1</sup> 0-3 scale**Table 3.***Means (SD) of the Contribution of Different Hackathon Components to Promoting Participants<sup>1</sup>*

	Resources	WA Group	Design Process Model	Mentors	Group Activity	Comp- etition	Online
Sense of a learners' community	1.25 (0.50)	1.25 (0.50)	1.00 (0.00)	1.75 (0.50)	2.00 (0.00)	1.75 (0.50)	1.00 (0.82)
Understanding of teaching and learning	1.19 (0.66)	1.15 (0.69)	1.53 (0.64)	1.31 (0.87)	1.73 (0.46)	1.13 (0.92)	1.40 (0.74)
Understanding of problem-solving	1.22 (0.73)	1.19 (0.83)	1.14 (0.80)	1.39 (0.70)	1.83 (0.51)	1.13 (0.89)	1.20 (0.78)
Recognizing the importance of collaboration	1.26 (0.69)	1.59 (0.59)	1.19 (0.68)	1.17 (0.82)	1.87 (0.34)	1.24 (0.77)	0.90 (0.79)
Thinking about academy–society relations	1.00 (0.67)	1.06 (0.80)	1.18 (0.81)	1.44 (0.73)	1.72 (0.58)	1.25 (0.58)	1.38 (0.72)

<sup>1</sup> 0–2 scale.**Table 4.***Number of Times Each Main Category of Codes Appeared in Every Dimension*

	Groups-External Resources	Groups-Internal Resources	Event Mechanism	Total Responses
Sense of a learners' community	0	3	1	3
Understanding of teaching and learning	4	4	1	7
Understanding of problem-solving	6	4	1	9
Recognizing the importance of collaboration	2	8	3	10
Thinking about academy–society relations	2	4	1	8

*Note.* A single response could have been coded under multiple categories.

Contributing to the understanding of teaching and learning were mostly “discussions with the group peers” (P9), and specifically “discussions with the grade-school pupils in the group” (P9).

Understanding of problem-solving was also benefited by group activity, first and foremost due to “the input and the knowledge of each of the group members” (P10) and the group activity per se, e.g., “the collaborative work on the final presentation” (P19). Some of the participants stated that even the challenges they faced during the group activity eventually benefited them:

How do I express myself in a group without hurting anyone? [...] It was difficult and challenging, but eventually I gained experience in how to think of a creative solution to a problem as part of a group.” (P1)

Our group is a not-so-good example, because we had had unsolved problems throughout the hackathon, mostly interpersonal. Still, I think it gave me lots of knowledge about how to work with people and how to talk with them so we could solve a problem together. (P25)

Naturally, group activity contributed to the recognition of the importance of collaboration. At a basic level, it was due to “brainstorming of the group members” (P19) and the fact that “analyzing the problems, and the need to stay focused, were done collaboratively” (P13). Furthermore, participants emphasized the heterogeneity of the groups as an important resource, as one of the participants put it:

Because there were people of different backgrounds [...] I felt more open to ideas others than mine, and eventually it paid off. I knew that variety improves working processes, but here I actually felt it. (P2)

Finally, group activity also helped in promoting thinking about academy–society relations. Student participants emphasized that “I felt that as students, who are exposed to academic studies, we have lots of power, impact, knowledge, and different thinking processes” (P2). Generally, the presence of grade-school students contributed to this dimension, as it helped “connecting the academy to the needs of the field” (P13). One participant stated that,

there should have been more people from Engineering, Computer Science, and the Exact Sciences [...] for having a meaningful impact on the education quality at a national level, so education would be research-based (P25).

## Event Mechanism

Under this category, we grouped responses related to time limitations, the competition that was announced, the fact that the event took place online, and familiarity with the event organizers. A few mentions of this category were evident across three dimensions: the sense of a learners' community, the understanding of teaching and learning, and the recognition of the importance of collaboration. Being part of an event that was organized from within their program helped the student participants in having a sense of a learners' community, mostly due to the “feeling of backup and encouragement from the event organizers who are my instructors” (P2).

That the event was held online helped the participants understand teaching and learning, as “it allowed everyone to express themselves, comparing to a face-to-face event where there is background noise from other groups” (P2). Some groups faced technical problems, mostly due to the event being held online, but even this eventually benefited participants in recognizing the importance of collaboration:

The fact that the event was online made the work more challenging, because it was more difficult to explain to do stuff. We wasted a lot of time on solving technical problems. On the other hand, because we understood that it was very difficult, it was evident that everybody was more patient to the others, which made the discussion open and pleasant. (P1)

Also, regarding that dimension, “the time limit required a high level of collaboration” (P12).

## Discussion and Conclusions

In this article, we reported on a study of the contribution of a university-organized hackathon on teaching and learning in emergency remote teaching (ERT) to its participants. Overall, we found that the highest contribution was to the recognition of the importance of collaboration. This is reasonable, as hackathons—by their very definition and structure—are events in which groups of participants work collaboratively to solve a given problem. Indeed, previous studies have already shown that hackathons contribute to participants' sense of collaboration (Sakhumuzi & Emmanuel, 2017; Wang, Roy, et al., 2018), which is a desired outcome as collaboration is key to students' professionalism (Choi & Choi, 2020). This can be explained by the intensive, hours-long work in a group, in the context of competition between groups, which may increase group cohesion, hence increasing perceptions of the importance of collaboration (Byun et al., 2020). Along with that, our findings also highlight



the importance of an available, accessible platform for communication during collaborative learning, particularly in cases where participants are remote from each other (Vogler & Hennig, 2014).

Another key contribution for participants was their thinking about the academy–society relationship, probably a result of the event being organized and led by a graduate program faculty and open to the public, with a majority of the participants being non-students. The most prominent contributors to that understanding were group activity and working with mentors. Recalling that groups were formed from within and outside the academy and that the mentor cohort was heterogeneous in that sense as well, we demonstrate how organizations may have a broad societal impact when opening up their collaboration spaces to further participation.

Taken together, these findings echo the concept of open innovation, which refers to an internal process that is becoming dependent on external knowledge and actors (Chiaroni et al., 2010; Enkel et al., 2009). Indeed, collaboration within and outside an organization was pointed out as a crucial component for promoting open innovation (Elmqvist et al., 2009; Perkmann & Walsh, 2007); such collaboration may benefit tremendously from good support and operation tools (Antikainen et al., 2010), as was found in our case. Indeed, hackathons have been suggested as a great means to promote open innovation (Bertello et al., 2021; Temiz, 2021).

Recall that the hackathon was held online, and still had a meaningful contribution to its participants. This very setting has had some advantages over a face-to-face meeting. First, it allowed an alignment between the hackathon topic—learning and teaching online during ERT—and the very fact that the event was held online still during times of emergency. Second, it enabled the participation of audiences that may have been otherwise excluded from such events, either due to accessibility or cost considerations (Bertello et al., 2021; Temiz, 2021), hence having some important implications on inclusion and heterogeneity, which eventually enhance produced ideas.

### Implications and Recommendations

This research demonstrates that online hackathons can be effectively handled and have a meaningful contribution to participants in various important aspects. Our findings highlight the importance of some key hackathon components, such as heterogeneous groups, an easy-to-use communication platform, a clear design model, and the availability of a variety of mentors. Following our experience and our findings, we have a few recommendations for instructors and academic units who would like to plan hackathons.

- Carefully plan the hackathon, set a clear goal, and use a well-established design model framework, a strict schedule with milestones, and an easy-to-use communication platform.

- Prepare participants for the hackathon, both regarding content and practice. Holding pre-event sessions will help in focusing participants on the discussed topics and will allow them some processing time. Explicitly guiding participants regarding the hackathon mechanism prior to the event will allow for smoother handling of it. Specifically, it is encouraged to allow for group forming and discussion prior to the official event opening.

- Involve participants and mentors from different disciplines from within and outside the academic milieu. Keeping the working groups heterogeneous will promote fruitful discussions, enrich final products, and impact participants' perceptions of the academy.

- Consider taking the advantage of online hackathons. Mostly, it will allow for broader participation of individuals of multi-cultural and multi-disciplinary backgrounds and may not negatively impact the effectiveness of the event.

### Limitations and Avenues for Future Research

This study is, of course, not without limitations. First, it was situated in a single country, characterized by a specific culture of education, technology, and technology implementation in schools. Moreover, we have studied a single hackathon event, which was also unique in its setting, that is, organized by a higher education institute and open to the public. Additionally, the studied event was anchored in the COVID-19 pandemic situation, which had some very unique characteristics. Consequently, our findings should be validated by similar studies in other countries and other contexts. However, despite these limitations, we feel that the contribution of the current study is of importance for promoting more effective use of hackathons by instructors and academic units, either as a pedagogical tool or as a means to outreach to the broader community.

Further studies might focus on online international hackathons—which are relatively easily enabled when conducting them online (Bertello et al., 2021; Temiz, 2021)—and the impact of multi-culture participants on the hackathon workspace. Participants from diverse countries can bring to their team diverse opinions and ideas, which might empower their collaborative learning, design process, and creativity. Other research should compare the relative benefits of an online hackathon to a face-to-face hackathon, to examine the differences between the participants and group learning and design process.

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