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## Educational hackathon: preparing students for collaborative competency

Dina Adinda, Nathalie Gettliffe, Najoua Mohib

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Collaboration is an essential skill for future education professionals because they will encounter challenges that will require collectively innovative solutions. Thus, this research evaluates the impact of a three-month class hackathon (a one-day event and three post-hackathon workshops) on the collaborative competencies of students of education. Further, the study examines the relationship between the development of collaborative competency and the innovative performance of the student teams ( $N = 18$ ) that participated in the hackathon. Participating undergraduate students ( $N = 72$ ) were required to fill out self-reports on five dimensions underlying their collaborative competency, and coaches conducted various observations during the hackathon. The results demonstrate that students' collaborative competency developed significantly during the entire course period. However, the findings also reveal that some student teams regressed during the hackathon day and overall course period. This study does not reveal any relationship between the students' perception of collaboration and their innovation ability.

**Keywords:** hackathon; education; collaborative competency; collaborative learning

## **Introduction**

Learning through collaboration, as well as developing students' collaborative competencies, are essential to preparing for 21<sup>st</sup>-century education (OECD 2018, Tucker, Fluckiger, and Gidel 2024). Thus, a hackathon, which refers to a gathering of small groups of participants over a short period to resolve a predetermined challenge (Juraschek et al. 2020), has been identified as a facilitator in developing collaborative competency (Pe-Than et al. 2019). Hackathons, which were originally designed as coding contests for students of computer science at the Massachusetts Institute of Technology (MIT) some 50 years ago, are now being conducted in different domains,

such as engineering (Porrás et al. 2018), healthcare (Wang et al. 2018; Bell, Murray, and Davies 2019), business (Granados and Pareja-Eastaway 2019), and fine arts (Briscoe and Mulligan 2014), to foster collaboration among participants, mostly students. However, there is limited information on the impact of the hackathon on the training of undergraduate students in the field of education. Moreover, the outcomes of hackathons seem to be under-investigated (Medina Angarita and Nolte 2020), requiring thorough research designs to identify competencies, such as collaboration, which are developed during hackathons.

This research elucidates the role of hackathons in enhancing students' collaborative competencies and identifies the possible correlation between students' collaborative competencies and their innovative performance within a collaborative project. To achieve this, we conducted a study employing an undergraduate course at the Faculty of Education and Lifelong Learning, University of Strasbourg, in France. This paper is structured as follows. The second section presents the literature review on hackathons and their learning approach to facilitating collaboration. The third section presents and describes our research methodology, and the fourth section reports the results of our analyses. The final section presents the discussion and conclusion of the research.

## **Literature review**

### ***Learning through hackathon: definition and goals***

Derived from “hack” and “marathon”, a hackathon is an event comprising small groups of participants over a short, specified period (Pe-Than et al. 2019). Hackathons are designed to proffer or recommend solutions or innovative applications for specific technologies, challenges, or techniques (Juraschek et al. 2020). Originally designed as

internal one- or two-day events in the field of information technology, hackathons allow project managers and interface designers to co-create (Komssi et al. 2015); they also allow engineers and computer scientists to collaborate and avail innovative solutions to the challenges of related fields. Nowadays, hackathons go by many names, such as “Codeathon”, “Ideathon”, “Makeathon” or “Appathon”. While names may vary, they all require participants to collaborate and think creatively to quickly solve specific problems. However, “hackathon” is the term most often used, particularly in France.

A specific methodology is usually used for this type of event. Generally, hackathons are organised in the following three phases (Granados and Pareja-Eastaway 2019):

(1) the pre-event, where the general presentation of the hackathon outcome(s) is organised through several short topic-specific talks and where the challenge is defined;

(2) the hackathon event proper, which comprises three steps, namely, team formation, team functioning, and project presentations at the end of the event (pitching);

(3) the post-event, which involves the feedback and the goal of the project.

Further, Pe-Than et al. (2019) recommended the following essential features for designing a successful hackathon:

(1) different participants’ expertise or backgrounds;

(2) a condensed working period;

(3) interruption-free working hours, which require self-organisation and autonomy during the event. Aillerie (2020) and Granados and Pareja-Eastaway (2019),

recommended the consideration of three other crucial elements, as follows:

(4) competition among participants;

(5) a clear goal to resolve technical or social external or internal issues; and

(6) a production-oriented work.

Hackathons have been incorporated with multiple purposes, such as the development of soft skills (Porrás et al. 2018), collaborative competition with industries (Suominen et al. 2018), interdisciplinary collaboration (Wang et al. 2018), or networking with users (Lyndon et al. 2018), in the higher education context. Thus, hackathons are generally perceived as an innovative design for student-centred teaching (Nandi and Mandernach 2016; Kienzler and Fontanesi 2017) and a key pathway towards fostering the development of 21<sup>st</sup>-century competencies (Cerisier and Perron 2017). To achieve their objectives, educational hackathons are designed following a collaborative learning approach (Safarova et al. 2015), especially in an online context, using approaches such as project-based (Kolmos et al. 2023) or computer-supported collaborative learning (CSCL) (Järvelä and Rosé 2022).

### ***Collaborative versus cooperative learning***

The terms “collaborative learning” and “cooperative learning” are often employed interchangeably. Indeed, collaborative and cooperative learning share some common assumptions (Matthews et al. 1995), which include that a teacher is a facilitator rather than a person who actively transmits knowledge, and that group learning enhances students’ responsibilities and develops their social skills. Although cooperative learning is employed as a generic term to represent teaching methods in which students work together (Cosnefroy and Lefevre 2018), it is still different from collaborative learning.

According to Dillenbourg and Baker, “cooperative learning” implies “the division of labour among participants, as an activity where each person is responsible for a portion of the problem” (1996, 188). In such situations, students have little interaction with each other and are responsible for the execution of their tasks to achieve the final product/group goals (Rose 2002). Thus, in cooperative learning,

teachers present direct instructions and offer specific guidelines and detailed procedures based on the learning goals. Contrarily, in collaborative learning, teachers offer fewer guidelines related to the overall process, thus allowing more freedom and creativity for students to assign their roles (Matthews et al. 1995; Gallavan and Juliano 2007). Here, teachers can also establish the learning outcomes with students, and expectations can be changed throughout the activity, allowing students to perform self-directed learning and critical thinking (Gallavan and Juliano 2007), thereby activating different strategies for thinking (Baudrit 2007). For students, collaborative learning requires a process of “shared conception of a problem” (Dillenbourg and Baker 1996,188) so that they can acknowledge their complementary skills and interact to achieve a common goal. Indeed, the performance of a specific task by only one member is not sufficient (Schrage 1990) because it relies on “learners’ mutual commitment” to clarify their reasoning and construct a shared meaning of the adopted goal and strategies (Rose 2002) through dialogue and interaction (Arvaja et al. 2004). Therefore, the collaborative learning approach seems to be more suitable to the hackathon format, as this type of event brings people to work together to tackle a particular challenge (Rys 2023).

### ***From collaborative learning to collaborative competency***

Collaboration is the result of a process of interactions to develop mutual knowledge; it tilts towards complementarity and partnership (Policard 2014). Johnson & Johnson (1991) identified the following four dimensions that underly the concept of collaboration: communication, trust, leadership, and creative conflict. Indeed, students must exchange ideas, share information (Khalil and Ebner 2017), defend their arguments, criticise, and negotiate their ideas with others to collaborate and achieve a shared conceptualisation of a challenge (Roschelle and Teasley 1995), thereby

producing shared knowledge (Dillenbourg 1999). Put differently, collaboration reveals the interdependence of individuals.

Generally, when teachers implement collaborative learning, they must ensure a favourable working climate to encourage mutual learning, exchange of ideas, and discussions among their students (So and Brush 2008). However, Bandura's triadic reciprocal causation indicated that learning behaviour is influenced by the learning environment and by an individual's personal characteristics, including competencies (Ponton and Carr 2012). Thus, to target students' collaboration, it is also essential to ensure that the learning environment availed by the hackathon can activate and promote the participants' collaborative competency (McManus and Aiken 2016).

Our literature review revealed that collaborative competency generally refers to the skills that are required for effective collaboration (Getha-Taylor 2008; Chang and Wang 2021). Thus, many researchers have attempted to identify the different components of collaborative competency considering the field in which collaboration is essential, e.g., management, business, and health (Getha-Taylor 2008; Orchard et al. 2012). Despite the multiplicity of descriptions, the competency framework of the Canadian Interprofessional Health Collaborative (CIHC) (2010) is widely employed framework in the education domain to help students achieve the collaborative competency that is considered crucial for interprofessional working in health and social care (Careau et al. 2013; Archibald, Trumpower, and MacDonald 2014; Policard 2014).

### **Research questions and hypothesis**

As stated in the previous section, hackathons have been conducted in multiple domains, such as healthcare (Kienzler and Fontanesi 2017; Wang et al. 2018; Lyndon et al. 2018; Suominen et al. 2018; Bell, Murray, and Davies 2019), business and innovation (Pe-

Than et al. 2019; Granados and Pareja-Eastaway 2019), and engineering (Porrás et al. 2018). However, research on hackathons is limited. Rys (2023) recently stated that “the hackathon is still a relatively undiscovered and unexplained method” (501). Moreover, few studies have investigated the collaborative process, as hackathons encourage collaboration by requiring participants to work together to achieve a common goal. Considering this gap and the research that has shown a positive correlation between a collaborative learning approach and students’ innovative performance (Wu et al. 2013), this study addresses the following questions:

- Does a collaborative learning scenario implemented through an educational hackathon support the development of students’ collaborative competency?
- What dimensions contribute the most to the development of collaborative competency in such a context?
- Does the development of students’ collaborative competency correlate with their innovative performances in a hackathon-based course?

For the first research question, we hypothesised that a collaborative learning scenario embedded in an educational hackathon can ensure the development of students’ collaborative competency. This hypothesis can be subsequently elucidated by the answer to our second research question.

Regarding the third research question, we hypothesised that the student teams with the highest perception of the development of their collaborative competency will produce the most innovative project.

## **Materials and methods**

This section presents the hackathon’s participants, the hackathon learning environment,



and the adopted research methodology in this study.

### ***Participants***

The participants of this study were second-year undergraduate students of the Faculty of Education and Lifelong Learning, University of Strasbourg. Before the hackathon event, 100 students were invited to participate in the study. Among them, 72 followed the entire protocol, representing 18 student teams. The participants were assured of the confidentiality and anonymity of their responses. Each of them was required to read and sign an informed consent form in accordance with the research ethics guidelines of the university. All the students were participating in a hackathon for the first time.

### ***Hackathon learning environment***

The hackathon was implemented in a course titled “Education Lab” over three months to prepare students for transformation and innovation in the field of education and lifelong learning. More specifically, the Education Lab course was designed to develop collaborative competency, which has been described employing five out of the six initial dimensions that had been identified by CIHC (2010). One dimension (“patient-centred care”) was excluded because of its specificity to the healthcare domain. Table 1 describes the five dimensions of collaborative competency that were targeted by the course.

The class started with the hackathon day (one day-one place), followed by three post-hackathon workshops. This format was designed to encourage students to elaborate on collaborative and innovative projects that can be improved over time.

On the hackathon day, the students had eight hours to resolve the following educational challenge: “Imagine the future of education and learning: New spaces, services, products, and practices.” They were required to work in teams of four to six

members, and one coach was assigned to each student team to help them elaborate their response to the educational challenge as precisely as possible. At the end of the day, each student team pitched the educational challenge they worked on, as well as the solution they proffered collaboratively, in three minutes.

Following the hackathon day, the students participated in three workshops (one per month). The first workshop targeted student's creative thinking and equipped them with the skills and strategies to further work together. During the second workshop, the students learnt to assess their achievements by identifying the strengths and weaknesses of their projects. During the last workshop, all the student teams presented short videos, which they had created, to present their project ideas, after which they were invited to discuss their learning experience during the Education Lab course.

### ***Instruments and measurements***

This study involved a pre-and post-test research design to assess the development of the undergraduate students' collaborative competency. We utilised the French version of a questionnaire as developed by Careau et al. (2013) based on the Interprofessional Collaborative Competency Attainment Survey (ICCAS). This questionnaire was utilised because of its reliability and ease of being transferred to the education sector (MacDonald et al. 2010). Another interesting aspect of this instrument is that it is based on a strong theoretical framework of collaboration related to different fields, including not only health but also social work and education (Henneman, Lee, and Cohen 1995; Bronstein 2002; McKee 2003; Slusser et al. 2019). Moreover, the lack of validated instruments for measuring collaborative competency is another reason that led to the use of the ICCAS.

However, as the questionnaire was designed and mainly used in the field of

health education, some items were reworded and deleted to better fit the context of future educators. The original questionnaire comprised 41 items. However, the questionnaire used in the current study consisted of 33 items, which were based on the following five dimensions of collaborative competency (Table 1): communication (10 items), role clarification (six items), team functioning (six items), collaborative leadership (seven items), and conflict management (four items). Thus, six items related to the dimension “patient care” and two items concerning the “roles of health professionals” were deleted to ensure appropriate fit. The same six-point Likert scale, from 1 = strongly disagree to 6 = strongly agree, was utilised, following the original version. The reliability of the new instrument, which appeared to be very good ( $\alpha = 0.937$ ), was examined by Cronbach’s  $\alpha$  test for all the items. We also conducted the same test for each selected dimension, and the following p-values demonstrated that they were very satisfactory:

- Dimension 1: Communication ( $p < .001$ )
- Dimension 2: Role clarification ( $p < .001$ )
- Dimension 3: Team functioning ( $p < .001$ )
- Dimension 4: Collaborative leadership ( $p < .001$ )
- Dimension 5: Conflict management ( $p < .001$ )

We relied on Pearson’s coefficient test, which assesses the intensity of the items in the scale, for the validity test (Martel et al. 2009). The results revealed high correlations of all the dimensions of the instrument ( $p < .001$ ). A pre-questionnaire was completed on the day of the hackathon, before the event started. A post-questionnaire was repeated three months later during the final workshop, organised as part of the Education Lab course linked to the hackathon.

Additionally, an observation grid was designed as a data collection instrument and used by the coaches to examine the participants during the two key moments of the hackathon day to assess the development of collaborative competency among team members. All the coaches performed these observations one hour after the start of the hackathon (during the questioning phase) and 30 minutes before the end of the event (during the preparation of the pitch). The observation grid included the same indicators as the questionnaire (Table 1) and was scored employing a 1–3 scale system according to the following score: 1 = “low” (barely existing), 2 = “medium” (moderately existing), and 3 = “high” (strongly present in the team). A comment section was added at the end of the grid to allow the coaches to share any observations on each team’s collaborative work.

### ***Data analysis and procedures***

#### *Data collection from the students’ questionnaires*

To identify the probable improvement in collaborative competency throughout the class period (hackathon day and three post-hackathon workshops), the Wilcoxon signed-rank test, which represents a non-parametric alternative to paired *t*-tests, was conducted on the overall pre- and post-test questionnaires ( $N = 72$ ). The test was also conducted for each dimension (communication, role clarification, team functioning, collaborative leadership, and conflict management) to identify the dimensions that would demonstrate a stronger development.

The results obtained from the students’ questionnaires were also gathered by the team to calculate two scores: the pre-mean and post-mean scores. Thereafter, for each student team ( $N = 18$ ), growth rates for the collaborative competency, as well as for all its dimensions, were calculated by the following equation:

$$\text{Growth rate} = (\text{POST} - \text{PRE})/\text{PRE} * 100 \quad (1)$$

POST and PRE are the scores of the post- and pre-tests, respectively.

#### *Data collection from the coaches' observations*

Further, Wilcoxon signed-rank test was employed to assess the development of collaborative competency between the beginning of the hackathon (PRE) and the end of the eight-hour event (POST). Furthermore, the growth rate for each student team was calculated for the overall scale, as well as each collaborative competency dimension.

#### *Correlations*

Pearson's correlation test was also used to determine the correlation between the students' growth rate and their final marks obtained in the course.

## **Results**

#### *Students' self-report on collaborative competency and its dimensions*

The scores of all the students' responses ( $N = 72$ ) were listed and compared. The results of the Wilcoxon signed-rank tests demonstrated the statistical significance of the students' progression regarding collaborative competency (Figure 1 and Table 2).

Thus, the analyses of the dimensions revealed that four of them ("communication", "team functioning," "collaborative leadership", "conflict management") improved significantly. This did not apply to "role clarification", which improved, though not significantly (see Table 2).

To identify the student teams ( $N = 18$ ) that increased their perceived collaborative competency, we distinguished three categories based on the ranges of obtained scores, as follows:

$\leq 0\%$ : regression or non-growth (red)

$> 0$  to  $\leq 10\%$ : moderate growth (yellow)

$> 10\%$ : significant growth (green)

Table 3 reveals that six student teams out of 18 progressed in collaborative competency and in all its dimensions. The results were homogeneous in all the dimensions for three of these teams (Team 6: high growth rate; Team 4 and 14: moderate growth). The other three exhibited moderate to high growth rates (Teams 11, 16, and 17). We also observed that one team regressed considerably (Team 2: no growth on the variable and its dimensions).

### ***Coaches' observations of the collaborative competencies of the student teams and their dimensions***

The role of the coaches included supporting the student teams ( $N = 18$ ) in their projects and to observing their respective team dynamics. The Wilcoxon signed-rank test of the scores, which were awarded by the coaches, indicated that the students significantly developed their collaborative competency during the hackathon event (Figure 2).

However, the results of the Wilcoxon signed-rank test of each dimension in Table 4 demonstrated that only “communication” increased significantly. The three following dimensions also progressed but not significantly: “role clarification,” “team functioning,” and “collaborative leadership.” We could not calculate the Wilcoxon signed-rank test of the “conflict management” dimension because most of the coaches ignored the fact that the students did not face any conflict management when writing in the comment section of the observation grid.

Additionally, we calculated the growth rates of all the student teams ( $N = 18$ ) from the coaches' observations during the hackathon. Table 5 details the results of the

analysis employing the same colour code as in Table 3. The following three categories were defined based on the ranges of the obtained scores:

$\leq 0\%$ : regression or non-growth (red)

$>0$  to  $\leq 30\%$ : moderate growth (yellow)

$>30\%$ : significant growth (green)

As observed in the previous analysis, the growth rates of the collaborative competency, as well as its dimensions, varied with the student teams. According to the coaches, two student teams (Teams 7 and 10) maintained their initial collaborative competency, while another two (Teams 12 and 13) regressed in this competency after the hackathon day. Only one student team (Team 17) exhibited an increased growth rate.

### ***Relationship between students' self-reported perceived collaborative competency and their innovative performance***

At the end of the Education Lab course, the student teams received final marks for their projects, in which they presented innovative education solutions. The coaches and the course teacher evaluated students' innovative performance by assessing originality, feasibility, clarity of objectives, and potential impact of the final team project. Each student received the same mark as the members of their team. To maintain consistency in evaluation, the organisers of the education hackathon used the same scoring system on a 5-point scale as follows: 0 (missing), 1 (poor), 2 (fair), 3 (good) and 4 (excellent).

The results of Pearson's correlation test did not exhibit any significant relation ( $r = -0.138$ ) between the students' progress regarding their collaborative competencies and innovative performances.

## **Conclusion and discussion**

In this section, we re-introduce our hypotheses and discuss the findings of this study.

### ***What are the impacts of the educational hackathon on collaborative competency?***

The Wilcoxon signed-rank tests of students' self-reports and coaches' observations revealed that the students' collaborative competencies developed in a significantly uniform manner. Therefore, we can confirm our first hypothesis that an educational hackathon can enhance students' collaborative competencies. This result supports the findings of previous studies, particularly on CSCL, which highlight the positive impact of collaborative learning scenarios on students' teamwork, communication, leadership, and responsibility skills (Hmelo-Silver et al. 2013; Smallwood and Gubnitskaia 2018; Paulsen, Dau, and Davidsen 2024).

The results regarding the growth rate of the student teams' collaborative competencies, based on both student self-reports and coach observations, are interesting. Differences in improvement between student teams suggest that group dynamics can play a critical role in the collaborative process, especially when students participate in an educational hackathon.

Another explanation for the observed differences in the growth rates of the collaborative competencies might be due to student characteristics and the composition of the student teams. Some studies have pointed out the influence of members' team behaviours and personalities on their team's learning performances (Liu, Magjuka, and Seung-hee 2008; Mubaraz et al. 2021).



***Which dimensions contribute the most to the development of collaborative competency?***

Considering both student self-reports and coach observations, the results indicate that “communication” and “collaborative leadership” were the strongest dimensions of collaborative competency.

The “communication” dimension improved significantly after the hackathon event as well as over the three-month period. Furthermore, the students’ self-reports and coaches’ observations (Tables 3 and 5) show that four out of five student teams gained communication skills by participating in the educational hackathon. This result is consistent with previous studies, indicating that “communication” is a core collaborative competency (Getha-Taylor 2008; Chang and Wang 2021).

The results also show significant differences in students’ perceptions of “team functioning”, “collaborative leadership”, and “conflict management”. However, although many researchers in the health domain consider “role clarification” crucial for effective collaboration (Careau 2013; Archibald, Trumpower, and MacDonald 2014; Policard 2014), there was no significant increase in this dimension. One possible explanation for this finding could lie in the students' backgrounds. The “role clarification” dimension, which Archibald, Trumpower, and MacDonald (2014, 553) defined as “the ability to explain one’s role and responsibility, as well as demonstrate an understanding of other people’s roles and responsibilities in the team,” may be relevant for hackathons in which the participants come from different professional backgrounds and expertise (Pe-Than et al. 2019). However, this is not the case for this educational hackathon, which was a gathering of students from the same domain.

Moreover, the lack of coaches’ observations on the “conflict management” dimension tended to indicate that conflict situations are likely to be minimised. The

literature shows that students and teachers generally have a negative perception of conflict, which is considered “an event that should be avoided” rather than an opportunity for skill development (Longaretti and Wilson 2006).

***What is the relationship between students’ collaborative competency and innovative performance?***

Presently, most hackathons are organised to trigger innovation through collaboration (Lyndon et al. 2018; Sadovykh et al. 2019; Granados and Pareja-Eastaway 2019; Pe-Than et al. 2019). This goal was shared by the Education Lab course, which required all the student teams to work together and develop a project that could transform the field of education (e.g., innovative tools, learning solutions, and new programs). Although it was hypothesised that the student teams with the highest perception regarding the development of their collaborative competencies would produce the best innovative project, this study did not reveal any correlation ( $r = -0.138$ ) between the growth rate of collaborative competency and the final marks obtained.

This finding contrasts with many studies that indicated that collaboration at work enhances innovation and successful outcomes (Katz and Martin 1997; Blomqvist, Hurmelinna, and Seppänen 2005; Fanousse, Nakandala, and Lan 2021). This result was also somewhat surprising in that previous studies demonstrated a strong relationship between collaborative learning approaches and students’ innovative performance (Wu et al. 2013) and academic achievement (Castillo, Heredia, and Gallardo 2017). The following hypothesis can be proposed to explain our observations. The student teams were likely too homogenous in terms of their skills and background, while heterogeneity is generally considered relevant for innovation (Huang et al. 2019).

## **Limitations and further developments**

Although this study offered significant insight into the impact of an educational hackathon on students' collaborative competency, three major limitations were observed. First, it would have been beneficial to compare this educational hackathon with those of two other courses, a one-day hackathon (without post-event workshops), and a traditional course based on lectures, both focused on innovation in education. Second, a qualitative study would have better elucidated the progress and regress of the student teams through the hackathon. The interviews with the coaches would have allowed us to verify whether their representation of the conflict was negative or not. Third, the self-evaluation as a method for measuring students' collaborative competency can be seen as a limitation. Previous studies show that self-reported data can be affected by several sources of bias related to the influence of participants' individual and personal characteristics (e.g., age, gender, cognitive skills, tendency to underestimate/overestimate) (Miller 2008; Keane and Griffin 2016). Therefore, we suggest that future research using self-assessment methods should triangulate data from multiple sources, such as peer evaluations and qualitative feedback from the perspectives of both students and teachers.

Despite these limitations, the findings of this study exhibit implications for researchers and teachers who are involved in designing hackathons and implementing innovation programs for students in education. In addition to the findings of Sørensen and Torfing (2011), our study indicated that collaboration fosters innovation under certain conditions that must be clarified in future studies. At the end of the class, most of the students admitted that they were not comfortable with the Education Lab course because it contrasted with the other contents of the programme, which were supported by traditional teaching approaches. They claimed that they had never been required to

be innovative before and acknowledged their shortcomings in fulfilling the objectives of the course even if they were satisfied. The students' testimonies, as well as the weakness observed in the submitted projects (lack of innovation, vague objectives, undefined potential effects, etc.), indicated that it would be beneficial to teach a common framework of knowledge for educational innovation through a pre-hackathon course. Moreover, considering the significance of collaboration for education professionals, it would be beneficial to describe and identify the specific components of the collaborative competencies that relate to the educational sector. The programs that were developed, following such a set of skills, could help future educators become better collaborators in the education system involving a wide range of stakeholders (teachers, administrative officers, parents, policymakers, etc.).

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**Data availability statement**

Data have not been shared because depositing data into public repositories was not part of the consent process.

**Data deposition**

Not applicable.

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Figure 1. Students' self-report on collaborative competency

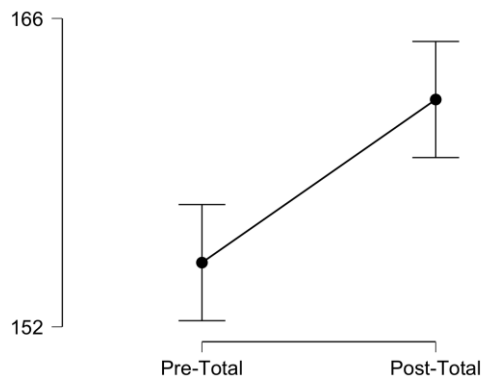
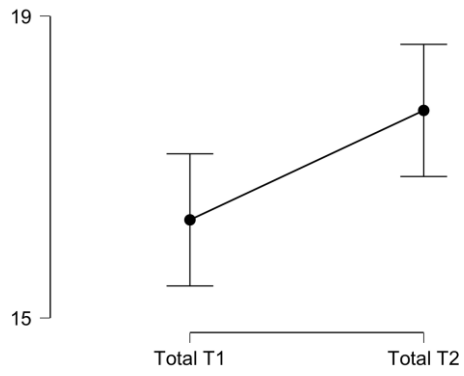


Figure 2. Coaches' observations of student team's collaborative competency



## Tables

**Table 1.** Dimensions and indicators of the collaborative competencies (adapted from the CIHC (2010))

<b>Dimensions</b>	<b>Indicators</b>
Communication	<ul style="list-style-type: none"><li>- Expressing ideas</li><li>- Sharing information</li><li>- Listening to others' points of view</li><li>- Using digital technology</li></ul>
Role clarification	<ul style="list-style-type: none"><li>- Recognising the various roles, responsibilities, and competencies</li></ul>
Team functioning	<ul style="list-style-type: none"><li>- Applying the principles of team dynamics to foster collective actions</li></ul>
Collaborative leadership	<ul style="list-style-type: none"><li>- Facilitating the distribution of leadership processes according to one's expertise</li></ul>
Conflict management	<ul style="list-style-type: none"><li>- Identifying the main sources of conflict or challenges in the context of the project</li></ul>

**Table 2.** Students' self-reports ( $N = 72$ ) on collaborative competency and its dimensions

	Questionnaire	Mean	W	p
<b>Variable</b>				
Collaborative competency	Pre	154.91	649.50	<.001**
	Post	162.31		
<b>Dimensions</b>				
Communication	Pre	48.86	515.50	<.001**
	Post	51.05		
Role clarification	Pre	27.56	928.50	0.188
	Post	28.37		
Team functioning	Pre	27.94	755.50	.038*
	Post	28.94		
Collaborative leadership	Pre	32.69	451.00	<.001**
	Post	35.01		
Conflict management	Pre	17.77	755.50	.035*
	Post	18.76		

\* $p < .05$ , \*\* $p < .001$ .

**Table 3.** Growth rate of the student teams' ( $N = 18$ ) collaborative competencies according to the students' self-reports

Team	Variable	Dimensions				
		Communication	Role clarification	Team functioning	Collaborative leadership	Conflict management
Team 1	2,31	4,35	11,61	0,00	2,23	-6,32
Team 2	-2,22	-5,48	-11,67	-9,17	-2,91	-6,17
Team 3	4,52	3,76	7	13,27	-1,46	2,63
Team 4	5,13	3,70	4,96	4,17	6,06	9,30
Team 5	0,62	4,60	-4,14	0,67	1,72	-4,12
Team 6	18,44	12,89	24,27	12,39	20,16	33,33
Team 7	2,73	7,85	-5,31	0,00	4,51	2,82
Team 8	-1,24	-5,94	1,14	-5,00	7,63	-12,50
Team 9	5,54	-0,55	-4,88	8,57	6,38	-15,71
Team 10	-2,96	1,14	-11,54	-3,90	-4,42	4,35
Team 11	13,31	13,14	22,22	10,16	13,92	3,70
Team 12	9,29	3,38	-2,35	13,75	19,10	22,00
Team 13	3,69	3,61	-3,39	4,03	8,89	5,00
Team 14	4,20	3,40	7,23	4,55	1,90	5,66
Team 15	5,85	2,67	-1,89	7,87	19,13	1,49
Team 16	18,85	14,35	8,51	14,78	24,43	20,34
Team 17	6,85	5,61	0,91	7,48	4,65	22,54
Team 18	2,43	10,32	-3,21	-6,80	5,47	3,85

**Table 4.** Coaches' observations on student teams' ( $N = 18$ ) collaborative competency and the dimensions

	Questionnaire	Mean	W	p
<b>Variable</b>				
Collaborative competency	Pre	16.22	20.000	.013*
	Post	18.05		
<b>Dimensions</b>				
Communication	Pre	9.61	23.500	.010*
	Post	10.55		
Role clarification	Pre	2.22	26.000	.144
	Post	2.55		
Team functioning	Pre	2.05	3.500	.071
	Post	2.38		
Collaborative leadership	Pre	2.33	11.000	.340
	Post	2.55		
Conflict management	Pre	NA	NA	NA
	Post	NA		

\* $p < .05$ .



**Table 5.** Growth rates of the student teams' ( $N = 18$ ) collaborative competencies according to the coaches' observations

Team	Variable	Dimensions				
		Communication	Role clarification	Team functioning	Collaborative leadership	Conflict management
Team 1	23,08	12,50	0,00	100,00	50,00	NA
Team 2	6,25	-10,00	100,00	0,00	50,00	
Team 3	11,76	10,00	0,00	100,00	0,00	
Team 4	11,11	20,00	0,00	0,00	0,00	
Team 5	7,69	25,00	-50,00	0,00	0,00	
Team 6	7,69	12,50	0,00	-50,00	100,00	
Team 7	0,00	10,00	-33,33	0,00	0,00	
Team 8	17,65	10,00	50,00	50,00	0,00	
Team 9	17,65	22,22	50,00	0,00	0,00	
Team 10	0,00	10,00	50,00	0,00	-66,67	
Team 11	18,75	11,11	200,00	0,00	0,00	
Team 12	-14,29	-8,33	-33,33	0,00	-33,33	
Team 13	-15,79	-18,18	-33,33	0,00	0,00	
Team 14	18,75	22,22	50,00	0,00	0,00	
Team 15	11,11	0,00	50,00	50,00	0,00	
Team 16	25,00	20,00	0,00	50,00	100,00	
Team 17	50,00	20,00	50,00	200,00	200,00	
Team 18	28,57	25,00	50,00	0,00	50,00	