

Towards Designing an Experience-based Course around Innovation Bootcamps — A Cohort Study

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Abstract— Context: This full research paper presents an experience-based course designed around a semester-long external Innovation Bootcamp activity. **Objective:** We sought to evaluate the impact of Innovation Bootcamp on students' learning and startup formation. To this end, we measured how the Innovation Bootcamp affected students' perceived challenges related to technical, soft project management skills and the startup formation mindset. **Method:** We conducted a cohort study comprising questionnaires, interviews, and focus groups with both students and stakeholders participating in the Innovation Bootcamp. In total, 44 students participated in the questionnaires run before and after the Innovation Bootcamps during both academic years. Moreover, we conducted four individual interviews (student cohort 1), four focus group interviews (student cohort 2), and six individual interviews with different stakeholders participating in the Innovation Bootcamp during both years. **Results:** We find that perceptions of challenges regarding soft and project management skills drop, while perceptions regarding technical skills challenges do not vary during the course. Students exhibit increased motivation to engage in startup formation following close collaboration with external stakeholders only after developing their first minimum viable product. **Contribution:** The overall outcomes of the study contribute to validating a new course design model, which will help develop a course framework to help future educators, researchers, and practitioners adopt Innovation Bootcamp activities within a software engineering-focused experience-based course.

Keywords — Experience-based course, Interdisciplinary course, Soft skills, Technical skills, Project management skills, Bootcamp, External stakeholders

I. INTRODUCTION

Experience-based learning is a methodology that allows students to develop their skills by relying on their background and experiences, an idea first proposed by Kolb [1]. Strong emphasis is also put on experiential learning [2] through multi- and interdisciplinary teams in innovative courses [3,4].

Many previous studies have reported combining inter- and multidisciplinary teams for realistic product creation through startup practices in an academic setting [1-6]. Software-intensive courses with a focus on minimum viable product (MVP) creation are also commonplace [7-10]; however, to the best of our knowledge, there has been no prior meticulous investigation of student skills and startup formation motivations incorporating external activities (i.e. Innovation Bootcamp) within experience-based courses.

During the last two years, we incorporated a three-day intensive Innovation Bootcamp external activity into our semester-long course Experts in Teamwork (EiT). These external activities helped students work with real projects

while developing software-based solutions for social good. They also allowed students to cooperate with industry, government bodies, and academia. Since then, we have provided students a new course design model. We wondered whether students were getting what we promised. To this end, we formulated the following research question (RQ):

RQ: *What is the impact of Innovation Bootcamp on students' learning and startup formation?*

To address the RQ, we designed a cohort study that gathered supplementary data (questionnaires, individual, and focus group interviews) to develop a "thick" description of how the Bootcamp activity affected students' technical, soft, and project management skills. In the first phase, we had students fill out questionnaires determining the values of dimensions related to (1) technical skill challenges, (2) soft skills (teamwork, communication, presentation, negotiation, and innovation) challenges, (3) project management challenges, (4) startup formation motivations, and (5) involvement of existing team members in startup formation. Student teams provided initial values for each dimension before Bootcamp Day 1. After Bootcamp Day 2, when the project's MVP had been developed and was ready to be pitched, student teams filled in the same questionnaire. The goal was to evaluate the variance in these two measurements and assess which dimensions vary. During the second phase, after completing the Bootcamp, we conducted interviews with (1) students, using random sampling from each team (cohort 1) and focus groups (cohort 2), and (2) all stakeholders who participated in the course in both years.

We found that the perceived value of soft skills and project management challenges dropped in the second questionnaire answers, a finding validated by the interviews with students and stakeholders and the students' project and process reports. The analysis revealed that students successfully explored soft skills related to face-to-face or online communication, brainstorming, and presentation, all of which boosted their confidence. Furthermore, Lean and Agile practices, together with Scrum Burndown Chart and Smartsheet platform [11] project management tools, increased students' confidence in planning projects. However, we did not notice any change in technical skills challenges. The qualitative data revealed little evidence of stakeholder efforts to boost students' technical skills during the Bootcamp. Startup formation motivation increased after Bootcamp Day 2, as reported in the students' interviews, whereas findings regarding existing team members' involvement in future startup formation ranged from a slight decrease in the quantitative data to more positive connotations during the interviews.

The rest of the paper is structured as follows. Section II presents related work. Section III describes the course and

Innovation Bootcamp setting. We present our study’s design and methodology in Section IV. Section V presents the results and key findings. Section VI discusses the findings. Finally, Section VII concludes the study and identifies opportunities for future work.

II. RELATED WORK

Kolb introduced experience-based learning as a tool for students to utilize their background competencies to develop their skills [1,2]. In the past 15 years, numerous research efforts have been made to introduce experience-based learning within a higher education setting. The Innovation Bootcamps are usually intensive, three- to four-day, hands-on, experiential learning events during which students exercise multiple design thinking concepts, define problems, and design solutions for challenges/projects [12]. Incorporating bootcamp activities in software-intensive, experience-based courses deserves researchers’ attention because of the benefit of such an approach for students’ technical, soft, and project management skills, especially through close interaction with external stakeholders.

Sidhu et al. [13] conducted a four-day intensive bootcamp class experience on innovation and entrepreneurship. Although they focused on the student mindset towards innovation, they used a bootcamp activity to influence this mindset. Using the Berkley Innovation Index open project concept, the authors claimed that their results were intended to measure whether entrepreneurial behaviors could be learned. The study depended on pre- and post-test values gathered before and after the bootcamp activity.

Moshirpour et al. [14] designed a bootcamp-based course focused on technical and programming skills. The aim of the bootcamp was to reinforce programming skills for non-programmers; they reported no soft or project management skills. The authors conducted a survey at the end of the bootcamp to assess students’ overall learning outcomes and satisfaction.

Similarly, Hickey and Salas [15] described extensive experience introducing bootcamp activities as a new model for learning web/mobile development and software entrepreneurship. Their longitudinal study focused on activities similar to those in incubators/accelerators boosted by further academic content.

We found no previous evidence concerning the incorporation of a bootcamp activity within software-intensive, experience-based courses.

III. COURSE AND BOOTCAMP SETTINGS

A. The Course

Our MSc degree course, EiT, is based on Kolb’s experiential learning approach [1]. Students are expected to collaboratively identify and propose specific innovative solutions that can be tackled using Software Engineering (SE) to achieve the Sustainable Development Goals defined by the United Nations (UN) [16]. The course included resources (e.g. compendium and exercises related to team dynamics) provided by learning assistants and course leaders. The course-specific learning objectives state that students should be able to (1) apply what they learned about interpersonal skills to jointly work in both the problem and solution domains; (2) apply fundamental group theory to

solve their specific collaborative situations; (3) reflect on their teamwork and analyze how the group communicates, plans, makes decisions, accomplishes tasks, handles disagreements, and relates to professional, social, and personal challenges; (4) conduct retrospective reflections at both individual and team levels; (5) take initiatives (actions) to encourage cooperation and to change patterns of interaction to create more productive, constructive, and social group collaboration. We introduced Innovation Bootcamp activities to the course over the past two years.

1) *The cohorts.* During both years, the cohorts comprised teams of students with different study backgrounds, including SE. The teams’ main characteristic was their multi- and interdisciplinary composition. Each team’s members were decided by the course leader before the start of the course, taking into account discipline and gender balance. Diversity in skillsets and backgrounds contributed to the development of relevant, innovative solutions. Team size varied from five to seven students. Self-structuring was common, and a balanced environment for making decisions supported team sustainability. Further, each team was required to apply group process theory [17] when coping with challenges and improving team dynamics.

2) *Course enrollment.* The course website, which was publicly available during both academic years, was announced to students by different faculty departments at NTNU. Recruitment occurred from October 1 to 30, 2018 and 2019. After recruitment was finalized, a total of 21 and 23 students participated the first and second year of the course, respectively. Table I reports the cohort demographics (e.g. students’ ages, genders, and academic backgrounds) for each academic year.

3) *Student evaluation.* In addition to the team project report, each student submitted an individual process report. The final deadline for the submission of the reports was one week after the last course day. The course description and assessment criteria provided the formal framework for the report, such that the process and project reports each accounted for 50% of the final grade. The team received a unique common grade.

TABLE I. COURSE DEMOGRAPHICS

| | <i>Cohort 1 (2019)</i> | | <i>Cohort 2 (2020)</i> | |
|--|------------------------|------------|------------------------|------------|
| | N# | Percentage | N# | Percentage |
| Gender | | | | |
| Male | 11 | 52% | 15 | 65% |
| Female | 10 | 48% | 8 | 35% |
| Age | | | | |
| 18-25 | 9 | 43% | 11 | 48% |
| 26-30 | 11 | 52% | 8 | 35% |
| 31-40 | 1 | 5% | 4 | 17% |
| Academic Discipline | | | | |
| Software, Computer, Electronic Engineering | 7 | 33% | 12 | 52% |
| Other (Social Sciences, Psychology, Geology, etc.) | 14 | 67% | 11 | 48% |

B. The Innovation Bootcamp

The event. The Innovation Bootcamp took place during three day-long events organized during the semester, supported in between by student–stakeholder online communication. The Innovation Bootcamp days occurred approximately once every 30 calendar days. In the interim, students had the opportunity to tackle doubts and questions while interacting remotely with the stakeholders.

However, the Innovation Bootcamp days mainly consisted of intensive, face-to-face collaborations between students and stakeholders. The objective was to motivate students to develop relevant solutions and business concepts through MVP prototypes that were then field-tested in realistic scenarios.

The course leaders and learning assistants provided support through state-of-the-art innovation tools and methods, which helped students set ambitious goals for developing their startups. Both years of Bootcamps followed similar course schedules involving several phases.

The Bootcamp-specific learning objectives for students were to: (1) create useful SE products addressing realistic societal problems, (2) foster innovative and lean thinking, (3) develop project management skills based on Lean and Agile methodologies, (4) learn to present and pitch products, (5) develop communication and negotiation skills, and (6) learn to tackle technical hurdles through stakeholder collaboration.

Bootcamp Day 1. We utilized practical exercises related to (1) thinking analogously, (2) brainstorming, (3) idea selection, and (4) solution proposal. *(1) Thinking analogously:* We started the day with a two-hour session of presentations from external stakeholders about societal challenges. The rest of Day 1 comprised several future thinking exercises. The prearranged teams were given time to get to know the stakeholders and express interest in their presented challenges. Each team could choose, at most, two stakeholders. *(2) Brainstorming and (3) Idea Selection:* To get their brains thinking, we presented the Futurescan poster with 200+ idea triggers [18]. During the first part of this exercise, three or four people per poster carefully read all the triggers. For each blank spot, they looked for a complementary future prediction. For every prediction, they described potential new problems. After 30 to 40 minutes, every brainstorm team had a long list of potential future problems. At the end of the brainstorm, every team was able to generate a potential creative idea and innovative solution to one of the presented challenges. *(4) Solution proposal:* Students presented their idea(s) in a tangible format. To help in this process, each team built a business canvas model, which they presented (over 10 to 15 minutes) to all the stakeholders and other teams. At the end of Day 1, the stakeholders and team agreed on a project idea to develop.

Interim 1. Students interacted with stakeholders using online tools (e.g. Microsoft Teams and Slack) on a weekly basis. This interim period lasted approximately four course weeks (30 days). Students addressed various questions and doubts related to evolving Day 1 project ideas into MVPs. Stakeholders professionally answered students’ concerns related to: (1) the context of the presented challenges, (2)

solutions already at stakeholders’ disposal, and (3) internal organizational composition and needs. The course leaders facilitated student–stakeholder interaction, helping avoid stagnation whenever students were reluctant to remotely communicate with stakeholders.

Bootcamp Day 2. Since Interim 1 addressed most students’ concerns, we dedicated Day 2 to idea development through (1) agile and lean methodology, (2) prototyping, and (3) business models. We first focused on idea development through the agile and lean methodology. In a two-hour session, we introduced the students with the Scrum framework and lean canvas model as a means to conduct project management and develop business ideas, respectively. Every team had to construct a Scrum burndown diagram for every sprint and fill in the lean canvas business model. Students then tried to prototype useful SE products or services addressing relevant societal challenges with a focus on UN Goals [16]. Moreover, students conducted customer surveys and developed business-to-business and business-to-customer canvas models and MVP prototypes. Invited startup entrepreneurs and experienced industry project managers played an active role during this Bootcamp day. Their competence helped students overcome challenges and technical issues during project development.

Interim 2. As during Interim 1, students actively communicated with stakeholders using online tools over 40 days. The students focused on MVP-related quality issues and testing, and the course leaders helped students realize the value of intellectual property (IP) rights by planning sessions exploring how students could protect their project artifacts. The active collaboration with stakeholders again proved vital while students tried to improve existing MPVs.

Bootcamp Day 3. This day first focused on students’ product/service presentations, which provided a clear overview of the achievements and states of the developed MVPs. Second, each student team pitched its project to investors and innovation organizations. Funding acquisition and project sustainability were key points discussed.

1) External stakeholders. The external stakeholders belonged to different sectors. Their role was to present a framework of practical social problems that could be addressed through SE practices. Their participation in the Innovation Bootcamp was key to fostering innovative ideas. Following the triple helix model of innovation [19], we chose stakeholders from three crucial sectors: government, represented by the Communes of Trondheim (first year) and Overhalla (second year); industry, represented by Capeesh (first year) and industry cluster companies (second year); and academia, represented by the students and instructors.

IV. METHODOLOGY

We designed a cohort study case study following the mixed-method approach described by Borrego et al. [20]. This approach relies on data that can supplement one another, whether the data collection is performed concurrently or sequentially. In our case, the initial data were gathered by questionnaire, and the supplementary data were collected via interviews.

A. Research Design Phases

We categorized our research into two essential phases:

- **Phase 1:** research design and preliminary investigation (quantitative approach: questionnaires).
- **Phase 2:** full data collection and data analysis (qualitative approach: interviews).

In the first phase, students were asked to answer the questionnaires after the initial Bootcamp presentation (Day 1) and after early prototype development (Day 2) based on MVP from the lean methodology.

The investigation drew from a quantitative questionnaire delivered to the same group the same way at different points in time. We grouped the considered dimensions into technical skills, soft skills (e.g., teamwork, communication, presentation, negotiation, and innovation), project management skills challenges, startup formation, and involvement of existing team members in startup formation motivations.

To minimize bias, the respondents did not have access to their answers from the first survey when completing the second one. Students rated the key dimensions using a Likert five-point scale.

The second phase involved (1) interviews with individual students based on random sampling from each team (cohort 1) and focus group interviews (cohort 2) and (2) interviews with all stakeholders participating in all Bootcamp days in both academic years.

The data gathered during Phase 2 complement the data obtained during Phase 1. Embedding the data encourages a deep understanding of the students' perceptions of the variations in skill challenges and startup formation motivations with existing team members.

B. Data Collection

We conducted the study during the spring semesters of 2018 and 2019. Each cohort comprised four teams with approximately five to six members, totaling 21 and 23 students in cohorts 1 and 2, respectively. Each team developed a project within the EIT course addressing different UN goals [16]. In the first cohort, all teams developed a mobile app solution. In the second cohort, the MVP solution proposals were more heterogeneous.

Projects from cohort 1. **Team 1** (UN Goal 10: Reducing Inequality) developed a language app to connect pairs of people with different nationalities and native languages. Users could learn a new language, meet in person, and win prizes while participating in multi-player games. **Team 2** (UN Goal 2: Zero Hunger) tackled malnutrition in Tanzania through a mobile app interface that helped mill operators provide nutrients to rural populations. **Team 3** (UN Goal 8: Defining Citizens' Needs for Better Economic Growth) developed an app to administer and report a detailed survey of social services available to expats, refugees, and international students in Trondheim, while also giving the international community a discussion forum. **Team 4** (UN Goal 13: Reducing the Carbon Footprint) developed an app to reduce Trondheim's carbon footprint by collecting, reusing, storing (in a central storeroom at NTNU), and redistributing expired food from supermarkets.

Projects from cohort 2. **Team 1** (UN Goal 3: Good Health and Well-Being) developed an app (Agora) for more

tech-savvy younger volunteers and a phone line and email service for the older population to improve relationships in Overhalla Commune by bringing diverging generations closer in both digital and physical space. **Team 2** (UN Goal 13: Climate Action) developed a website, Fin For Wood (FFW), to facilitate wood waste recycling in country Norway by connecting sellers and buyers. **Team 3** (UN Goal 8: Decent Work and Economic Growth) developed a mobile app to tackle real-time communication on construction sites by reducing delays for field workers and project managers. **Team 4** (UN Goal 11: Sustainable Cities and Communities) developed freely moveable walls relying on mechanical parts controlled by smart sensors and the IoT to produce customized apartments and office spaces. We collected the data according to the phases described early in this section:

Phase 1 - Questionnaires. In both academic years, we presented the students with the questionnaire before the first Bootcamp day. We asked students to anonymously complete the online questions, focusing on the dimensions reported in Table II. At the end of Bootcamp Day 2, we asked the students to complete the same questionnaire, this time reflecting on skill challenge outcomes and startup formation.

TABLE II. QUESTIONNAIRE INSTRUMENT

| Question asked | Dimension analysis | Value (1-5) |
|---|---|-------------|
| To what extent are soft skills (teamwork, communication, presentation, negotiation and innovation) a challenge in developing the final product? | Soft Skills Challenge | |
| To what extent are technical skills a challenge in developing the final product? | Technical Skills Challenge | |
| To what extent are project management skills a challenge in delivering the final product? | Project Management Challenge | |
| I am highly motivated in startup formation | Startup Formation Motivation | |
| I am highly motivated in involving my team members in startup formation | Involving Team Members in Startup Formation | |

Phase 2 - Student interviews. We conducted the students' semi-structured interviews between Bootcamp Days 2 and 3 (Interim 2) following a question template carefully prepared by two of the authors (Table III).

During the first year, we interviewed a total of four students (one representative from each of the four student teams). We used random sampling to pick every individual team member. We assumed that every team member during their semester-long collaboration had acquired extensive knowledge about the project and process as well as the rest of the team members. Thus, each team representative could provide detailed answers to our questions. During the second year, we conducted four focus group interviews involving all student teams (23 students in total). We changed our interview strategy from one representative for each team to a focus group approach to acquire an in-depth understanding of the various dimensions. Not only could all student opinions be heard in focus groups, but participants could also stimulate new thoughts from each other.

TABLE III. STUDENTS' INTERVIEW TEMPLATE

| Interview part | Question |
|--------------------------------------|--|
| Part 1 – Background Questions | <ol style="list-style-type: none"> 1. What is your team composition? 2. What is your project about? 3. What are your key motivations for participating in the Bootcamp? How did you benefit from the interaction with the stakeholders? |
| Part 2 – Specific Questions | <ol style="list-style-type: none"> 1. What technical challenges did you have? What kinds of technical skills did you learn during the Bootcamp? 2. What soft skills did you and your team acquire during the Bootcamp? 3. What project management approaches did you learn from the Bootcamp? 4. How did you use the new project management skills to develop your project? 5. How much did the stakeholder participate during the project? 6. What motivates you to create a startup after the Bootcamp? 7. Would you involve your team members in future startup formation? |

The semi-structured interview process took place in two parts. The first part primarily discussed the project. The second part examined perceptions of technical, soft, and project management skills gained during the Bootcamp event and through interaction with external stakeholders.

Phase 2 – Stakeholders' interviews. The semi-structured interviews with the stakeholders occurred after the Bootcamp event and the students' interviews. We interviewed all external stakeholders active during the Bootcamp days in both years. The semi-structured interview guide (Table IV) was also formulated ahead of time by two of the authors and was executed by the first author.

We again split the interview process into two parts. In the first part, we acquired information related to the stakeholders' professional backgrounds. In the second, we asked specific questions about their motivations to participate in the Bootcamp, skills they believed students had acquired from them, and motivations to form startups with the students.

TABLE IV. STAKEHOLDERS' INTERVIEW TEMPLATE

| Interview part | Question |
|--------------------------------------|---|
| Part 1 – Background Questions | <ol style="list-style-type: none"> 1. What is your professional background? What is your role in your organization? 2. How long have you been working in your organization? |
| Part 2 – Specific Questions | <ol style="list-style-type: none"> 1. What is your primary motivation in participating in the Bootcamp activity as a stakeholder? 2. What technical skills do you think students have gained while collaborating with you? 3. What project management skills do you think students have gained while collaborating with you? 4. What soft skills do you think students have gained while collaborating with you? 5. What motivates you to create a startup after the Bootcamp with the students? |

C. Data Analysis

1) *Quantitative analysis.* During the first data gathering, we did not know what to expect from the investigation. We

decided to consider the same group and to analyze the mean and variance of the answers obtained before and after Bootcamp. After analyzing the data from the first academic year, we deemed it relevant to gather and analyze similar data regarding the mean and variance of the student questionnaire answers for the second academic year.

Repeatedly in the second year, as in the first year, we decided to deepen our understanding by aggregating the quantitative data with specific qualitative data. We describe this second phase of the investigation in the following.

2) *Qualitative analysis.* After carefully collecting the interview data, we then applied a thematic analysis approach [21] to identify recurring patterns of soft, technical, project management skills, startup formation, and motivations to involve existing team members in future startups.

The steps we followed to conduct the systematic analysis were as follows: (1) **Reading the transcripts.** This step initially involved quick browsing and correcting the transcribed data from the audio recordings. Later, we reviewed the transcribed data more carefully by judiciously reading line by line. (2) **Coding.** During this step, we focused on choosing and labeling (coding) relevant words, phrases, and sentences. The labels revealed more about perceptions related to Bootcamp activities. (3) **Creating themes.** After gathering all the codes, we decided on the most relevant ones and created different categories (themes), dropping or merging many of the initial codes from the previous step. (4) **Labeling and connecting themes.** In this step, we decided which themes were most relevant and defined appropriate names. We also attempted to identify relationships among the themes. (5) **Summarizing the results.** We used an inductive coding approach [22]. We interpreted raw textual data to develop our concepts, codes, and themes. After deciding on the themes' importance and hierarchy, we generated a diagram summarizing the results [23]. To fulfill the five steps, we used the thematic coding tool NVivo 12 [24]. NVivo served as a collaboration tool to maintain our raw data and facilitate the authors' coding process. However, we manually performed the analysis and coding process.

V. RESULTS

To address the **RQ**, we present the findings concerning the impacts of the Bootcamp on students' technical, soft, project management startup formation, and motivation to involve existing stakeholders from both a quantitative and qualitative perspective.

A. Quantitative Results

During the quantitative phase of the investigation, we calculated the means and variances of the chosen dimensions, as shown in Figure 1. Per the Likert five-point scale, the values (y-axis) vary from 1 to 5 for each dimension (x-axis) before and after Bootcamp Days 1 and 2.

For the *technical skills challenge*, we obtained the following results. There was no variation in the median (**M**), minimum (**Min**), or maximum (**Max**) of the student technical skills challenge in *either cohort*.

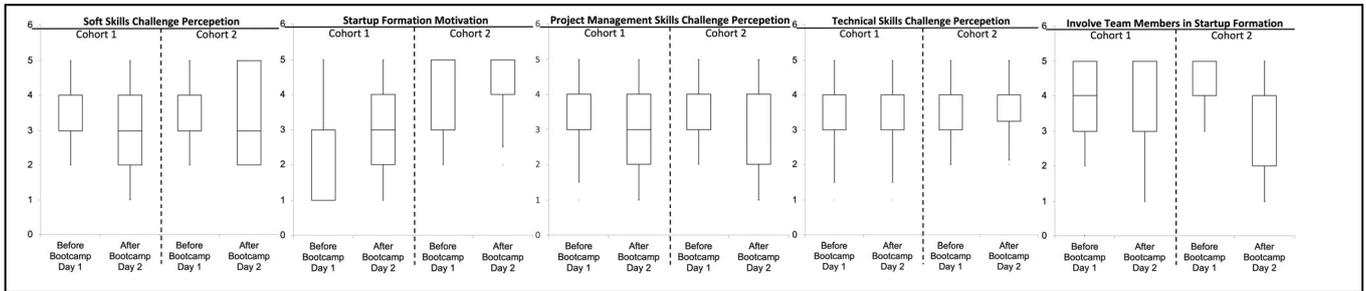


Fig. 1. Box plot representation of technical, soft, project management skills, startup formation motivation, and involvement of existing team members variation before and after Bootcamp Days 1 and 2.

Values for the *soft skills challenge* varied as follows. For the *first cohort*, the median *M* and minimum *Min* values dropped. There was no variation in the *Max*. For the *second cohort*, the median value *M* dropped, but there was no variation in *Min* or *Max*.

Values for the *project management skills challenge* varied as follows. For the *first cohort*, the median value *M* dropped. There was no variation in *Min* or *Max*. For the *second cohort*, there was no variation in the *M* or *Max*, but *Min* dropped. Values for the students' *startup formation motivation* varied as follows. For the *first cohort*, the *M* of student motivation to form a startup retained its value. There was no variation in *Min* or *Max*. For the *second cohort*, the median value *M* increased, whereas the *Min* and *Max* retained the same value. Values for the *involvement of existing team members* in startup formation varied as follows. For the *first cohort*, the median value *M* and *Min* decreased, but there was no variation in the *Max* value. For the *second cohort*, *M* and *Max* retained their values, while the *Min* value dropped.

B. Qualitative Results

In the second part of the investigation, we performed a thematic analysis of students' perceptions regarding challenges related to technical, soft, and project management skills.

1) *Technical skills challenges*. The students' interview reports regarding efforts made in *MVP development* were among the most positively perceived technical aspects. However, students from *both cohorts* acquired little technical knowledge during the Innovation Bootcamp phases. One student reported the following:

"...Each of us [*Students*] brings our own previous work experiences and technical skills into use for developing the project..." [*Team 3 – Cohort 1*]

During a focus group interview, another team reported:

"...What stakeholders showed us was a concept... but not any implementation ideas..." [*Team 2 – Cohort 2*]

While working in an interdisciplinary team, the students expanded their knowledge in the different study backgrounds. It was also common to exchange roles. However, if a product required specific software engineering skills the team had to rely on the skills of the most competent team member in the MVP development:

"...We [*Students*] developed the prototype based on X's skills in our team..." [*Team 4 – Cohort 1*]

Similarly, other focus group interviews revealed:

"...We [*Students*] built the system using Microsoft Teams, but they [*Stakeholders*] didn't help us with figuring out how to do it..." [*Team 3 – Cohort 2*]

In the same vein, one stakeholder interview showed:

"...Yeah in technical terms they [*Stakeholders*] suggested about stability and sound proofing and other factors... I think that they have made us think about other issues that we hadn't thought about but did not provide us with any solution..." [*Team 4 – Cohort 2*]

2) *Soft skills challenges*. The students learned to *communicate* with stakeholders and *exchange feedback* while acquiring relevant information to develop their projects. *Presenting and pitching* were among the most-appreciated activities during the Bootcamp. One student's interview report read as follows:

"...The stakeholder came in, and we presented to her our ideas, and she was able to kind of guide us in the direction, and she thought it was a good idea what the app should do..." [*Team 2 – Cohort 1*]

Similarly, another interview report emphasized the value of feedback while collaborating with stakeholders:

"...So, giving feedback and then taking feedback: I think that that is something that I haven't done in the past. So that's a very good aspect of the collaboration with them [*Stakeholders*]..." [*Team 2 – Cohort 2*]

Moreover, one of the stakeholder interviews revealed:

"...During the presentations and pitch sessions, I [*Stakeholder*] was able to provide feedback by indicating project directions quickly..." [*Stakeholder for Team 2 – Cohort 1*]

Perspectives were positive regarding *online coordination and communication* via Slack and Microsoft Teams. After the Bootcamp, students felt confident collaborating online with professionals. One student mentioned:

"...They [*Stakeholders*] included us in a slack chat where we could ask questions to them directly, which was very nice and helped us deal with frequent questions we had regarding the project. The door has always been open from their side..." [*Team 1 – Cohort 1*]

Another focus group interview reported the following:

"...I think, personally, I didn't learn something completely new, but it [*online communication*] definitely

helped to improve my soft skills... I think the communication was challenging at the start until we found the right channel [Microsoft Teams]..." [Team 4 – Cohort 2]

Stakeholders repeatedly discussed their contributions:

"...During the presentations and pitch sessions, I [Stakeholder] was able to provide feedback by indicating project directions quickly..." [Stakeholder Team 2 – Cohort 1]

"...I think the main contribution was to help students ask the right questions to the companies. First, we present the cases, and then we can see that the students really focused on being a small part of the challenge instead of seeing the whole picture... we help them think bigger..." [Stakeholder Team 3 – Cohort 1]

3) Project management skills challenges. Project management was essential to project-planning approaches in developing the final MVPs. Students acknowledged the benefit of using Agile/Scrum in project planning, reporting the following in two interviews:

"...The use of Scrum Burndown Charts allowed us to follow the project properly even in between calendar time gaps during the Bootcamp days..." [Team 3 – Cohort 1]

"...We have intensively used within the group Scrum and daily meetings, together with other tools, such as Smartsheets..." [Team 3 – Cohort 1]

Students managed their projects mostly on their own, although stakeholders helped them in the process:

"...At times, I can tell I think we have done that [project management] ourselves, but also they [Stakeholders] have been helpful at some level when contributing to project management..." [Team 4 – Cohort 2]

4) Startup formation motivations. The students' reports during the interviews showed that the main startup formation motivations were brand establishment, working for themselves rather than others, and contributing to social change via information and communication technologies. One student expressed:

"...If I wanted to make my effort in society, then the best option for me is to establish my own startup. And, uh, anything to help me to establish my own brand and work on the idea I have and release it to the world or give it to society. And I prefer to work for myself than other companies..." [Team 2 – Cohort 2]

Even among students who preferred job security and wanted to work for large organizations, there was optimism related to the possibility of making an impact on society through startup formation. Other students were simply committed to their projects and wanted to pursue them further and contribute to society. When asked about the possibility of startup formation, two students noted the following:

"...For me, it's all different because of my background [European Studies]. I'm not the type of person who wants to be an entrepreneur. I prefer working for a big organization.

But I think it's [startup formation] really inspiring to contribute to social change. That's what I like about it..." and "...she [Stakeholder] really helped to bring out, like, the entrepreneurial side of the project..." [Team 1 – Cohort 1]

"...Yeah, I think it's a cool project. So, at first, I didn't want to go further with it, but now that I've become committed to it, I would be motivated to go through it because I think it's very useful product for the society..." [Team 4 – Cohort 2]

5) Involve existing team members in startup formation. The involvement of team members in startup formation took different forms. Students discussed forming startups with (1) existing team members, (2) other team members not part of the course, and (3) Bootcamp stakeholders.

One of the interviewees reported:

"...Yeah. Team members are fine. Yes, I would involve the present ones, as well as others, in the future..." [Team 3 – Cohort 1]

Another student viewed involving existing team members as a great opportunity:

"...certain members of our team I really, really like, and I admire a lot of the things that are the qualities that they have. So, if I were to create a new team, I think that I've gained collaborators that come from other backgrounds compared to the ones that I have from before... to start a startup again..." [Team 2 – Cohort 1]

We had similar reports from the focus groups:

"...I would very much like to involve all of the group members. I feel like we have every incentive to develop the startup and live up to the expectations... and they have the criteria for developing the product... I don't think we would need to involve any other people..." [Team 3 – Cohort 2]

"...I think the group has priority. I was thinking the same—that I would have a whole group—because we all known well the project..." [Team 1 – Cohort 2]

Another student expressed that, although he learned a lot from his team members, he preferred to work with other students from his department to pursue startup formation:

"...Yes, I have thought about receiving help from some student at our department, but, uh, maybe not my teammates here. But I have learned from my current team members about improving my teamwork skills..." [Team 1 – Cohort 2]

In most cases, stakeholders were viewed as potential future customers or mentors. Several interview reports from both students and stakeholders emphasized the following:

"...for our project, we have decided to focus more on selling our product to the stakeholders..." [Team 2 – Cohort 1]

"...We were creating a product for ourselves, so asking them about becoming part of our team felt like a weird thing to do for me. At least, that's how I've seen them [as customers] ..." [Team 3 – Cohort 2]

“...they [*Student teams*] need competency in regard to consultancy or mentorship. I don't see any challenge of providing both...” [*Stakeholder Team 1 – Cohort 2*]

VI. DISCUSSIONS

The quantitative results (cf. Section V.A) aligned with the reports from student interviews in Section V.B.

Indeed, students from both cohorts relied heavily on previous experiences while developing their projects. The stakeholders also seemed to agree with the students' technical choices. We confirmed our findings regarding the lack of variance in the quantitative data by gathering further qualitative evidence from interviews and students' project/process reports. The students reported positive feelings towards the soft skills acquired during close collaboration with the stakeholders. A plethora of activities, including giving and receiving feedback, presenting, communicating online, and brainstorming, allowed the students to improve their soft skills. Thus, the observed value drop in the quantitative results reflects the students' improved confidence in coping with soft skills challenges in a more realistic setting. The students learned to manage their projects despite lacking relevant prior experience. The utilized Agile methods, such as Scrum, were key to project management. From the gathered quantitative data, we observed a drop in challenges relating to project management skills (Figure 1), indicating improved skills coping with project management in a more realistic context. This finding was later confirmed during the interviews.

Indeed, after close collaboration with the stakeholders during Bootcamp, the students were highly motivated to embark on startup formation. Many had entrepreneurial mindsets and viewed startup formation as an opportunity. Others were not fully convinced, but appreciated the long-term value of startup formation for societal change. The increase we observed in the quantitative data was justified by the qualitative findings. Most of the students also realized the value of working in an interdisciplinary group; however, their feelings regarding involving existing team members in future startup initiatives varied (cf. Section V.A). Although there was an overall drop in the students' desire to form startups with their teams (mostly in *cohort 1*), Section V.B revealed that many students were open to involving existing team members in startup formation (observed in *cohort 2*). The discussion about the stakeholder's role in a future startup formation only appeared during the second phase of our investigation. However, we realized that we were unable to fully match stakeholders with students in the future startup formation process. Challenges arose when connecting those who were less experienced (students) with those who were more experienced (stakeholders), leading to team imbalances in the startup context. Students commonly considered the stakeholders to be merely customers or clients, and occasionally mentors.

The students' study background influences, to some extent, their answers during the interviews. We made such observations in a specific case (*[Team 1 – Cohort 1]*), where the student coming from a European study background had little inclination towards startup formation. The discussion

of how the study background impacts students' skills and startup formation mindset requires meticulous investigation.

Key findings

1. Technical challenges. The Bootcamp did not significantly impact the students' technical skills.
2. Soft skills challenges. The Bootcamp activities broadened and bolstered the students' soft skills toolset, boosted by the active participation of external stakeholders.
3. Project management challenge. Students learned significantly from utilizing agile and lean approaches to project management.
4. Startup formation motivation. Students exhibited increased motivation to form startups following close collaboration with external stakeholders and the development of their first MVP.
5. Involvement of existing team members in startup formation. Involvement of existing team members was perceived as positive in most cases, but students did not exclude the possibility of collaborating with other future team members.

VII. CONCLUSION AND FUTURE WORK

We designed our EiT course to allow students to interact with external stakeholders through Bootcamp activities. We sought to evaluate whether students realized the relevance of the Bootcamp and how it affected their technical, soft, and project management skills. To answer our question, we conducted a cohort study based on a mixed-methods approach. We distributed a questionnaire to both cohorts before Bootcamp Day 1 and after Day 2 (upon developing the first project MVP). Furthermore, we conducted semi-structured interviews with stakeholders and individuals selected from the student groups.

After a meticulous investigation, we conclude that our course model incorporating a semester-long Innovation Bootcamp activity successfully aligns with the experience-based learning model. We also conclude that our findings, which are based on rigorously gathered data, support a unique course design model that fosters a startup formation mindset through multi-disciplinary student teams. We conclude that the Innovation Bootcamp: (1) positively impacted students' soft and project management skills, but did not have any influence in their technical skills; (2) positively impacted student startup formation mindset; (3) positively impacted the students' perception to involve existing team members in future startups and appraise the value of an inter- and multidisciplinary team in a startup context; To complete our investigation and deliver a robust framework for educators, researchers, and practitioners, we intend to further investigate: (1) How can we involve the stakeholders more, and what are their motivations and challenges? (2) How can IPs be adequately handled? And (3) How can the three entities—academia, industry, and government—be involved in helping students acquire funding?

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