Encourage students to apply their knowledge and think “out of the box” while collaborating with local industry - Case Study Industrial Seminar

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***Abstract*— Our societies require talented engineers, who are trained in different engineering fields. Simultaneously these students should have the ability to collaborate and work with people of different disciplines and be able to look for innovation. Engineering programs have been developing different approaches to enhance these required skills, for example through capstones and hackathons. Capstones projects, which are often several months long, aim to prepare students for the transition from school to work. Frequently, these projects are designed to serve companies or startups. Hackathon events are intense and short sessions where students solve a challenge in short periods of time, often between 24 to 36 hours.**

However, it is needed an approach that exposes students, of different disciplines, to a wider number of industries with a more collaborative approach. We need interventions in which students can experience how their knowledge contributes to the innovation and visions of different stakeholders. Furthermore, these learning interventions, where we promote a collaborative experience among the participants where everybody learns from everybody, should require less time than with capstones or hackathons.

The University of Turku developed the Industrial Seminar on Future Technologies course for master and phd advanced students, where we address: multidisciplinarity, collaboration, connection with engineering industry and innovation. Students in this course are exposed to challenges and visions of different companies in diverse domains, e.g. biotechnology, metal industry, maritime. Each seminar session focuses on one company, and we work together to address the session’s aim in at most four hours. For each session participants have a pre-assignment, which is aligned to the objective of the session, and a post-assignment that focuses on the session’s reflection. An important aspect to make each session successful is the preparation of the session with the local company. Hence this course addresses different objectives: (i) Expose students to industry, (ii) Students gain awareness of how their knowledge is relevant for different industry challenges and visions, (iii) Collaboration between session participants (from different backgrounds and from the guest company), (iv) Possibility to innovate (“think out of the box”), (v) University of Turku builds bridges with the local industry, as together with each guest company we go through a process of “sharpening” the company’s challenge or vision for this particular seminar session. In this paper we analyze this course with its outcomes, utilizing the final results of each session, and the feedback from students and industry representatives.

Keywords—hackathons, industry collaboration, multidisciplinarity, co-design, capstone

I. INTRODUCTION

Countries require competitive industries, which can innovate their products, services and systems according to global needs. These industries require talented human capital across different knowledge areas. Additionally, these talents should have the skills to work and collaborate together. From the myriad of professions, it has been studied [1] that engineers support the growth and economic development of a country while at the same time they help to improve the citizens’ quality of life. Paradoxically, it is difficult to find qualified engineers. Governments have to create strategies on how to attract this talent from overseas, or produce the talent nationally by investing in engineering education [1].

Finland needs to increase the number of qualified master degree level engineers to support the economic growth of Southwestern Finland [2]. In 2017 the strategy taken by the Finnish Ministry of Education and Culture (MoEC) was to establish the project of FITech (Finnish Institute of Technology). FITech is a network of seven Finnish universities providing technology degree programs across Finland to supply the needed talent to Southwestern Finland [2]. Today the project is recognized as FITech Turku.

University of Turku (UTU) is a multidisciplinary university located in southwestern Finland, and it is a member of the FITech Turku project. Since the beginning of the FITech Turku project, UTU offers to the network two academic minors: (1) Co-creation and Platform Economy and (2) Industrial ICT. The minors are selections of related courses that can be included in a degree as a minor. The size varies in 20-30 ECTS.

Students from any partner university within the FITech Turku network can decide to study in these minors offered by UTU. These minors support the incoming students, who are unfamiliar with Turku and its industry to get to know the region and the local companies. With this purpose UTU designed and implemented two “landing” courses, one for each minor with the goal to facilitate the arrival of multidisciplinary group of engineering master students from different regions of the country and start to connecting these new talents to the local industry as soon as possible. One of these courses is the Industrial Seminar in Future Technologies which belongs to the Industrial ICT minor and it is analyzed within this manuscript.

II. BACKGROUND

UTU’s Department of computing is responsible for the design and implementation of the Industrial Seminar course. The design of this course should take into consideration the following aspects:

- Connect future talent with local industry.
- Bring students from different universities to collaborate together.
- Promote design thinking skills that address the innovation needs of the local industry.
- Build upon UTU's multidisciplinarity profile.
- Take into account UTU does not offer all the engineering expertise needed by local industry, however it is part of the FITech network.

Department of computing already offers a capstone course, which offers master students collaboration with industry. Additionally the department has experience and expertise in organizing hackathon events and utilizing co-design methods.

Hence the question is what kind of course can UTU design, with high academic excellence, to support the mobility and collaboration expected within the FITech project to benefit the industry needs in southwestern Finland? From this question derives the two research questions of this study:

RQ1. How to converge the pedagogical approach of capstone projects and hackathons – in a new, seminar-based course utilizing co-design methods to complement the promotion of industry collaboration in an academic setting?

RQ2. What are the outcomes of this new course?

A. Capstones

UTU offers to its master level students in the Faculty of Technology a capstone course following the CDIO framework (Conceiving – Designing – Implementing – Operating) [3]. This course has a duration of approximately 9 months. By the end of the course, the students have designed and implemented a proof-of-concept level solution to a fairly complex real-world problem. The course builds upon the idea of providing a situation that simulates various aspects from engineering working life phenomena in a safe environment that also allows failures [3].

At the beginning of the course there are sessions where the project topics are presented and the students are introduced to planning and managing their project. After this orientation the teams are organized by the teachers of the course following a criteria [3], and each team focus on one particular topic. The course offers some traditional lecturing with specific aims related to the common stage of the projects by providing a short introduction to the students. The topics to be solved during the course are collected previously by the course teachers from industry and research groups. During the course a series of meetings are scheduled between the team members, the teacher and the owner of the topic (either industry representative or researchers).

The workload of the teachers in charge of the capstone is high due to all the coordination and knowledge needed during the different phases of the course (e.g., collect the capstone projects, creation of teams, support the team progress) in addition to the classroom activities (e.g., lecturing, review and evaluate status reports, pitching demonstrations).

According to Dutson [4] research indicates that in order to increase the success of a capstone topic proposed by industry, the organization should appoint an interested person to follow up the supervision of the project.

B. Hackathons

Hackathon events, hacking (or coding) marathons, have been initiated in companies as a way to generate innovation in their business. The final outcome of a hackathon is not a finished or polished product. It might be a concept, a prototype or a mock up.

Today the hackathon concept is also used in large jams, for example the Global Game Jam (GGJ) [5] which started in 2009. Decker [6] indicates that jams that tended towards playfulness facilitated more innovation. A "typical" hackathon structure is to join the hackathon venue where the participants will work for approximately 48 hrs, often a weekend. On Friday evening, when the hackathon starts, participants gather for an overview of the event, listen to the rules and regulations, and theme and goals for the weekend. The participants work during the weekend, often the organizers offer food and on Sunday afternoon the results are presented. If the hackathon has a prize to offer, the winner is announced after the final pitch presentation of the participants. The popularity of hackathons and game jams has attracted the academic community. In particular, these events can be part of conference programs, or as a resource for academic study [7]–[9].

Despite the popularity of the hackathons, reports of success stories in these events [10], [11] and massive amounts of participation, there are some points of concern around hackathons. For example, hackathons promote "geek stereotypes" which in many occasions disengage other groups to participate (e.g. women) [12]. To appeal to a more diverse audience, organizers are exploring different approaches such as avoiding competition, ensuring a clean and welcoming environment, and broadening r ecruiting [13].

Other concerns are the poor software design practices in hackathons [6], some question if a development cycle of 48 hrs (or 24 or 12 hrs depending on the hackathon format) help to promote good Software Engineering practices. Additionally, companies have recognized the challenge to turn the hackathon outcomes into products that are of real business value [14].

It is recognized that hackathons provide opportunities to practice agility and iteration. In traditional computer-science programs, hackathons offer an opportunity for students to learn to work with artists and designers in concrete projects. This is a valuable experience that is often missing in traditional lectures [6].

C. Co-design

Recently manufacturing companies are increasingly open to approaches that define the product based on what their customers need, either in business to business or business to customers [15]. To be able to design this one needs to utilize user-centered design methods which allows to design a product not from the experts' perspective but from the end-users', or customers' needs. This approach implies that designers utilize a set of methods to listen to the end users, from observations, interviews and designing the things together. The growing approach to design together, experts and end-users, has enabled the growth of the concept of co-creation and co-design. These two terms, co-design and co-creation, are often confused or used as synonyms. We utilize the definition given by Sanders and Stappers [15] to identify these.

Co-creation is a broad term as it refers to any act of collective creativity, i.e. creativity that is shared by two or more people. Thus it includes applications ranging from the physical to the metaphysical. Co-design is a particular instance of co-creation and it applies to the collective creativity across the whole span of a design process. The collaboration is with designers and people not trained in design working together in the design development process.

III. Industry Seminar in Future Technologies

The Industry Seminar in Future Technologies course consists of a series of sessions where industry and students work together for four hours, in a presencial session, to address a challenge of vision of a guest company. The following subsections clarify in detail how the course functions.

A. Students and academic participants of each session

The course is open to any advanced student (master and PhD) in UTU and in the FITech network. Additionally, the course welcomes researchers to be part of each session.If a participant has been present in six seminar sessions and elaborated the pre- and post- assignment of each session, then the course can grant to student 5 ECTs (European Credit Transfer System; in Finland one ECT is equivalent to 27 hrs of study). The enrollment is open for each seminar, so one can join this course at any moment during the academic year. We are welcoming constantly students who have the willingness to be exposed to this learning approach! This seminar takes place once per month as we are contacting companies constantly, and we need to coordinate with them before the seminar.

B. Industry

The course invites one company per session to be our guest. The course welcomes organizations of any size (large, medium and small). Before each seminar session, the course facilitator and the representative of the company go through an iterative process to define jointly the aim and objectives of the session. This process aids both parties to understand each other, and to prepare the needed information for the students preparation before the seminar session and the actual presentation during the session.

C. Content

Each company has a different challenge to be addressed, consequently the academic knowledge needed for each session varies. After the objectives of the session are agreed with the guest company, the facilitator of the course prepares the pre-assignment for the session. The pre-assignment has the purpose to guide the preparation of the seminar participants so that they can gain the needed knowledge about the topic to be addressed during the session and enrich the exchange of ideas during the time we are together. The design of the pre-assignment takes into account that the background and expertise of the different participants is diverse. During the session we only utilize less than an hour to present the guest company and the challenge to the participants. If it is needed, complementary academic information is offered during the session, to serve as a reference point, often within the domain of design thinking, co-design, design science or sustainability. As a post-assignment, the participants write an essay with their personal reflection of the session and their outcomes. Pre- and post- assignment can be shared to the guest company.

D. Course Aims

Students gain awareness of the visions and challenges of different industries related to the use of new technologies in the field of ICT. Students will go through a comprehensive exploration of ideas and analyze the information of current state of the art from the perspective of industry and academia. Within the aims of the course:

- Participants should demonstrate the ability to prepare appropriately to participate effectively in each seminar discussion.
- Participants will demonstrate the ability to distinguish opinions and beliefs from claims and evidence and recognize that kinds of evidence will vary from subject to subject.
- Participants will demonstrate the ability to evaluate and synthesize sources of information.
- Participants will demonstrate the ability to work collaboratively in a multidisciplinary team to ideate solutions.
- Participants will follow discussions, oral arguments, and presentations, noting main points or evidence and tracking threads through different comments.

E. Practical processes

Each seminar session goes through seven steps, and the time invested in each step varies according to the circumstances.

1) Step 1. Invitation

To connect with a company, and to invite it to be a guest company. This connection might be initiated by UTU or by a company. When the step is initiated by UTU it may take some time until we are able to talk with the correct person within the organization who decides if the particular company wants to be a guest company for this course or not. When the company contacts us directly this step finalizes swiftly as the company is already looking for this type of collaboration.

2) Step 2. Agree on a challenge.

It might take more than one meeting for the company representatives to decide on the challenge they want to address during their seminar session. Often the company has different needs and to focus on one particular challenge requires an effort to analyze the needs and problems they are facing and prioritize the one they want to explore with UTU. The facilitator of the course supports the organization to go through this process.

3) Step 3. Preparation

Together, the guest company and the course facilitator define the session objectives and the background information needed to be presented to the participants for the session. This work can have several meetings and serves to add clarity to both parties of what can be achieved during the seminar session and what information is needed to achieve those objectives. Within the outcomes of this step are: the definition of the pre-assignment, the presentation of the session, the session publicity, which is displayed in the blog of the course (https://blogit.utu.fi/industryseminars/). Additionally in this step is defined the day of the session and the time. UTU suggests having these sessions on Fridays between 12 to 16 hrs.

4) Step 4. Practical formalities

The seminar session can take place at the university facilities or at the company facilities. Once the day and time for the session are decided, all the corresponding arrangements for the locations are made.

5) Step 5. Publicity

Each session is advertised within UTU and in the FITech network.

6) Step 6: Session

During the session at least one representative from the guest company must be present. The session is divided as follows:

The first 30 min to an hour is the presentation by the guest company. The participants are encouraged to ask questions to understand the challenge and its context.

Working time by teams. The facilitator organizes the teams assuring that each group is as diverse as possible, and avoiding that participants from the same degree program are together. During this independent work a team can request support from the company representative or the course facilitator.

Half an hour before the session finalizes, each team presents their solutions to the rest of the audience. During the presentation, the space is open for discussion and how to enrich ideas.

7) Step 7. Closure

Post assignments are made by the participants. All the material produced during this session is shared with the guest industry.

IV. METHODOLOGY

The Industrial Seminar in Future Technologies course is analyzed utilizing the data extracted from the following instruments: the enrollment form for each seminar session and two online evaluation surveys. The surveys are answered voluntarily after each seminar session. One of the surveys is for the participants and another for the company representatives. We did not collect this information for the first company of this seminar series. The questions in the online surveys are quantitative and qualitative. The questions of the participants survey is based on UTU's standard questions for evaluating courses at the department of computing. We include questions addressing how to improve the sessions and their learning experiences to gain an understanding on the impact of each session in the learning experience of the participants. The survey for the guest company participants aims to evaluate the complete process they go through during their industrial seminar session. The qualitative responses were grouped in categories that emerged from their analysis, following a content analysis method. The total number of entries from the student's survey is 16 and six on the suvey for companies.

V. OUTCOMES

A. Sessions

At the moment of this report, May 2021, we have conducted eight seminar sessions. The participants should enroll to each seminar session and in the enrollment page we ask them their current knowledge about the company of that session. Table 1 illustrates the most common answer in reference to this question.

TABLE 1. GUEST COMPANIES AND PARTICIPANTS KNOWLEDGE OF THE COMPANY.

Guest Company	Participants common answer of their current knowledge about the guest company
Mariachi	NOTE: question was not present in this enrollment.
Bayer	*"Almost nothing"* "*I know what Bayer does, but nothing about their Turku branch*." "*German big pharma, develops and produces drugs.*"
Pemamek	*"Not too much*" "*Subcontractor for energy sector. Developer for metals handling. Producer of efficient industrial lines*".
Tulli (public organization)	"*Imports go through them, digitalisation processes ongoing"*
Auramarine	"*Nothing"* "*Fuel supply provider"*
Kongsberg	*"vessels and remote automata*" "*No much*"
Valmet	"*It is subcontractor for automotive industry*".
Warmos Lämmitys	*"Nothing yet*" "*They are producing heaters for different types of customers"*

B. Students' Feedback

1) Questions addressing a self-learning assessment.

Table 2 illustrates the median of the quantitative questions evaluating the self-learning experience. The scale utilized is 1= strongly disagree to 5 = strongly agree.

TABLE 2. STUDENTS' LEARNING SELF-EVALUATION.

Category	Mean	Median
The learning outcomes of the session were clear	3.6	4.5
I feel that I have reached the general goals of the session.	4.3	4.5
The used teaching methods enhanced learning.	3.9	4.5
The session deepened my previous know-how.	3.7	4
The session advanced applying theoretical knowledge to practical know-how.	3.6	4.5
The facilitators helped me to comprehensively understand the issues to be worked during the session.	4.2	5
The topics discussed on the session were useful.	3.9	5
It was easy for me to approach the facilitators.	4.2	5
The teaching methods on the session were modern and versatile.	4.1	5
The facilitators were motivated to support the seminar flow.	4.6	5

The facilitators were well-informed on the content of the session.	4.5	5

The quantitative data indicates a positive learning experience. However to understand these results, we analyse the qualitative feedback.

Five categories emerged from the answers given by the participants to the question: What do you feel you learned during this seminar session?

Company discovery. This category acknowledges what the participant discovers about the guest company. Examples of their expressions:

- "I learnt that [company] really cares about customers and their experience - it was not obvious from my knowledge."
- "I learnt about the interesting market niche that [company] occupies, about their problems."
- "It was useful to get to know what they are concerned with and what they think about Digital Twins technology in particular"
- "How a modern global manufacturing business is organized, how they run their production, the way they imagine and approach one of their manufacturing problems"

Learning. The category emerges from the participant recognition of the consent or learning experiences in the session, that emerge from the learning methods utilized. For example:

- "Understanding the frame of the problem (practical issue)"
- "Many things I have never heard of"
- " In general, I feel that the value of these seminars is very high for me."

Apply knowledge. This category emerges when the answer of the respondents addresses how their knowledge can serve the industry or might work out of academia. Example:

- "It gives an idea about how new technologies can enter a company."
- "I learned that there are limits to what you can change within an organization, and that design needs to consider these limits. The best solution is not always a possible solution. We as technology creators need to at the same time, question the existing realities and framing of a problem, but also take in account those realities to understand how feasible it is to actually make the changes. A solution to a problem will always be a compromise between the ideal solution and reality."
- "I observed that the customer doesn't always know what it wants."

Multidisciplinarity. This category emerges from the comments that address the value of work with different knowledge areas. For example:

- "Open new ideas in different field"
- "I also learnt about some new technologies that [my team-mate] described."

Listening. This category emerges from the comments addressing this skill. For example:

- "I liked the comments from the people invited by [company]: they shared their experiences from the design field, software design, management etc. "
- "having the domain experts come with a preconceived solution, but through the session the participants argued that the solution was not the best for the problem, and there was a reframing of the problem which allowed a new solution space."

2) Questions addressing the experience in the session.

Three categories emerged from the answers given by the participants to the question: What were the best things about the seminar session?

Content. This category encloses the comments addressing the information exchange. For example:

- "Very precise, concrete and detailed information about [company]."
- "The presentations from [company] and sharing with them the solutions."
- "Working with a real problem and with the real domain experts was very interesting. It is not easy to do this usually in university settings."
- "Learned about generative design approaches being developed at Catia of Dassault Systems."

Social dynamics. The category emerges from the comments given to the observations addressing social behaviors and interactions that take place in the sessions for examples:

- " To see a modern CEO using her time efficiently (she was doing some homework while we others were working...)"
- "Cake, the [sweets] and brainstorming"
- "To get acquainted with [company] - it was really interesting. I also enjoyed the conversations during the trip."
- "I learnt most from the participants - I think many ideas were good and can be used as examples in solving other problems."
- "We had an excellent team because people with more technical background were active, they had their own ideas, and they provided good answers to all questions belonging to their competence."

Method. The category encloses the comments that address the methods utilized in the sessions. For example:

- "Freedom. Combined with the difficulty of the problem, it provided me an opportunity to work in my own ways, and it turned out to be useful for myself and for the guest company."

Improvements. The co-design approach is also performed by example, so the facilitator of the course constantly asks the participants: What should be improved in

each session? The answer to this question delivers the current topics to consider for improvement:

- Time management. Assure there is enough time for the pre- and post-assignment, and clear monitoring of the time in each session.
- Social dynamics. Assure that the inclusion of different types of learners is taking place. Monitor that listening is taking place across the different teams.
- Assure that facilitators from the guest company offer quality input and at the same time leave the space to let the participants work.
- Constant refining. To assure that the pre-assignment and the content of the presentation is aligned with the expected outcome of the session.

C. *Industry's Feedback*

Table 3 illustrates the quantitative median general perceptions from industry in this course and the process.

TABLE 3. COMPANIES FEEDBACK

Category	Median
How EASY (1) or DIFFICULT (5) it was to COLLABORATE with UTU during the preparation of your session on the industrial seminar course?	1
Rank the RELEVANCE of the topic worked for your seminar session from your company's perspective (1=VERY RELEVANT, 5= COMPLETELY IRRELEVANT)	2
Rank the VALUE of the TIME invested by your company while planning and preparing the seminar, including the time during the session. (1=GOOD INVESTMENT, 5=BAD INVESTMENT, not good use for my time)	1.5
Rank the ATTITUDE of the university STUDENTS during the seminar session (1=POSITIVE ATTITUDE and interested in the topic, 5=NEGATIVE ATTITUDE and completely disinterested)	1

To the question: Would you recommend other organizations to be part of this seminar (yes, maybe, no)?, all respondents answered: yes. The reason they gave to recommend the course are categorized below.

Outcome. This category emerges from the answers that addressed the outcome of the seminar session. For example:

- "We got interesting ideas and new perspectives"
- "Our goal of the session was to gain inputs, ideas and thinking around what the future might be bringing, so looking further down the road."

Process. The category encloses the ideas that are linked to the process the industry goes through to have this session. For example:

- "Challenging but still friendly attitude throughout the robust process worked well in enriching our ideas."
- "We did find it very easy and straightforward to collaborate with UTU. The challenge was around coming down to concrete and specific points and conclusions for a certain area."

Facilitator. This category groups the ideas that are linked to the facilitator of the course. For example:

- "[Facilitator] was a great coordinator for the project and because of her perseverance we got the project through successfully."
- "The organisation was great"

Participants. The category groups the sentences that address the participants. For example:

- "the students were really motivated!"
- "The interest towards the topic among the students was on a very good level."
- "The students were also very curious and open minded which provided a new perspective."
- "I always find it uplifting and inspiring to talk to students and hear their fresh ideas. They are always motivated to solve real problems and throw themselves into new challenges."

The following question aims to listen from the industry if this offers value to them. The question is: What, in your opinion, is a valuable aspect of this process? As a process we refer to the different steps of our workflow, including: - Our meetings- Your internal definition of the challenge- Different stages in the seminar session with the students. The category that emerged from the responses.

Before the seminar session. This category encloses the sentences that address the work performed before the seminar session. For example:

- "Our meetings and our definition of the challenge made us better summarize, define and understand our challenge and the problems there."
- "The definition for the challenge is of course crucial for the results. In my case I wanted it to be a bit open, to give the students more space to "innovate" and think about the process from different angles and get some "out of the box" or new methodology thinking."
- "It was valuable to me to think of all the aspects of our challenge and try to figure out the right angle to be solved"

Human aspects. The category emerges from grouping the ideas addressing interaction with others. For example:

- "Teamwork was the best part and seeing the genuine interest towards our company and products."
- "The most valuable aspect was the interaction together with the students."
- "I also get a lot of new ideas from talking to both the students and the [facilitator] during the process because they ask questions that help me look at the challenge from different perspectives."

Process. The category emerges from the sentencing addressing the process the guest company went through during this collaboration. For example:

- "The stages during the seminar are very good and I don't know what to change. Since there needs to be an introduction for everyone, introduction about the company and the challenge."
- "All are. Guiding worked well in the meetings phase."

- "All steps in the process are very important and valuable"

The last question aims to explore what types of collaboration could further emerge. The question states: In your opinion what would be your vision for future collaboration between your organization and UTU. The answer indicates that the guest companies are interested to continue the collaboration. Some of the answers are:

- "As needs arise for new ideas and prototyping I'd be happy to collaborate."
- "Same kind of projects are good, one per year for example. Also we are looking for [thesis worker] students all the time so there would be a good place to do collaboration also."
- "I would like us to find specific areas to focus on that could be used in the students work (topics for thesis and research related)."
- "There might be possibility for summer jobs or writing a thesis within this subject?"
- "I have already asked a student to do his thesis for us on this subject and I hope I get to talk to the teachers and researchers on it as well. I'm willing to do new projects with UTU. "

Uptoday, we have worked with large, medium and small companies. Each organization has its own challenges. However small companies have explicitly acknowledged they value this collaboration. For example:

"Thank you for this experience. I hope more companies - not only big ones - would know about these kinds of opportunities and take the step towards collaboration."

VI. Discussion

Industrial Seminar in Future Technologies course promotes discovery, connection and collaboration between individuals of different educational backgrounds, and between future talents in academia and industry. It is versatile and has a nontraditional approach while exposing participants to challenges and vision of the industry in Southwestern Finland and finding solutions in collaboration.

Based on the course outcomes, the authors claim that the learning objectives of the course are fulfilled as the students report:

- To discover different companies,
- To gain awareness about how their studies could be applied in the industry,
- Relevance of collaboration between individuals from different disciplines, and different social dynamics,
- The importance of listening.

The learning methods knitted in the course stress in offering a learning experience for the seminar participants and facilitators. Instead of lecturing, each session designs the conditions needed to immerse the learners in a relatively short time, into a real life problem. Learning is promoted through conversations and interactions with the company representatives and other peers during the session. The social dynamics during each session are important to build the trust needed to freely share ideas, as it is not a competition but a collaborative effort to find solutions to the problem presented.

Additionally, the participants prepare themselves for a lifelong learning process as they make themselves ready for each seminar session. Across different sessions, the participants gain awareness on how their knowledge can be applied in industry and what challenges they might face in different types of organizations and gain insights on the local industry. They find the value of the multidisciplinary work in different set of scenarios while working collaboratively. Furthermore, as students and industry reported, there is an added value in the process and the human interaction.

The efforts that the companies invest into preparing their challenge, engage them during the whole process. We hypothesise that in this setting, the problems connect participants while looking for solutions.

A. Next steps

Based on the industry feedback, today the Industrial Seminar in Future Technologies course is being transformed as one "portal" to connect industry with future talents and with further collaboration possibilities within UTU. For the next seminar sessions, if an idea or concept is relevant and the guest industry would like to build upon it, the Department of Computing in UTU offers the following possibilities: (i) Capstone course, (ii) Master Thesis, (iii) Student project, (iv) Internship, (v) Collaboration to create a funded project, (vi) Consultancy. In case a company is interested to increase their expertise in particular research area offered by UTU, e.g. contract research transfer.

Additionally, it is important to address the participants' feedback in the following sessions of the course.

B. Contribution of the Industrial Seminar in Future Technologies to the Engineering Education Research

Industrial Seminar in Future technologies utilizes a co-design method during the process of each guest company, by working together defining the challenge and preparing the pre-assignments. The method is tacitly utilized in the sessions. The preparation for each session builds the conditions, the need for guidance and the attitude required to search solutions by co-design and collaborating. It is necessary to take into account the social dynamics, existing knowledge (in content and experiences) of the participants.The face to face session of 4 hrs is intense. Due that all participants prepare themselves for the session and bring their expertise and willingness to collaborate ideas emerge within a constructive environment and interaction.

The industrial seminar might be related to a Hackathon due to the shortness of the face to face session and the dynamics for idea generation, while it is closer to a Capstone in the preparation needed to generate ideas (Table 4). The outcomes of the seminar course are mainly ideas and concepts. As a course, the industrial seminar offers the possibility to experience six industries within the same course. However due to the process with each company, the sessions spread across an academic year.

TABLE 4. COMPARING HACKATHON, CAPSTONE AND INDUSTRIAL SEMINAR

Category	Hackathon	Capstone	Industrial Seminar

Content preparation for the topic.	NO	YES	YES
Student's work focus on a company	12 to 48hrs	~ 8 months	~ 12 hrs per session per company ~ 72 hrs total course (6 companies)
Outcome	Dynamic mockups	Proof of concept "level product"	Ideas / concepts
Contact with companies	1 per hackathon	1 per project	Minimum 6

An advantage of the flexibility and dynamism of the industrial seminar course is that it allows participants to enroll when the topic is of their interest and welcomes different types of participants beyond students.

It is relevant to mention that the industrial seminar course does not focus on a product or prototype but in understanding the context, the problem, the resources (tools and human) when searching for solutions. It is about building a collaborative space to promote ideation.

Within the challenges of this new type of courses is:

- To connect with enough companies who are interested and willing to embrace this process to support them.
- Challenge the status quo of a university teacher, from being a person to deliver the content to be a facilitator. To think "out of the box" starts with the faculty.
- See a course as a contribution to academia and industry and serve both stakeholders.
- Facilitator should have the knowledge and skills to co-design the challenge and needed assignments with the guest company and creator of the learning experiences.

To further develop the Industrial Seminar in Future Technologies and expand its benefits to different organizations, research in the areas of challenge-based education and transdisciplinary education is needed to incorporate the relevant elements. In addition, an in-depth reflection of the co-design process that takes place both with the companies while defining the challenge and during each session would enhance the replicability of this course in other contexts.

VII. Conclusions

The industrial seminar in future technologies course is an example on how academia can dynamically support industry while educating and preparing new talents for the workforce. Students have the opportunity to discover and contribute to different companies while gaining experience in fundamental non-technical skills such as listening, negotiating, creative thinking and teamwork, while being exposed to different groups of people in each session. Simultaneously, the students utilize their technical knowledge to contribute in designing solutions at a conceptual phase.

Due to the intensive work of each session, the course can be confused with a hackathon. At difference to hackathons, the participants require preparation to tackle the challenge. However, the short cycles of each session make the course inclusive for students and researchers of different disciplines, and accessible for industry. Furthermore, each cycle offers the opportunity to build an understanding of the challenges of the local industry and how academia can potentially contribute in the solution.

For industry, the industry seminar offers a direct and undemanding entry to collaborate with academia with a reasonable amount of effort and investment in time and other resources.

References

[1] 'Engineering and economic growth: a global view', Royal Academy of Engineering, Sep. 2016. Accessed: May 14, 2021. [Online]. Available: https://www.raeng.org.uk/news/news-releases/2016/september/new-global-study-proves-link-between-engineering-a

[2] Anonymize for review

[3] T. Vasankari and A.-M. Majanoja, 'Practical Software Engineering Capstone Course – Framework for Large, Open-Ended Projects to Graduate Student Teams', in *Computer Supported Education*, Cham, 2019, pp. 310–327. doi: 10.1007/978-3-030-21151-6_16.

[4] A. J. Dutson, R. H. Todd, S. P. Magleby, and C. D. Sorensen, 'A Review of Literature on Teaching Engineering Design Through Project-Oriented Capstone Courses', *J. Eng. Educ.*, vol. 86, no. 1, pp. 17–28, 1997, doi: https://doi.org/10.1002/j.2168-9830.1997.tb00260.x.

[5] 'Global Game Jam, Inc.', *Global Game Jam*, Sep. 13, 2013. https://globalgamejam.org/about (accessed May 17, 2021).

[6] A. Decker, K. Eiselt, and K. Voll, 'Understanding and improving the culture of hackathons: Think global hack local', in *2015 IEEE Frontiers in Education Conference (FIE)*, Oct. 2015, pp. 1–8. doi: 10.1109/FIE.2015.7344211.

[7] J. Porras *et al.*, 'Hackathons in Software Engineering Education - Lessons Learned from a Decade of Events', in *2018 IEEE/ACM International Workshop on Software Engineering Education for Millennials (SEEM)*, Jun. 2018, pp. 40–47.

[8] Y. Liu, J. C. Cannell, and J. H. Coffman, 'Gannon University Hackathon: A Combination of Virtual and Onsite Education Event to Recruit High-School Students within Cybersecurity Major', in *2020 IEEE Frontiers in Education Conference (FIE)*, Oct. 2020, pp. 1–4. doi: 10.1109/FIE44824.2020.9273888.

[9] B. A. Hecht *et al.*, 'The KumbhThon technical hackathon for Nashik: A model for STEM education and social entrepreneurship', in *2014 IEEE Integrated STEM Education Conference*, Mar. 2014, pp. 1–5. doi: 10.1109/ISECon.2014.6891024.

[10] J. A. Preston, J. Chastine, C. O'Donnell, T. Tseng, and B. MacIntyre, 'Game Jams: Community, Motivations, and Learning among Jammers', *Int. J. Game-Based Learn.*, vol. 2, no. 3, pp. 51–70, 2012, doi: 10.4018/ijgbl.2012070104.

[11] V. Kankainen, A. Kultima, and M. Meriläinen, 'Motivations of game jam organizers: case of finnish game jam community', in *Proceedings of the 14th International Conference on the Foundations of Digital Games*, New York, NY, USA, Aug. 2019, pp. 1–8. doi: 10.1145/3337722.3341840.

[12] A. Fowler, F. Khosmood, A. Arya, and G. Lai, *The Global Game Jam for Teaching and Learning*.

[13] P. Johnson, 'How hackathons can become more female-friendly | PCWorld', Feb. 16, 2014. https://www.pcworld.com/article/2098246/how-hackathons-can-become-more-female-friendly.html (accessed May 17, 2021).

[14] M. Komssi, D. Pichlis, M. Raatikainen, K. Kindstrom, and J. Jarvinen, 'What are Hackathons for?', *IEEE Softw.*, vol. 32, no. 05, pp. 60–67, Sep. 2015, doi: 10.1109/MS.2014.78.

[15] E. B.-N. Sanders and P. J. Stappers, 'Co-creation and the new landscapes of design', *CoDesign*, vol. 4, no. 1, pp. 5–18, Mar. 2008, doi: 10.1080/15710880701875068.