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COMICIR- COMMERCIALIZATION OF INNOVATIVE CHALLENGES FROM INDUSTRY AND RESEARCH

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ABSTRACT

At Linköping university, a model to facilitate impact and bridge the gap between research, education, and business creation, has been developed. It is named "ComICIR", which stands for Commercialization of Innovative Challenges from Industry and Research. The model allows researchers, firms, and students to work in a co-creation process that are built on the following five steps: (1) research validation, (2) idea generation, (3) idea validation, (4) idea evaluation and, (5) innovation strategy. In the paper, we describe the model and analyse how challenges and ideas could be developed and experientially based pedagogical approaches could be adjusted in order to benefit the regional ecosystem of research, education and industry and contribute to reaching increased impact of innovative ideas and ventures. Our main finding is that CBL is beneficial but requires close cooperation between teachers and innovation support actors. Flexibility is needed to

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fit the purpose of the course as well as the needs of the challenge providers. Hence, challenges need to be categorized and qualified to take into account the aim and scope of the challenge as well as its degree of development as this affects how the challenges should be written and treated to get the best outcome.

1 INTRODUCTION

1.1 The need of a working model for collaboration

The global challenges caused by climate change, poverty and health are more important than ever to solve. Furthermore, actors such as the knowledge and innovation centre EIT (European institute of innovation and Technology) Raw Materials, along with the scheme EIT HEI (Higher Education Institute) Initiative promotes “deep tech” as the main remedy to the societal challenges and points in particular at PhD students in deep tech areas as the new entrepreneurs who can save the world. We support the idea that science and research ideas have potential to become remedies to a lot of the current and upcoming societal challenges - from pandemics to digitalization, energy and sustainability transitions. However, to have an impact, research-based ideas need to be packaged and commercialized and as shown by e.g., Toledano et al 2022, this is not always an easy matter. In order to facilitate commercialization, the interaction between research, education and innovation (i.e., the so-called knowledge triangle) is crucial.

Students, in challenge based I&E (innovation and entrepreneurship) courses, get the opportunity to work with ideas within their domain of expertise, and the researchers or external actors involved, get the opportunity to have their ideas tested, validated and evaluated from an entrepreneurship and business perspective. The students leverage their work in case of a business plan or a report that can serve as base for decisions of how to proceed with the idea. In best cases they also get the opportunity to complement their commercial constellations with new team members. Although this setup seems rather straightforward and has been implemented all over the world, the results are not always overwhelmingly good.

The aim of this paper is therefore to describe how we work with challenges and ideas emanating from research at Linköping university (LiU). We analyse how challenges and ideas could be evaluated and how experientially-based pedagogical approaches can be adjusted in order to benefit the regional ecosystem of research, education and industry in order to reach increased impact of innovative ideas.

1.2 About experiential learning

Experiential learning methods originate from the thoughts of Dewey (1938; 1963) and are anchored in the doing and the reflections thereof. Within this pedagogic family we can find pedagogical approaches such as CBL (challenge-based learning) and PjBL (project-based learning). These methods will be briefly described below. CBL is an approach for learning that has become increasingly popular during recent years. A search in the database Scopus on CBL gives that before 2006 less than 20 papers were published and today the number exceeds 400. A search in Google Scholar gives about almost 4000 hits, whereof the vast majority is published 2020 or later. Previous studies (Eldebo et al 2022; Norrman et al 2022) have reviewed CBL-related papers and found that most of them focused on CBL from a student perspective, while both the teacher perspective and the challenge providers (CPs

from here on) perspective was not as well studied. However, to be able to conduct this pedagogy, challenges and CPs are crucial. Starting with the challenge per se, it can be defined as a real-world wicked problem that calls for action and is supplied by an external actor (Norrman et al 2022; Gudonienė et al., 2021).

In a recent CDIO-paper (Norrman et al 2022) the authors have focused on challenges and in their study the following important criteria was highlighted: (1) Openness - by means formulated so that the students can take on the challenge and make use of their competences and interests in the development work in, (2) Wickedness - by means of complexity and lack of a preferred solution, (3) Reality - no “made up” problems lacking real needs, and (4) Pedagogical - the challenge need to fit the pedagogical missions of open innovation processes.

In CBL open innovation processes are part of the game and the challenge works as “a lever for boosting/generating innovation and mobilizing teams made up of various profiles” (Gunnarsson & Swartz 2021 p. 7). I.e., the mixture of teams (CPs and learners included) is of importance and hence actors from the entire quadruple helix are wanted - from student/learners to companies, researchers, organizations and even citizens are wanted. The benefits of challenge-based learning include increased student engagement and motivation, improved critical thinking and problem-solving skills, and better preparation for real-world challenges and careers. It also promotes the development of important skills such as collaboration, communication, and creativity.

The teacher role becomes important and in the ECIU context (www.eciu.se), the teacher is renamed into “teamcher”. Previous research (Eldebo et al 2022) defines the teamcher “as an individual who, either alone or as a part of a team, arranges, leads and supports CBL activities” (p 804). Teamchers (Eldebo et al 2022) take on mainly three roles, the teacher, the coach and the organizer of CBL activities. Of these, the first are knowledge oriented (such as the traditional teacher role), the second is oriented toward facilitation and coaching and related to the development process, while the third are directed to organizing the scene for learning, i.e., the creation of challenges and incepting the collaboration with CPs.

In the ECIU context (see www.eciu.eu) CBL has been put forward as the main pedagogical approach, the process starts with the launch of a challenge - a so-called “big idea” out of which the students define the particular challenge or problem that they in their team want to solve. The CBL open innovation process is then conducted following three main phases. The first, the “engage phase” is about identifying the problem and narrowing down the challenge so that it fits the prerequisites of the team. The second is the “investigate phase”, which is about digging out information on context, stakeholders and other aspects affecting the challenge. Finally, the “act phase” is about creation, description, package, and presentation of the solution.

Like CBL, PjBL is a student-centred pedagogical approach. The basic assumption for PjBL is that students are trained to deal with problems, work with external stakeholders and reflect on their learning process. Students are supposed to be active in their learning process. Common aspects of the approaches are according to Gunnarsson and Swartz (2021) the focus on learning outcomes, team operations, feedback and assessment, coaching, challenge, work process and external stakeholders. However, the focus in PjBL is on improving student learning outcomes in relation to science and critical thinking. Its aim and scope is also less open than for CBL. Hence, when CBL strives to find innovation, PjBL focuses more on

developing the path of the project, for example a product or a business model, which commonly not include an open innovation process or a start from a big fuzzy idea.

2 METHODOLOGY

This paper is based on literature studies and upon the own practice generated at Linköping university and in the BOOGIE-U project. Regarding the former, peer reviewed literature has been searched in academic databases (e.g., Scopus and google scholar). Main key words have been experiential learning and challenge/project-based learning. Furthermore, we have searched for literature related to industry-university collaboration, regional innovation systems, ecosystems and studies mentioning the so-called knowledge triangle between research/innovation, education and business/trade & industry, using key words such as “commercialization”, “innovation” and “industry”. Since the guidelines advocate short reference lists, the number of references cited has been kept low. The practice underpinning the model has been applied in several courses at Linköping university and has developed over the years based on feedback (e.g. through interviews) and evaluations. Furthermore, within the BOOGIE-U project, several of the participating partners have worked with challenge-based learning in their courses and events and through the dialogues and development work, experience have been shared among the partners (cf. Norrman et al 2022; Norrman & Scroccaro 2021). As a result of the BOOGIE-U project, the LiU model for supplying challenges from research groups was refined and conceptualized.

3 THE EMPIRICAL WORK

3.1. LiU CBL-based I&E courses

We have in Linköping run CBL-based I&E courses for several years and at different educational levels and during the years improved the practice of how to cooperate with the surrounding regional innovation ecosystem. For this paper we use 3 courses as the empirical development base. All these courses are project courses where students in teams have worked to develop some kind of business related to an external part. Course1, Entrepreneurship and idea development (6 ETCS), a program course given at candidate level, open for several engineering programs and mandatory for one program. Annually it involves about 60-80 students, and about 10-15 challenges. The course is run over an entire semester and twice a year as part of the engineering programs. The CPs are engaged by means that they meet students 2-3 times.[2] Course 2, InGenious cross disciplinary (8 ETCS) project is a free-standing course open for all that have acquired at least 90 ETCS credits in whatever subject(s). The course is run over an entire semester and is given annually to about 40-60 students and about 6-10 challenges are involved. The CPs are engaged by means that they co-create with the students and meet them 3-6 times during the course.[3] Course 3, Innovative entrepreneurship (6 ETCS) is a program course, given at master level at several of the engineering programs at LiU. For a couple of programs, it's mandatory. It is run once a year during the second half of the spring period. It attracts about 70-100 students and requires about 15-20 challenges. The

[2] https://studieinfo.liu.se/en/kurs/teio94
[3] https://studieinfo.liu.se/kurs/799G52

CPs are commonly rather loosely tied to the course and interact with the students 1-2 times during the course.[4]

As can be seen from the above, we handle about 35-45 challenges and CPs per year, which in itself is a great challenge for the involved teamchers. Previously this has been solved through networks and contacts of the involved personnel, however, such organization is heavily vulnerable as it becomes dependent on individuals. Hence, we realized that to continue and to scale up, we needed an established organization. As the creation of such organizations was one of the tasks of the BOOGIE-U project we took the advantage and formalized the work.

3.2 The practical setup of I&E courses

In general, our I&E courses are run as a mixture of theory and practice. CBL is the main pedagogical method for the project work. The read thread is created through events, and these are described below: In Course 1 and Course 3 where the focus is business development, the courses start with an Idea Jam. At this occasion a number of challenges are pitched to the students and groups are formed based on the individual student's interest in the challenges given. The challenges are standardized and structured on the following headlines: (1) Name of the challenge (descriptive), (2) Picture (that relates to the challenge), (3) Background and main problem (the context and what needs to be dealt with), (4) The challenge (open and directed to the students; your challenge is to come up with...), (5) Contact (names and contact info to the CP). In the inGenious course, students apply to a challenge at forehand via the inGenious website.

Shitty prototyping is an event that appears in all courses and serves two main purposes; (1) ideate and create a visual prototype of a possible solution so that minds can join together, and (2) boost the team building process. The workshop as such is a serious play (Norrman et al 2017), where students use crafts material to build prototypes of their ideas. Halfway through the course we commonly arrange a Value Creation Forum, based on the Stanford Research Institute methodology to give, and take feedback. During this seminar the teams give a short 2–3-minute pitch and receive feedback. Finally, there is a graduation event, which contains pitches and a mini exhibition. The program setup differs a little between the courses though, but external actors and the CPs are commonly invited. The group work is reported in case of a business plan or in the inGenious course a project report, which also is handed over to the CPs. The students also write learning reflections and in Course 3 we have utilized the EntreComp framework (Bacigalupo 2020) to aid the reflection regarding attained skills.

3.3 The ComICIR model

Linköping University has a long tradition of cooperation with industry, both regarding research and fundings. One example is the innovation agency Vinnova, and its support schemes for challenge driven innovation. Applying for such funding implies that a consortium of firms and/or public organizations need to back up the research team behind the application. To increase the efficiency and focus on the commercialization processes of the challenges, and to engage students in solving real, complex, interdisciplinary problems that are relevant to commercialization in the

[4] https://studieinfo.liu.se/en/kurs/teio06

challenged driven innovation, we have developed a model where researchers with their research projects cooperate with students in entrepreneurship courses.

Since our courses have an experiential pedagogical approach and aim to offer the students skills and knowledge in I&E processes, it is of high importance that the students get the opportunity to get experience from a sharp and real-life entrepreneurship process, where there also could be opportunities to join the commercial constellation. Furthermore, the researchers can get new fresh ideas of how to commercialize their research and their ideas also undergo a verification process. In the below Figure 1, the process is illustrated.

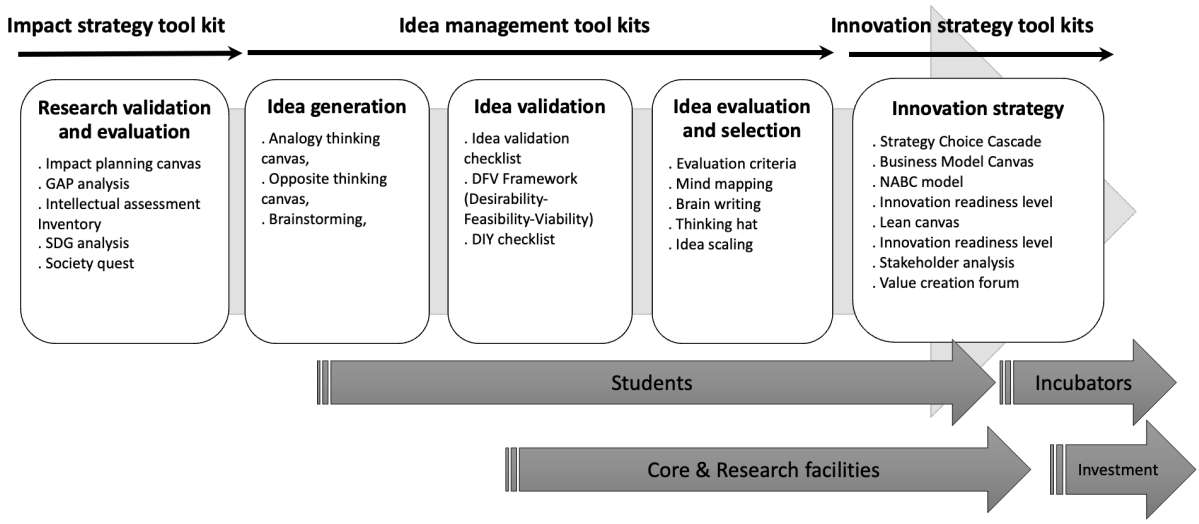

Fig. 1. - Co-creation process for commercialization of research ideas at LiU

The first step is research validation and evaluation, and this is run by the research teams and the advisors and coaches at LiU Innovation. During this part it is decided what applications of the research that could be most suitable for commercialization and the research teams are informed of what they can expect from acting as challenge providers in an entrepreneurship course. Next step is idea generation, which starts at the Idea Jam, where the research teams get a group of students that starts an ideation process. The work is supported by lectures and workshops throughout the I&E course. During this phase students are in contact with the CPs which act as a “sounding board” in the idea development process. At the end of the course the students present their work in case of a business plan, that the research group could either take or leave. If things turn out well, they could start cooperating with the students also after the course- on their own or as a part of matching efforts and activities run by the innovation and incubator support actors. The above figure also shows actors in the regional innovation system such as research facilities, investors, and incubators. When taking in challenges from external parties the process is a little bit different and can best be described as a dialogue to design the challenge. In the courses the same process is applied for all challenges.

4 ANALYSIS

The ComICIR-model has been tested on about 50 cases of various types, whereof at least 50% can be regarded as deep tech or at least technically advanced and business-oriented challenges from start-ups and research groups. The model as such has the potential to be scaled and formalized to reach out to industry, governmental bodies, and NGOs. During 2022 it was tested on research groups with focus on biotech and biomedical engineering. During the spring semester 2023 it has been tested to help new ventures and public bodies such as the region of Östergötland and its municipalities, to find solutions on challenges in line with the SDG 11 – sustainable cities and communities.

In interviews with CPs representing companies, it was revealed that they engage to maintain or get contacts with the university and the students, to get new ideas and solutions and to get information. For challenges to work, it's therefore important that they focus on real problems. Factors that can make companies reluctant is the openness and fuzziness, by means of that they don't know what they will get back. Dialogues with researchers show that they engage as they need help with the commercialisation process, i.e., to define customers and their needs, framing the product, mapping the competition landscape, creating business models, and formulating the impact for the society.

After implementing and testing the model in a strict CBL manner, following the CBL approach of the ECIU in three courses we have realized that CBL - by means of being based on open big ideas searching for any type of solution in an open innovation process - might not be the best way of running the courses to create impact of the all the challenges/ideas given. The reason for this is that there is an immediate risk that the students - and thereby also the solutions - deviates too much from what the idea owners want to have. Hence, if the mission is impact and commercialization, it may be better to narrow down the challenge and abandon a too open aim and scope. In the below figure 2 we have put the pedagogical approaches CBL and PjBL on the vertical axis and the type of idea/challenge on the horizontal. This gives us guidance in how to treat different type of cases for the courses.

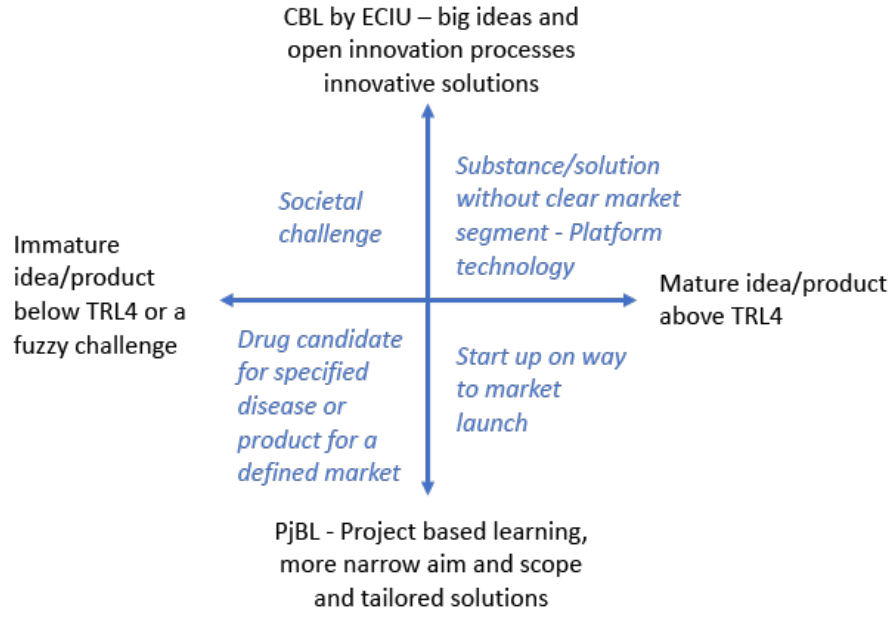

Fig. 2. - Aim and scope of idea/challenge versus pedagogical approach

Type and stage of development, i.e., the innovation readiness level steers degree of openness and unconditionality of the innovation process. I.e., if the idea/challenge comes from a research project and is at an early stage - the CBL process described above might work very well. But if there is a product higher up at the TRL (Technology Readiness Level) scale than 4 (Technology validated in the lab), both students and CPs come better out if the challenge is narrower and more focused on an intended solution. To be able to understand the ideas/challenges is therefore essential and this entails that it is important that teachers, coaches, and CPs, in collaboration can judge the development level of the idea and co-develop the challenge so that the best prerequisites are created and also the degree of to which CBL/PjBL is applied in the process. An immediate implication of this is that selection of ideas/challenges cannot be ad-hoc, neither can they be treated in a similar way - if the goal is to reach impact. To reach this, a more individual and customized approach is needed.

5 CONCLUSIONS

The aim of this paper was to describe how we work with challenges and ideas emanating from research at Linköping university and from external CPs. We have analysed how challenges and ideas could be evaluated and how experientially-based pedagogical approaches can be adjusted in order to benefit the regional ecosystem of research, education and industry in order to reach increased impact of innovative ideas. Our main findings are as follows: (1) The ComICIR model works as it brings together research, education and innovation in an efficient and effective way and creates relevance and meaning for both the students, that gets a sharp learning context, and the idea/challenge providers, that gets new perspectives and basis for further decisions. (2) CBL and PjBL are related learning approaches that fit slightly different purposes. The type of challenge and stage of development are the main parameters to decide how to work with the idea/challenge. (3) The teacher team needs to have both academic knowledge and practical business development skills as they must be able to understand what type of ideas/challenges they deal with. Among the limitations of this study can be mentioned that this is an ongoing work. More tests will be run, and the model will be further developed.

6. ACKNOWLEDGMENTS

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