When problem based learning becomes entrepreneurial – a facilitator view on student challenges

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WHEN PROBLEM-BASED LEARNING BECOMES ENTREPRENEURIAL – A FACILITATOR'S VIEW ON STUDENT CHALLENGES

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ABSTRACT

Integration of entrepreneurship in current engineering education emphasises the need for engineers to initiate and drive innovation processes that transform ideas into societal value. Learnings from the history of engineering and the at times unsustainable impact of technology on society have drawn attention to user

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requirements and the societal context of technological innovations. In addition to this view, entrepreneurial education underlines the need to move beyond reactively addressing user requirements and societal developments to proactively creating opportunities and realising their potential to change societal patterns and trajectories. Grand challenges, such as climate change and the recent COVID-19 pandemic, have indeed confirmed the need for such abilities. This paper argues that when integrating entrepreneurship in engineering education, the pedagogical approach to how we teach entrepreneurial engineering will inevitably have to be revisited. The study aims to explore the facilitation of entrepreneurial projects in a problem-based learning (PBL) environment. Design-based research (DBR) was conducted to co-develop and test guidelines and models for entrepreneurial PBL based on existing PBL approaches. In this process, ten facilitators of entrepreneurial PBL projects were continuously challenged to change their perspective from being facilitators to students and from being practitioners to reflective practitioners. In this paper, we especially report on the part of the study investigating the following question: What challenges do students experience when PBL becomes entrepreneurial? The paper concludes with insights into the nuances of entrepreneurial PBL and closes with a short discussion on the need for more research to ensure integration and not the addition of entrepreneurship in engineering education.

1   INTRODUCTION

"We live in a rapidly changing society where it is essential that everyone has the capacity to act upon opportunities and ideas, to work with others, to manage dynamic carriers and shape the future for the common good. To achieve these goals we need people, teams and organisations with an entrepreneurial mindset, in every aspect of life." [1, p. 3]

On this note, the European Commission presented the European Entrepreneurship Competence Framework (EntreComp), distinguishing between three pillars of entrepreneurial competencies in the following way [1]:

1. ideas and opportunities, including the competencies related to spotting opportunities, creativity, vision, valuing ideas and ethical and sustainable thinking;
2. resources, including competencies related to motivation and perseverance, self-awareness and self-efficacy, financial and economic literacy, mobilising others and mobilising resources;
3. into action, including learning through experience, working with others, planning and management, taking the initiative and coping with ambiguity, uncertainty and risk.

This framework for competencies relates to the whole entrepreneurial process from idea to value creation, and the focus on going "into action" captures both the learning "about", "for" and "through" entrepreneurship [2]. Thrane et al. [3] argue for a learning "through" strategy, where the learning experience is seen as a co-evolutionary

process. Mäkimurto-Koivuma and Belt [4] suggest adding learning "in" entrepreneurship to underline the importance of experiencing entrepreneurship in a real-life context. Aligned with this approach, Mäkimurto-Koivuma and Belt [4] highlight active learning methods for learning "in" and "through" entrepreneurship, with reference to Graaff and Kolmos [5].

Problem-based learning (PBL) is one of the approaches which makes use of active learning methods. A PBL curriculum combines specific cognitive, collaborative and content-related strategies [6]. From a cognitive point of view, learning is based on experiences with real-life problems, and learning is collaboratively organised in participant-directed teams working on projects. Content-wise, learning is interdisciplinary and exemplary and emphasises theory as well as practice.

The focus on real-life problems as the starting point in PBL will offer students the opportunity to experience entrepreneurship in a real-life context, and the focus on collaborative learning embedded in PBL is aligned with the view of entrepreneurship as a co-evolutionary process. However, as with any other pedagogical model, there is, and should be, sensitivity towards the context of use, and in this case we are specifically interested in distinguishing PBL and entrepreneurial PBL to address specific concerns for the entrepreneurial project. More specifically, we work from the following research question:

What challenges do students experience when PBL becomes entrepreneurial?

2 METHODOLOGY

Challenges for students in entrepreneurial PBL are addressed as a part of a longitudinal design-based study. This study has as its primary purpose to clarify principles for facilitating students who want to pursue an idea by initiating a start-up project with a view to creating value and business, or at least a business plan, based on an idea. In the following, the overall research design of this longitudinal design-based study is presented together with the more specific context and methods used to study students' challenges in entrepreneurial PBL.

2.1 Research design – a longitudinal design-based study

This study follows the conduct design-based research (DBR) presented by Reimann [7] including the following three phases:

1. preparing the experiment, including clarifying instructional goals and starting points, envisioning a learning trajectory and placing the experiment in a theoretical context;
2. experimenting to support learning, including collecting data in cycles of design and analysis, applying interpretive frameworks and formulating and testing domain-specific instructional theories;
3. conducting retrospective analysis, including argumentative grammar, establishing trust in the findings and ensuring repeatability and generalisability.

Specific for DBR are multiple iterations, the development of learning theories along with innovative real-life practices, development of design principles and, last but not least, collaborative partnerships between researchers and practitioners [8].

This longitudinal DBR has as its main purpose to improve the facilitation of entrepreneurial PBL by an improved awareness of the distinct types of competences, problem design and project organisation needed for entrepreneurship as well as the following implications for teaching practice. An overview of the first part of the study (co-creating the guides) is pictured in figure 1.

Data collection from workshop 1
- reflection on the current facilitation of start-ups
- Co-developing adapted PBL applications to further guide future practice

Preparing the experiment
Partnership core developed, starting points, goals and learning trajectory and theoretical framework clarified

Relating findings to conceptual frameworks for:
- EntreComp
- Problem design

Partnership planning meeting

Data collection from workshop 2
- Validating insights from workshop
- Co-creating the facilitator role in a entrepreneurial PBL environment

Formulating first draft of principles for Entrepreneurial PBL
- Core challenges for students
- New strategy for problem design

Relating findings to conceptual frameworks for:
- Facilitation in a PBL environment

Partnership planning meeting

Formulating comprehensive guidelines for:
- facilitating Entrepreneurial PBL (for facilitators)
- adapting PBL practices to entrepreneurial PBL (for students)

Planning test and retrospective analyses
Researchers outside the previous partnership included to carry out evaluations of the guidelines including response from staff and students

Workshop 3 – Validating guidelines
- Prereadings and comments selected for final revision

Guideline published and brought into practice
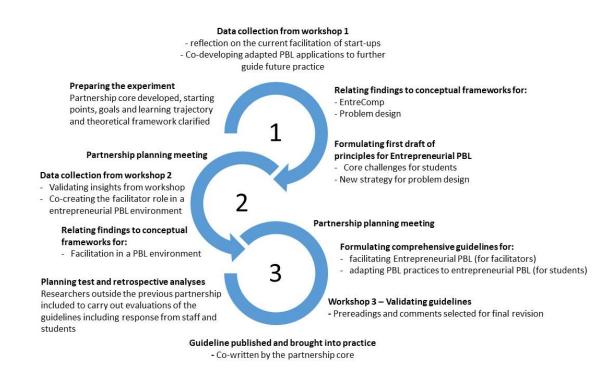- Co-written by the partnership core

Fig. 1. Overview of the first part of the longitudinal design-based study; the second part of the third iteration includes evaluation and revision of the guides to be carried out in 2022/2023.

A guide for staff to facilitate entrepreneurial PBL and a guide to support students in carrying out a problem-based and entrepreneurial project have served as the main boundary objects to formulate actual design principles for the facilitation process. The ambition has been to co-construct the guide in a partnership between PBL researchers and facilitators.

From 2019 to 2020, ten facilitators of entrepreneurial PBL projects were continuously challenged to change their perspective from being facilitators to students and from being practitioners to reflective practitioners. They were introduced to cases and asked to reflect on the challenges students typically face in different phases of a project and the themes, questions and advice in which this would likely result. They were challenged to put themselves in the role of the students making a problem

design and thereby to identify, analyse and formulate the problem using PBL methodology and to provide input to matches and mismatches, which informed new adapted instructional models. They were challenged to reflect on their own role as a facilitator in the entrepreneurial project and to reflect on their own learning style and differences in the way they (to their surprise) advised students during the different phases of the entrepreneurial project. Furthermore, they were challenged to view facilitation as an impact on organisational learning and to consider the importance of collective interpretations and shared-meaning structures in entrepreneurial project groups.

Data were primarily collected by feedback sheets, on which groups of participants as well as individuals were asked to provide short written statements summarising their main concerns and reflections. These feedback sheets followed a previously fixed structure with themes and overall questions for the groups/individuals to fill out. After the workshops, the data were collected and summarised to be presented at the subsequent workshops. Furthermore, when writing up the guides [9,10], the insights from participants were supplemented with other sources.

In this paper, we report in particular on the part of the study investigating the challenges students experience when PBL becomes entrepreneurial. The empirical base for this part was created during the first iteration at workshop 1. The group was working from a fictive case, picturing a group of media technology students having the idea of creating an intelligent walker to assist walking-impaired persons in new ways. The start-up was integrated in a half-year problem-based project of 15 european credits according to the european credit transfer system (approx. 450 working hours per student). In three groups, the participants were asked to decide on the core challenges that students would most likely experience at the beginning, middle and end of the semester project. All participants were experienced facilitators of entrepreneurial projects. The findings were validated in the second iteration at workshop 2 and were further used to guide facilitation practices in the third iteration.

3   RESULTS

Table 1 presents the key challenges that facilitators noted as common for students working on entrepreneurial projects. Based on these insights as well as the follow-up questions related to the themes, questions and advice in which such challenges would most likely result, the challenges where grouped according to three themes. One theme centres around the power of the idea, another around the need to cross traditional borders and, last but not least, a final theme relates to the resilience needed on the part of students to work on insecure ground.

3.1 Challenge 1: Tunnel vision – the power of the idea

This first challenge centres around one of the more fundamental barriers to entrepreneurship, that is reluctance to "kill you darlings". The idea is, as such a darling, it holds an embedded promise and perceived greatness that make students risk actually engaging in a start-up. As can be seen from Table 1, unrealistic

expectations about the potential of the idea and blind spots related to already similar solutions are symptoms of an idea-generated tunnel vision.

Table 1. Key challenges at the beginning, mid and final stage of the start-up project. The challenges are presented directly as noted by facilitators (translated into English).

Beginning	Mid-term	Final stage
- Unsure about what it takes and where to start – need help to proceed - Unrealistic expectations about the potential of the idea - Insecure about a lot of things – resources, competencies, benefit/potential, impact on personal life - Too far in the process considering what they actually need (they lack insight) - Having a hard time approaching users/customers (validation)	- Having a hard time understanding what they have signed up for - Having a hard time defining the business model - Lack of professional competencies - Lacking an overview of how to present their idea to external panels - Are blind to knowledge suggesting that the idea "exists" and no further iteration is possible - Having a hard time making a time schedule and setting up targets - There is (still) a typical lack of validation	- Motivation to do enough and the right things (move into execution mode) - Developing a prototype - Prove concept and test business model - Access to user groups - Lack of resources - Lack of funding in general and for prototyping - Lack of "squid" competences - Having a lot of excuses why it was not possible (for me) including personal/private circumstances - They are stuck – no progress

The impact of not questioning the idea can furthermore have a negative spin-off effect on the motivation to validate the market potential of the idea. Why validate what is already perfect, and why question potential consumers when it is just a matter of convincing them about the brilliant prospects of this idea? The facilitators experienced that such an attitude, although caricatured in this context, can be a barrier, can bypass or slow down the process of validating market potentials and outlining value propositions in the business modelling process. However, as competence frameworks like EntreComp [1] do not specifically highlight the

importance of critical thinking, it can also be argued that this is a more general blind spot in the outline of an entrepreneurial mindset.

3.2 Challenge 2: Intensified boundary work

The overview of student challenges provided by facilitators show that students have to cross different boundaries during their entrepreneurial project.

First of all, the process of entrepreneurial PBL is different from more traditional PBL processes due to the central focus on the idea in the problem-design process. Facilitators experience the problem-design process as challenging for students, as they have a hard time planning the process and getting an overview of expected deliveries. This challenge for students to transfer planning experiences from a PBL project to entrepreneurial PBL was, nevertheless, also considered a challenge for the facilitators. In the guideline [9,10], a specific focus was therefore on providing a road map of the problem-design process in entrepreneurial PBL, not as a matter of fact but as a frame of reference to guide student-directed entrepreneurial projects.

Secondly, the increased focus on business modelling in entrepreneurial PBL outlines a process that calls for interdisciplinary interaction; as in any business, different professions are needed to generate value out of ideas. Furthermore, there is an intensified need for transdisciplinary collaboration as interaction with potential user groups is considered a necessity in the entrepreneurial mindset. Facilitators reported the need to push students out of their comfort zone of the university. The challenges in the last phase of the process (see Table 1) indicate that such a lack of drive can result in some rather extensive and comprehensive challenges in the last phase of the project. Stakeholder interaction is needed in order to validate assumptions of user needs, provide proof of a concept, make a prototype and test the business model, etc. The iterative nature of entrepreneurship calls for not just one but continuous interaction with key stakeholders.

3.3 Challenge 3: Lacking resilience

Finally, Table 1 also illustrates the personal dimension of entrepreneurship. These identified challenges relate very much to competences stressed in the EntreComp framework, such as self-awareness and self-efficacy, motivation and perseverance as well as coping with ambiguity, uncertainty and risk. It should be noted that in this case these challenges are observed among students who are experienced with self-directed learning and open-ended problem-based projects involving a high degree of uncertainty. This fact puts the insecurity level for an entrepreneurial newcomer into perspective. As noted in Table 1, students in start-ups feel insecure about a lot of things – resources, competencies, benefit/potential of the idea and even about how this will impact their personal life. Facilitators therefore stressed the importance of questioning students to find out what the uncertainty is about, how they feel about it and why. In other words, although entrepreneurship is a co-constructing endeavour, it is also a very personal matter.

With respect to this, it is worth noticing that even though learning outcomes are stated on the individual level and what could be called resilience competence is

recognised as important for an entrepreneurial mindset, it is typically not an integrated part of the curriculum. Facilitators reported that when students gave up on their idea, they had a hard time acknowledging the learning outcome of the start-up project. This underlines the importance of increased attention to affective learning outcomes in the curricula of entrepreneurship education and the need for taxonomies to assess students' abilities to establish and uphold resilience.

4   SUMMARY

In this paper, we have argued for the differences between students' challenges in project-based PBL and entrepreneurial PBL, and we have pointed out key differences in entrepreneurial PBL due to the power of the idea, the intensified need for boundary work and the ambiguity and uncertainty of the entrepreneurial problem-based project. From the outset, we have also argued for the need for more research on curricula design for entrepreneurship, and we have highlighted critical thinking, adapted models for problem design and affective learning outcomes as potential areas of research. As entrepreneurship is a fundamental element of technological innovation, our engineering education research communities are, in our view, central players.

5   ACKNOWLEDGMENTS

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