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REAL-LIFE CASES IN CHALLENGE-BASED LEARNING

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ABSTRACT

Challenge-based learning is a teaching approach where the learning takes place through the identification, analysis and design of a solution to a sociotechnical challenge (problem). In this paper we present how we use challenge-based learning in a 2nd year course with focus on entrepreneurship. We especially focus on the cases and on how the students value working with real-life cases and what information is important. Based on a survey, we found that the students enjoyed working with real-life cases, which they found both motivating and as a good frame for the course. They did however stress the importance of having a good contact with the case-owner. The students also mentioned that the case should be relevant and realistic in addition to being well-framed and open. Furthermore, the students also highlighted the importance of having access to case-owners, data and to other stakeholders. Based on these reflections – and our own observations during this course over the past four years, we offer a list of recommendations for choosing and framing cases - and for aligning expectations with case-owners with regards to results and availability; especially when it comes to the use of cases as a tool for learning in more introductory courses, such as ours.

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1 INTRODUCTION

1.1 Background: Challenge-based learning

Engineering students are increasingly expected to be able to handle complex global 21st century challenges and to develop innovative technological and sustainable solutions (Hadgraft and Kolmos, 2020). In order to ensure these competences, more and more engineering programs focus on active learning methods including group work, by offering courses based on challenge-based learning, problem-based learning etc.

Challenge-based learning (CBL) focuses on student-centered learning and has become increasingly popular in engineering programs and courses. CBL offers a frame for inter-disciplinary group work where teams of students address real-life, open-ended challenges. CBL aims to stimulate students to take the lead in their own learning, by acquiring and applying relevant knowledge to cases and challenges in order to both suggest solutions and develop interdisciplinary skills (Helker et al., 2024). In CBL, the teacher acts as a facilitator (Doulougeri et al., 2024).

CBL normally starts with an open-ended, real-life challenge, ideally addressed by interdisciplinary teams, as the students should integrate knowledge and skills from multiple areas. The students propose solutions to the challenges after a process of problem identification, investigation, ideation and implementation, applying entrepreneurial tools and design thinking (Doulougeri et al., 2024)

Cases used for CBL are normally societally relevant and connected to sustainable development goals. The cases are often presented by external partners and the student teams collaborate with both the case-owners, and internal and external stakeholders to develop a solution (Doulougeri et al., 2024). The use of real-life challenges allows students to link new and prior knowledge, while applying it to new challenges (Hadcraft and Kolmos, 2020); and by also addressing sociotechnical issues, the cases address pressing current challenges such as climate change; thus requiring that the students apply a combination of technological innovation, policy development and societal engagement (Malmqvist et al., 2015).

Challenges and cases in CBL are often characterized by being open-ended and real-world, with external industry partners and societal stakeholders (Doulougeri et al., 2024). The cases can be created by a group of teachers; it has however been reported to be difficult to create the cases both with and without industry partners (Doulougeri et al., 2024) and it is also time consuming (Bombaerts et al. (2021). There are many examples of literature in which external (extra-academic actors) are used in CBL projects, but only little information about what their input was, their perceptions of the CBL approach, and whether their participation was evaluated (Gallagher and Savage, 2020).

1.2 Case study description

In this study, we present how we work with challenge-based learning (CBL) in a 2nd year introductory entrepreneurship course. The goal of the course is that students develop an entrepreneurial mindset while at the same time developing an innovative solution to a case challenge. The students come from different BEng programs and bring a range of skills and competences to the course. The students are grouped in mixed, interdisciplinary groups.

The course consists of common sessions where students are introduced to various methods (e.g. Business Model Canvas, Effectuation, Value Proposition etc), and sessions where students pitch for their peers and receive feedback (from both peers and teachers). In addition, the students work independently on their own group projects and plan how to collect data and meet with stakeholders and case-owner. The students (in groups) can choose which challenge to work with. In the beginning of the course the cases are presented, and at the end of the course there is a poster session where the students pitch their solutions to the other groups, teachers and case-owners and receive feedback before handing in their final reports. The cases are connected to the local environment with a focus on real-life, open-ended challenges from local companies, start-ups or organisations. The students are asked to develop a solution with societal values in addition to sustainability focus. The case-owners are contacted some months before the course starts and we have a meeting with them to discuss the case and alignment expectations with regards to how the students can contact them, data available for the students etc.

An example of a case description

Case description – Food scraps for sled dog food

A large part of Sisimiut's waste is food. This resource is mostly thrown away and burned, but can it possibly be used differently? Sisimiut has about 2000 sled dogs, and as it is now, all their food is imported from outside.

Investigate, among other things, the Fish Factory, the Board, the Supermarkets, institutions and possibly catchers' residual waste.

Case questions:

- o Can the discarded food resource be used as dog food?
- o What is thrown away in the various production companies, institutions and eateries?
- o What is the total food resource from waste? Give an estimated value in terms of protein, carbohydrate and fat.
- o How should the leftovers be processed in order for it to be used as dog food?
- o Can production possibly be run circularly?

Throughout the course the students have the opportunity to meet with the case-owner and other stakeholders to ask questions relating to the case.

The learning activities consist of both activating learning elements such as design thinking, ideation - and self-regulated learning in form of group work, self-study and reflection on the student's own learning process. Furthermore, the students are encouraged to venture outside campus to meet the users, customers and stakeholders with relevance for the project.

In the first week of the course various definitions of entrepreneurship and innovation are introduced and the students are introduced to design thinking and effectuation. Theory is tested in practice by exercises. An individual portfolio is written based on the use of the methods and tools (individual report).

The groups develop a business opportunity and write a business plan and in the

process use entrepreneurial methods. The students should contact potential users/customers for ideating, having their feedback and use the feedback for further development of their concept/solution.

The groups present their result at a poster presentation during the the last week of the course. Subsequently, each group prepares a final report (group report) and submit it on the last day of the course – while each student also individually update and submit a revised portfolio of methods and tools, also reflection on the feedback they have received during the course.

During the course, the students work with peer feedback, thereby training them to give and receive feedback. More information about the course '*Entrepreneurship in Greenland*' and the learning objectives can be found in the course description at <https://kurser.dtu.dk/course/62054>

As is normally the case in CBL, the teachers increasingly act as facilitators in order to provide scaffolding and support the students while they work on the challenges. The teachers are available every day during the course. The first week of the course is more teacher directed with joint teaching sessions, while the last two weeks primarily consist of group work; with both planned group feedback sessions on specific topics (e.g. business model canvas for the case solution) - and both individual and group sparring sessions with the teachers when needed.

The course is a three-week course taking place at DTU's campus in Sisimiut, Greenland. The students primarily come from the two Bachelor of Engineering programs in Fisheries Technology and Arctic Civil Engineering - and for these students the course is mandatory and placed between their 2nd and 3rd semester. Furthermore, the course is open for other students to take as an elective course, and in 2023 five students from the Bachelor of Engineering program in Global Business Engineering participated (travelling to Greenland for the course). A total of 16 students were enrolled in the course in August 2023. And four groups were formed to include students from the different disciplines.

The course is an intensive 5 ECTS course where the students work every day for three weeks. The outcome after the course is a concept for how to solve the challenge – while using the methods learned during the course. It is not expected that the students in the relatively short period of time the course runs, produce prototypes or set their solution into actual production.

The course has been running since 2020 and each year we have used (new) real-life open-ended cases provided by local companies and start-ups. This time we asked the students about the cases, and what is important for them when working with cases in their courses.

2 METHODOLOGY

2.1 Background

The data was collected during the course held in August 2023.

The cases were all from Sisimiut/Greenland and included cases from start-up's and from more established companies. All cases focused on actual challenges observed by the case owner. The cases were chosen to be relevant for engineers and to have a technical aspect and a socio/sustainable focus.

In 2023 the student groups could choose between three different cases: One on using rest products for food for Greenlandic sled dogs; one on a design of a local knowledge walking-trail in Sisimiut for tourists; and one on the use of local rock and stone in production/construction. Two groups chose the sled dog-case, and one group each chose the remaining two cases.

2.2 Survey

A survey was conducted during the course. The survey consisted of 5 questions related to the use of real-life cases. There were 16 students enrolled in the course and of those 11 students handed in the survey.

Q1: Do you think it is relevant to work with cases in teaching? Please explain why/why not?

Q2: What do you think is important when working with a case in class?

Q3: What is important in relation to the case-maker/company?

Q4: What should a good case description contain (feel free to write keywords) of information?

Q5: Good advice for using cases in teaching.

The survey was handed out to the students in class, and they had time to fill it out and hand it in during class.

3 Results

Overall, the students enjoyed working with real-life cases, which they found motivating and as a good frame for the course. They did however stress the importance of having a good contact with the case-owner. The students also mentioned that the case should be relevant and realistic. Furthermore, the students highlighted the importance of having access to data and to stakeholders.

The feedback from the students fell in three categories:

- The cases provided a good and motivational frame for learning
- The importance of contact with the case-owner
- The importance of a well selected, well-framed, relevant and open case

The case as motivational frame for learning

Most respondents found the case to be a very relevant, motivational frame for the course and theory – and stated that it supported both learning and transfer of new knowledge. They stated that the case made it easier to relate theory to the real world, and that the real-life challenges made the theory much more relatable.

Statements (translated from Danish):

- “I think it is very relevant working with real life cases gives a better understanding of the goals and methods we read about. Also it makes it easier to remember the methods when I can connect it to an example”
- “It helps to connect the theory we learn in the classroom with the world outside”
- “it gives a deeper understanding”
- “it is easier to think of when it is a real-life problem”
- “It provides a good frame”

The importance of contact with the case-owner

The respondents generally stated that it is important that the case-owners have time to talk with the students about the case; that they are available – and willing to be “disturbed” by the students. Also important that they (and their case) have a relevant technical and educational background.

Statements (translated from Danish):

- “They must be contactable and not too ‘big’”
- “[Important] that they have time for some questions / time to meet”
- “important that the case-owner knows or has an education within the case-industry”
- “Availability [is important]”
- “It is important that they are willing to cooperate and be disturbed by the students”

The importance of a well-selected, well-framed, relevant and open case:

The respondents emphasized throughout the questions the importance of a well-selected case, and they stated that the cases must be both relevant, open-ended – and well-framed. And at the right level and relatable for the students with regards to both their own background - and the topic of the specific course.

Statements (translated from Danish):

- “The case must seem approachable”
- “it is important that the cases you can choose are realistic”
- “Also [important] that the case is relevant for where you are”
- “important that the case is well investigated by those who pose it”
- “must contain a topic that can be viewed from different perspectives”
- “[the case must be] inspiring (idea generating) ... open question”
- “[the challenge must be] open but not too open and a frame that is not too narrow”
- “[the case must be] relatable”

Overall observations and reflections

We have been working with (different) real-life cases in this course every year since its launch in 2020. In 2023, we found that the set-up was working particularly well – and that it supported the group work process and the scaffolding and application of

both new and existing tools and knowledge in the mixed student groups. One important difference this year was, that the case owners were much more available throughout the course, and it seemed to be easier for the students to form a working relationship with their case owners. This was further emphasized by the fact that all case owners participated in the final poster presentation session; also asking further questions to the groups regarding their solutions and thoughts, which has not been the case to that extent in earlier courses.

All in all, this has confirmed what both we – and the CBL-model stresses: that it is important to work with real-life – and open-ended challenges; and that it enforces both the motivation and co-creation in the teams – especially when they are able to have a continuous dialogue with the case owners. This also further supported the development of a team-identity in the groups, emphasising the use of the group's interdisciplinary skills and knowledge.

When working with open-ended real-life cases in challenge-based learning we recommend the following reflections when designing the course and choosing cases – especially in an introductory course like ours:

- 1) The use of real-life – and open ended – case-challenges is central
- 2) The cases must be framed to fit the learning objectives for the specific course, i.e. in this course, the cases must function as a supporting learning tool for the entrepreneurial content of the course
- and not primarily be a 'wish-list' from the case-owner.
- 3) It is important that the case-owners are available during the course and willing to meet with the students and discuss the case and possible solutions
- this stipulates that importance of the case-owner keeping an open mind with regards to possible solutions (rather than having a fixed solution in mind).
- 4) Based on the case-owners we have worked with over the years, we find that it may be more important that the (albeit still a real-life) case is framed to fit the course – rather than an actual company's specific demands and wishes. This also stipulates the importance of the case-owner understanding the learning objectives and/or setting of the specific course in order to engage in dialogue with the students – and having an open mind with regards to possible solutions. Especially in an introductory course like the one described.
- 5) In more advanced courses it may be more relevant to have more non-prepared case-owners (with regards to the specific course), as the dialogue with them will be a larger part of finding innovative solutions for the benefit of both the specific company – and globally.

It is overall our impression that the success of this year's cases as frames for the course to a large extent was based on the case-owners' understanding of the purpose and frame of the course (and thus their cases' role as tools for student learning) – and their willingness to enter into an open dialogue with the students, rather than having a preset mind with regards to a concrete and specific solution.

This paper thus introduces a novel and innovative approach to the development of challenges and cases for CBL where the case-owner not only develop the case but also is closely involved in the students' learning process throughout the course.

4 SUMMARY AND ACKNOWLEDGEMENTS

In this paper we present how we work with challenge-based learning in a course with the purpose of introducing entrepreneurship to the students. This time we asked the students what is important for them when working with cases in their courses. And based on their responses – and our own observations, we offer suggestions regarding the kind of cases and the frame around them in a challenge-based learning setting.

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