# Self-directed approach as an opportunity to learn in Challenge-based learning (CBL).

## A CBL experience with cross-disciplinary learners at the University of Trento.

Alessandra Scroccaro
*(University of Trento, Italy)*
Alessandro Rossi
*(University of Trento, Italy)*

**Abstract**
*Challenge-Based Learning (CBL), the experiential learning and pedagogical approach through which learners (students, instructors, companies, stakeholders, communities) are actively involved in designing a sustainable solution for a real-world problem, is gaining momentum in various Higher Education Institutions around the world. Despite this multiplication of learning initiatives, evaluation in CBL is still an overlooked topic both by scholars and practitioners. Moreover, assessment is closely linked to the teaching and learning process and can also influence the evolution of the challenge, because it is directly involved in the feedback, teamwork, and relationship between students, instructors, challenge providers, and stakeholders. Explaining why assessment is so important in CBL is one of the objectives of this chapter. Therefore, in line with the spirit of the handbook, the aim of this chapter is also to inspire, give suggestions and tools for novel ways of assessing the learning process in CBL.*
*Through a challenge launched by the University of Trento, involving a local non-profit integrative health fund, we understood the importance to integrate the formative with the summative assessment, to evaluate not only the final results but also the learning process. We experienced the fundamentals and the difficulties of self-directed learning through which students are called to co-design their learning experience, monitor teamwork, and assess their progress. Support and guidance from instructors are required to be successful in this cultural shift through which teachers are no more traditional professors and students are finally the experts in the challenge.*

Keywords: Teaching and Learning, Self-assessment, Challenge-based Learning, Reflection, Self-directed approach, Summative and formative assessment, Learning process, Constructivist approach.

## 1. INTRODUCTION

Challenge-Based Learning (CBL) as an experiential learning and pedagogical approach through which learners (students, instructors, companies, stakeholders, communities) are actively involved in designing a sustainable solution for real-world problems is gaining momentum at various Higher Education Institutions (HEIs) worldwide (Vignoli et al., 2021).

CBL is a revolutionary way of teaching and learning because it engages a change of perspective with regards to roles, methods and approaches, and it has been impactful in the learning assessment too. Changing the way of teaching and learning has consequently had an impact on the learning goals assessment, the way through which instructors can assess the learning of students, as well as the tools, methods and approaches used for the challenge (Observatory Tecnológico of Educational de Monterrey, 2015; Nichols and Cator, 2016).

CBL methodologies have found fertile ground in the University of Trento too due to the openness to new ways of teaching and learning, a wide stakeholders' network, previous innovative learning experiences, and a local dynamic ecosystem focused on innovation.

Moreover, the University of Trento has recently co-founded the ECIU University (European Consortium of Innovative Universities), an EU-funded European University based on challenge education, innovation and research. The ECIU aims at creating a completely new educational model on a European scale, where learners, teachers, and researchers cooperate with cities and businesses and solve real-life challenges based on the UN SDGs (United Nations Sustainable Development Goals).

"Challenge" has become a buzzword and in the literature, we can find a considerable number of studies analyzing the positive effects on students, particularly regarding the strengthening of soft skills and the emergence of creativity and innovativeness (Yang et al., 2018). Despite the multiplication of learning initiatives, the assessment part in CBL is still an overlooked topic both in the literature and in practice. Moreover, assessment practices are strictly connected with teaching and learning processes and can impact the evolution of the challenge too, because they influence the relations between learners, instructors, challenge providers, and stakeholders.

Explaining why assessment is so important in CBL is one of the objectives of this chapter. Therefore, aligned with the spirit of the entire handbook, the aim of this chapter is also to inspire, give suggestions and offer tools for novel ways of assessing learners in CBL learning processes.

In order to pursue these objectives, the chapter is structured as follows. Firstly, we will review the main types of assessment commonly applied in the context of CBL in HEIs. Then, we will present a series of assessment tools recently adopted in a challenge launched by the University of Trento. For this challenge, we will examine how we set the learning objectives and chose the evaluation tools, identifying the main lessons learned. Finally, we will explore future directions for the application of evaluation in future CBL initiatives.

## 2. CBL AND ASSESSMENT

By CBL we mean "a learning experience where the learning takes place through the identification, analysis and design of a solution to a sociotechnical problem. The learning experience is typically multidisciplinary, takes place in an international context and aims to find a collaboratively developed solution, which is environmentally, socially and economically sustainable" (Kohn Rådberg, Lundqvist, Malmqvist, and Hagvall Svensson, 2020, p. 22). Starting from this broad definition, CBL is a pedagogical approach inscribed in constructivism and student-centered learning perspective (Piaget, 1950; Vygotsky, 1978), through which

students are actively involved in identifying, analyzing, and designing a solution that solves a challenge on current problems and real issues (Nichols and Cator, 2008; Observatory Tecnológico of Educational de Monterrey, 2015). CBL finds its basis in experiential learning (Kolb, 2014). Accordingly, challenge participants learn through the experience process by defining their challenge, working in teams, applying previous knowledge, and mobilizing their networks in order to develop a final solution. During a challenge, they collect information, meet stakeholders, formulate ideas, discuss and develop various solutions until the final presentation and discussion with the challenge provider.

Usually, students work in teams and are supervised by teachers who assume the role of facilitators of the learning process: rather than employing the traditional role of experts, in this case, instructors guide teams in their process of constructing questions, gathering information, analyzing data, proposing solutions, and implementing the final result (Duffy and Raymer, 2010). Teams connect with a challenge provider (who can be a company, a public or private institution, a non-profit organization, and so on) which launches the challenge. Students define the problems they want to work on, manage autonomously their team and acquire the knowledge and skills needed to solve the challenge. Evidence shows high levels of motivation of learners even if CBL can require more work and more engagement than the standard courses (Swinden, 2013).

Common academic practices usually employ a standardized approach to teaching. Despite this approach still being standard practice, there is a growing understanding that every student is a unique person with specific learning needs and different ways of learning (Gardner, 1999). Since CBL recognizes the importance of giving some responsibility to learners for their learning and assessment, participants are often involved in the co-design of their learning objectives and of their achievements.

CBL modules are often designed so that students may become co-designers of their learning process, both at the substantive and the assessment sides (Ni Bheoláin, Lowney, and O'Riordan, 2020). Since students feel empowered for their learning, they can partly choose the agenda, while teachers, as guides, can personalize the learning process. As a consequence, they become partners in the learning and assessment processes. Born mainly in the US, then in the UK, Canada, and Australia (Healey, Flint, and Harrington, 2016; Mercer-Mapstone and al. 2017) the concept of students' partnership is more and more recognized and supported in Europe. The students' partnership is "a relationship in which all involved– students, academics, professional services staff, senior managers, students' unions, and so on – are actively engaged in and stand to gain from the process of learning and working together" (Cook-Sather, Bovill, and Felten, 2014, p. 12).

CBL is a method in which learners are pushed to discuss critically societal challenges and other issues of global importance (which are intrinsically complex). Before building a creative and sustainable solution, they have to figure out the right questions on their own. Critical thinking is one of the 21st Century skills and one of the most recommended capacities required by the job market (World Economic Forum, 2020). This is partly why HEIs propose more and more tools to enable students' reflections on their own progress and their teamwork.

Hence, critical thinking in CBL is related to reflective thinking in terms of what the philosopher John Dewey defined as a deliberate and active process. Reflection would be an "active, persistent and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it, and further conclusions to which it leads" (Dewey, 1933, p. 118). In the same line, challenge-based learning is a pedagogical expression of a learning context in which students do not recall an event with a passive or reactive approach.

On the contrary, reflection can be really useful for making sense of situations or events that we found puzzling or hard to explain. In this pedagogy, reflection for learning should include recalling the event and then posing questions to explore why things turned out the way they did and what possible actions could have given a different outcome. Critical thinking is very much related to experiential learning and to problem-focused learning. Critical and reflective thinking is essential in CBL because of the interdisciplinary nature of challenges.
In this context, self-assessment tools are instruments that students can employ to evaluate the quality of their work, measure their performance with the stated goals and learning objectives, identify the strengths and weaknesses in their work and plan for iterations and improvements.
Since CBL is still regarded as a novel way of teaching and learning, instructors need new assessment approaches, methods and tools. In Table 1 we summarized the main differences that can differentiate the assessment in the CBL approach in respect to a traditional class (Observatory Tecnológico of Educational de Monterrey, 2015; Ní Bheoláin, R., Lowney, R., and O'Riordan, 2020).

*Table 1. Main differences in assessment between traditional classroom and CBL*

| Traditional class | CBL |
|---|---|
| The syllabus as well as the learning goals are fixed, and they are decided before the start of the course by teachers. | The syllabus is structured before the start of the course, but it can be changed in function of participants and teamwork needs. Learning goals can be co-designed with participants (see paragraph 3.1). |
| Learning is based on passive assimilation and then repetition. Assessment practices follow this perspective. | Learning is based on doing, interacting, negotiating. Participants start from what they already know and from their contact networks. Assessment practices follow this perspective. |
| Teacher-centered approach. | Self-directed and reflective approach. |
| Assessment is primarily summative. | The summative assessment is integrated with the formative one. |
| Assessment is entirely decided by the teacher. | The assessment is partly decided by participants. Students can be evaluated also by externals (such as companies, mentors, challenge providers, etc.). |
| Teachers use traditional assessment techniques such as final quizzes, surveys, and so on. | Teachers master a wide range of assessment techniques and usually, they use more than one tool in order to evaluate different aspects of the learning process and outcomes (see Table 2). |
| The teaching assessment, if required, it's standardized. | The teaching assessment is always included in the programme and it's provided to participants, at the end of the laboratory. Instructors, staff, and mentors can provide feedback to each other in order to improve the overall course design and delivery. |
| Assessment practices are meant solely for students. | Assessment tools can be provided for all learners (not only students, but also teachers, challenge providers, institutions, companies, and other challenge stakeholders). |

Generally speaking, we tend to conceive assessment as the final part of a learning process, an action that allows evaluating the achievement of a goal (summative evaluation). But CBL is meant to develop not only technical skills and knowledge, but also transversal competences or soft skills, such as empathy, the capacity to work in a team, problem-solving, stress and time management, communication skills, and so on. That is why assessment processes should measure not only the evaluation of the achievement of certain results but also the strengthening of personal and social competences.

In CBL, as the process is equally important as the outcome, the summative evaluation is integrated with the formative one, which permits monitoring the learning process during the experience. In this context, it is important to provide not only a summative evaluation but also a formative one in order to check the progress of individuals and teams, giving them feedback (both on the content and the process).
Moreover, in CBL the challenge provider can be involved as an evaluator of the assessment process and can provide feedback on various components and elements of the learning process.
In Table 2 we identify the main assessment techniques and tools applied by teachers in CBL programs (Pandy, Petrosino, Austin and Barr, 2004; Cooper and Niu, 2010; Bovill, Cook-Sather and Felten, 2011; O'Mahony et al., 2012; Membrillo-Hernández and García-García, 2020), identifying their specific goals. We propose to differentiate the techniques and tools for formative and for summative assessments, where "techniques" stand for the procedures used by teachers to collect information about student learning and "tools" stand for the instruments used to record information about student learning.

*Table 2. Summary of the main student learning assessment tools applied in CBL*

| Type | Technique | Instrument | Goal |
|---|---|---|---|
| Formative | Teamwork and individual monitoring | • Observation scales<br>• Diaries<br>• Checklists and Rubrics<br>• Tests or test exercises<br>• Questionnaires<br>• Schemes and Maps<br>• Debates with experts from training partners<br>• Role play or simulation | The monitoring of the individual work or the teamwork |
| | Self-assessment techniques (see paragraph 1.2) | • Observation scales<br>• Diaries<br>• Learning Contract<br>• Reflection Report | The improvement of the self-reflection skills |
| | Peer Evaluation | • Surveys<br>• Questionnaires<br>• Observation scales | The incentive of the peer learning and feedback |
| Summative | Final assessment | • Evidence portfolio<br>• Final Report<br>• Laboratory guides<br>• Oral, plastic or tangible production (device, prototype, etc.)<br>• Solution implementation activities<br>• Oral and written statement of the proposed solution<br>• Explanatory videos of the support of the proposed solution | The evaluation of the final results and the achieved knowledge |

## 3. The CHALLENGE APPROACH AT THE UNIVERSITY OF TRENTO AND THE Healthcare fund challenge

The University of Trento has a long-standing tradition in offering innovation challenges to its students, stakeholders, and companies. Challenge-based education programs are launched in collaboration with local and national for-profit and non-profit organizations and proposed to interdisciplinary and international teams, composing not only by students from the University of Trento, but also by participants coming from other HEIs. More recently these programs are opened to lifelong learners, professionals who care about their personal and professional development. Within the ECIU, the University of Trento has approached more and more challenges related to the SDG 11: “Make cities and human settlements inclusive, safe, resilient and sustainable”, in collaboration also with public administrations and communities.

In this chapter we will explain the recent **“**Healthcare Fund” challenge, a 6-week CBL extra-curricular initiative that has taken part in spring 2021 in the context of ECIU University. The challenge provider was Sanifonds, a private non-profit local integrative healthcare fund.

The challenge was built to support the company in finding new perspectives, including the development of new strategies to engage with customers in a fast-changing environment.

The University of Trento selected 15 students from Trento, the University of Stavanger and the University of Aveiro (all members in the ECIU alliance) and composed four mixed teams, following the criteria of different nationalities, disciplinary backgrounds, and gender balance.

Students were followed and supported by “team(c)hers”, which in the “ECIU jargon” designates instructors who mainly support teams as coaches rather than engaging in frontal teaching. They are first and foremost facilitators and guides in the challenge process. They select participants, create teams, welcome them to the challenge and provide all the support by employing a diversified and tailored series of methods, approaches and tools. They have also the function of guiding the interactions between students and the challenge provider and easing information exchange and meetings.

For this specific challenge, the main learning goals for students were related to 1) Teamwork: the capacity to work in a multidisciplinary and intercultural team; 2) Problem-solving: the capacity to redefine the challenge and solve it in a business sound way; 3) Applied knowledge: the learning by doing of Business model vocabulary, tools, and knowledge; 4) Communication: How to communicate effectively a project, and how to present it in front of the company; 5) Personal goal: every student was allowed to choose a specific personal goal, such as a technical or a soft skill they wanted to improve.

Due to Covid-19 restrictions, the Challenge was entirely organized online, pushing the full use of the emerging digital and smart technologies (Secundo et al. 2021), through social networks and collaborative platforms (Gupta and Bharadwaj, 2013).

We crafted a series of digital learning environments that enabled the educational challenge: teams interacted remotely through videoconferencing and could use collaborative virtual whiteboards on which to brainstorm, build their ideas and create prototypes and project blueprints. Classroom management was delivered through a shared folder with templates and instructions. The assessment part was entirely provided online through a series of shared documents and online surveys.

### 3.1. The three CBL phases in the Healthcare funds challenge

The Healthcare fund challenge was structured into three main parts, following the CBL steps used at the ECIU University (see Table 3):

- Phase 1 - Engage: this is the first step through which students were onboarded and introduced to the challenge work plan. All the participants, teachers, students and external partners were prompted on the challenge specifications, making sure that they had all the essential information on how to define the problem to be solved, ask the right questions, and agreed on the final challenge to work on.
- Phase 2 - Investigate: in this second step students were tasked to find relevant information and analyze it. They could collect second-hand data (such as expert and industry reports, articles in magazines and scientific journals, public agencies data, and so on) and embark on first-hand data collection (via interviews, online polls and surveys, fieldwork, etc.). Teams had to demonstrate that they have successfully addressed all of the questions and developed clear conclusions, setting the foundation for the solutions proposed in the next step. In this phase, they discussed their work advancements and discoveries with the challenge provider who gave feedback according to different criteria such as sustainability, project feasibility and readiness for the company, and so on.
- Phase 3 - Act: in this final step teams, starting from the shared knowledge previously gained, turned their insights and early stage proposals in a final project to showcase in front of all the teams, tea(m)chers and a panel of judges selected by the challenge provider, who has also to choose the winner of the challenge.

Transversal to all steps, teams could contact autonomously the challenge provider and other stakeholders to gather feedback on their progress and to guide subsequent teamwork.
Parallel to the three steps, mentorship was provided: the very first meetings were mandatory while along the pathway these consultations become recommended rather than compulsory. Some of the instructions were provided also by e-mail and by the use of shared folders. For each step, teams had to deliver an output to advance through the challenge and receive feedback from the team(c)hers and the challenge provider.
For the assessment part, individuals and teams had to deliver some outcomes (see section 3) at the beginning, during and after the challenge. We describe the three phases in the next sub-sections.

*Table 3. Three CBL phases in the Healthcare fund challenge and their assessment tools*

| **ECIU CBL steps** | **1. Engage** | **2. Investigate** | **3. Act** |
|---|---|---|---|
| **Activities** | • Problem definition and validation<br>• Emerging questions | • Data collection<br>• Fieldwork<br>• Interviews<br>• Surveys | • Solution validation and definition<br>• Design of the presentation |
| **Outputs** | • Redefinition of the Challenge | • First Project presentation | • Final Project |
| **Assessment tools** | • Learning Contract<br>• Team Outcome + Learning diary | • Team Outcome + Learning diary<br>• Peer Evaluation | • Team Outcome + Learning diary<br>• Reflection Report |

### 3.2. Engage phase

The Engage phase was the first step of the challenge, dedicated to have a better comprehension of the issue and the problem the challenge provider wanted to solve. Teams focused on exploring the challenge propositions according to a divergent approach: they collected information from the web, the literature, interviews, online polls and surveys, fieldwork, and so on in order to understand the key elements of the problem, the challenge provider market and possible competitors, by mobilizing all students' resources (prior knowledge, local contacts, personal networks, online and offline research, etc.). Participants worked in teams but, in this phase, open collaboration and sharing of results across teams were actively encouraged as means to increase learning about the problem by all participants and level the playing field for the subsequent steps.
The fact that teams were international helped in having a wide overview of the same problem in other countries and circumstances. Diversity played an important role in adding new information and in visualizing the same problem and challenge according to different perspectives. They could compare Sanifonds with similar entities in different regions/countries, by analyzing companies with similar business models, or with similar aims and mandates but different business models.
In this step, teams were asked to be very imaginative and not to jump to conclusions, but rather to focus on the problem and to provide as an outcome the redefinition of the challenge.
Extensive discussions were promoted through brainstorming techniques aimed to remove inhibitions and to share as many insights as possible, so as to build a rich constellation of ideas to be connected in later phases. In this stage, for managerial implications, teams needed to identify a team representative who was in charge to communicate with the tea(m)chers.
Students were surprised at first sight to experience new roles in teaching and learning and to familiarize themselves with an approach different from what they were used to. Team(c)hers did not tell students exactly what they had to do. On the way round, teams had to find out creative ways to explore all aspects connected to the challenge, the market, the company, possible competitors and alternative solutions available in the market, etc. In other words, participants needed to do a quick switch from the traditional student approach to a new proactive approach where they could find their own way to the goal.

### 3.3. The Investigate phase

From the second step, the competition started and teams worked without sharing any other information. In this step, teams were called to be disruptive and creative as much as possible in order to generate ideas and present them to the challenge provider in order to receive feedback and develop the solution in the third phase.
Teams were strongly recommended to use lateral thinking and brainstorming to develop new ideas and offer a wide range of proposals, from more traditional to more disruptive ones. The presentation of the ideas was in front of the challenge provider and it was another opportunity to ask for clarifications and information from the challenge provider.
After the presentation, Sanifonds had identified the ideas that in their eyes were more promising and assigned each team the task to go in more depth in one of the presented. They selected according to the competence team showed, the enthusiasm during the presentation and - of course - according to their needs. In order to be aligned with the challenge provider, teams had to be sure to correctly identify their needs and be effective in the presentation. Teams had to convince the challenge provider that they would be good at going in more depth in their project.
In addition to this presentation, in this phase teams had to provide the Peer Evaluation (see section 3.3).

### 3.4. The Act phase

The third phase was the final rush of the competition. Teams were focused to turn the project into a sound and applicable Business Proposal for the demo day. In this stage, strong validation was needed and teams could collect more evidence from different stakeholders.
In this phase, mentorship was recommended but non-mandatory. If teams needed to check the presentation before the demo day, they could show it to have inputs and suggestions. Otherwise, they presented it in front of the challenge provider.
The Demo day was dedicated to the presentation of the final project and the challenge provider had to evaluate it and rank the teams (see section 3.4).

## 4. THE ASSESSMENT AND THE SELF-DIRECTED APPROACH IN THE HEALTHCARE FUND CHALLENGE

In the Healthcare fund challenge, the University of Trento tested an integrated assessment structure in order to combine the summative assessment with the formative one, invite students to self-reflect on their learning process and achievements, allow students to become partly co-designers of the assessment, personalize the learning process in function of the students' learning needs, minimize misunderstandings and poorly communicated expectations, through a transparent sharing of the assessment process and attribute new roles to students and teachers.
Starting with these goals in mind, the assessment was built from the five learning goals proposed to students through the Learning Contract (see section 3.1):

1) Teamwork: the capacity to work in a multidisciplinary and intercultural team.
2) Problem-solving: the capacity to redefine the challenge and solve it in a business sound way.
3) Applied knowledge: the learning by doing of Business model vocabulary, tools, and knowledge.
4) Communication: How to communicate effectively your project, and how to present it in front of the challenge provider.
5) Personal goal: every student could choose a specific personal goal, such as a technical or soft skill.

We mixed formative with summative tools to evaluate the ongoing process and the achieved results of teams and individuals. The formative evaluation was composed of: the learning contract; the learning diaries and outcomes; the peer evaluation; the reflection report. The summative assessment was composed of the outcomes included in the learning diaries; the final projects (presented in front of the challenge provider).
Table 4 shows the assessment tools we used for the Healthcare fund challenge, explaining which are formative or summative ones, to whom they are addressed, who are the evaluators, the goal of each tool, the period in which the tool was proposed to participants and the outcome. In the following sections, we explore the selected tools in detail.

*Table 4. Assessment tools for the Healthcare fund challenge*

| Tool | Type | Recipient | Evaluator | Goal | Period | Outcome |
|---|---|---|---|---|---|---|
| Learning Agreement | Formative | Student | Team(c)hers | Co-design the learning process with students. Students can identify their learning goals and their strategies to achieve them | At the beginning of the Challenge | Completed and signed agreement |
| Learning diaries and outcomes | Formative | Team | Team(c)hers | Teams evaluate their teamwork | During the Challenge | One-pager and slide presentation |
| Peer Evaluation | Formative | Student | Student | Individual students evaluate their teammates and discuss in team | During the Challenge | Online surveys |
| Final Project | Summative | Team | Challenge provider | Teams present their final business idea | At the end of the Challenge | Final pitch |
| Reflection Report | Formative | Student | Team(c)hers | Students can evaluate if they achieved their learning goals and reflect about the experience | After the Challenge | 4-pages document |

### 4.1. The Learning Contract

The learning contract is an individual agreement negotiated between the team(c)hers and the students to ensure that certain activities are undertaken to achieve an identified learning goal (Knowles, 1986).

The learning contract was provided a week before the start of the Healthcare Fund Challenge and it was primarily a document that put the basis of the learning experience and could give a direction to students, since it clarified the learning goals and gave the chance to co-design partly the learning process, in becoming aware of the objectives and the expected results. Through the learning contract, students explored their readiness to learn and their self-directed learning skills. Students discovered their learning objectives, how they were going to be evaluated, and identified their learning goal too, choosing how they were going to assess their achievements.

Moreover, the learning contract matched with the final Reflection report (see section 3.5) and students could discuss critically if what they had expected, was really achieved or not, at what level and how.

It was composed by two parts: a first one in which benefits and responsibilities of students and responsibilities for team(c)hers were described; a second one in which a table summarized the learning goals and had to be completed by students:

- What are you going to learn? (Objectives): the first column contains the learning goals.
- How are you going to learn it? What do you have to do to meet each of the objectives defined? (Resources and Strategies): the second column explores the strategies and resources that students can mobilize in order to achieve the learning goals.

- How are you going to know that you learned it? What is the specific task that you have to complete to demonstrate learning? (Evidence): the third column identifies the tasks that the student has to put in place to achieve his/her objectives.
- How are you going to prove that you learned it? Who will receive the product of your learning and how will they evaluate it? (Verification): the fourth column is dedicated to the different modalities through which students are assessed.

**4.2. Learning diaries and outcomes**

Learning diaries and outcomes are one-pager reports delivered for each phase of the challenge and were introduced to evaluate the team's quality of work and understanding of the undergoing process. This tool allowed everyone to have a clear idea of what had been done so far, measure the temperature in the team, adjust the pace of every teammate, and refine the work progress.
In the learning diaries, teams evaluated how they were working by answering these four questions:

1) What went well so far in the teamwork during a specific phase? (strengths of their teamwork)? Here students can point out their teamwork strength points, such as good communication, good organization, good problem solving, great atmosphere, etc. and can include a practice example of what they had experienced in teams.
2) What did we learn as a team? This question means what are the lessons learned that could be useful in the next phase to climb up obstacles, as we learned that we need to coordinate better our work, we need to identify and assign feasible tasks for each step, etc.
3) What to improve in your teamwork in order to work better together? (weaknesses of their teamwork)? For this question, teams can identify their teamwork weak points, such as misunderstandings, overlapping, bad time management, etc. and can include a practice example of what they had experienced so far.
4) What will they put into practice (strategies to improve actions for the next steps)? Starting from the previous question, from the lessons learned, teams have to identify what they will do practically to work better as a team, such as they will start to share all their doubts at the beginning of each meeting, without waiting too much time and see it come bigger, they will try to coordinate their tasks in a better way, etc.

**4.3. Peer evaluation**

Peer evaluation was provided during the second phase of the Healthcare Fund Challenge. Peer evaluation is not so common in universities. Nevertheless, it has a great potential to strengthen the assessment capacities too by giving constructive and meaningful feedback to teammates and receiving back teammates' points of view. It is a way through which students can give feedback to their teammates and the other way around, experiencing important turning points of their experience.
Giving and receiving feedback to get things out in the open so that issues can be resolved and students can find ways to work together better. Moreover, regular feedback can prevent conflict from happening in the first place. Small issues can be resolved before they have a chance to escalate into something bigger.
In the Healthcare fund Challenge, feedback regarded a) the regular attendance of group meetings; b) the level of meaningful contribution to group discussions; c) the completion of group assignments on time; d) the quality of work; e) the cooperative and supportive attitude; and 6) the contribution to the success of the project. Students had to give votes from 1 to 5 for

each criterion to their teammates. A final open comment could be added by student addressed to the team.
As teams were multicultural and interdisciplinary, students met an enriching diversity that helped them open their mind and confront themselves with different ways of thinking.
The results of the peer review were sent to the teams, anonymously and in aggregate data, in order to not be able to identify the authors, and might be the subject of discussions in the teams. Mentors may facilitate these exchanges.
As a result of this evaluation, again some drop-outs happened and team(c)hers had to recompose the teams.

**4.4. The Final Project**
Each team presented the final project in 7-minute pitch in front of a mixed jury composed of the challenge provider and the team(c)hers. Teams receive an evaluation on the overall proposed solution, the match with the objective of the challenge and the need of the challenge provider, and the quality of the presentation and the Questions and Answers session.
Teams were ranked by the challenge provider according to the criteria. Every student received a completion certificate from ECIU and a reference letter from the challenge provider.

**4.5. The Reflection Report**
After the challenge, students had to write and provide a reflection report (Gibbs, 1988). This document had the aim to guide students through 6 stages to learn from the experience that they had just left behind them and give the chance to put some order, identify what went well and what did not go well, and plan their next actions. This individual report matched the student's learning contract (see section 3.1). The reflection report is divided into 6 steps:

1) Description: Here students have a chance to describe the challenge experience in detail. The main points to include here concern what happened. Feelings and conclusions come later.
2) Feelings: Here students explore any feelings or thoughts that they had during the challenge and how they may have impacted the experience.
3) Evaluation: Here students had a chance to evaluate what worked and what did not work in the challenge experience, trying to be as objective and honest as possible, and by focusing on both the positive and the negative aspects of the experience.
4) Analysis**:** The analysis step is where students can make sense of what happened. Up until now, they have focused on details around what happened. Now they have to extract meaning from it, targeting the different aspects that went well or poorly and asking themselves why.
5) Conclusions**:** In this section, students can make conclusions about what happened during the challenge. Here they specifically summarize their learning goals and highlight in what way they achieved them.
6) Action plan**:** At this step, students plan for what they would do differently in a similar or related experience in the future. It can also be extremely helpful to think about how they will help themselves to act differently: in that sense, students do not only plan what they will do differently, but also how they will make sure it happens. Sometimes just the realization is enough, but other times reminders might be helpful. That is why this last stage is called action plan.

## 5. LESSONS LEARNED AND FUTURE DIRECTIONS

Starting from the Healthcare Fund Challenge we identified some lessons learned which we offer as recommendations for future similar initiatives.

We had some drop-outs among the participants for different reasons: one student felt he couldn't tackle the challenge without more formal guidance from teachers. He explained he was used to having more structured directives from teachers. Another student decided to quit the team because she didn't find a strong motivation. Another one left the challenge in the middle because of miscomprehensions and different points of view with the teammates.

The first lesson is that students have to be accompanied and supported by the instructor in the new assessment approach, from the very beginning, if they are not familiar with educational formats which call for being responsible for their learning and assessment. Thus, they should not be left alone in this shift: they have to be convinced of the value to create their learning and then followed during the co-design of the experience so as to minimize the risk of drop-outs.

The second lesson is that the explanation of the new assessment structure has to be done at the very beginning of the initiative and the instructor has to guide the class in the redaction of the learning contract in order to answer all questions and to provide clarification and motivation.

The third lesson learned is the need to build a more structured assessment scaffold aligned with the learning pathway, but at the same time not to overburden the students' workload. It is fundamental to find a good balance between the proposition of the self-assessment tools and the teamwork required in order to finalize a sustainable solution corresponding to the challenge.

The fourth lesson learned is that the challenge provider too should be supported more during its learning process and provided by specific training in challenge-based learning, in order to be aligned with the challenge path. Moreover, the challenge provider too could experience the monitoring and the achieving of specific learning objectives, through defined self-assessment tools.

Apart from these general considerations, we would like to underline specific lessons learned for each assessment tool used in the Healthcare Fund Challenge.

### 5.1. The Learning Contract

For a 6-weeks learning program, five learning goals seemed too demanding, given the short time available to solve the challenge. It could be easier to focus on three learning goals, helping students in identifying their personal gaps or skills to develop and improve. If the learning format requires a test, it could be useful to keep skills from already tested and academically validated tools, such as the LifeComp (Sala et al., 2020) and EntreComp (Bacigalupo et al., 2016) categorization.

LifeComp is the European Framework for Personal, Social, and Learning to Learn Key Competence set up in 2018 by the Council Recommendation on Key Competences for Lifelong Learning. This framework identifies competences applying to all spheres of life that can be acquired through formal informal and non-formal education.

The EntreComp is the European Entrepreneurship Competence Framework that explains what is meant by an entrepreneurial mindset, offering a comprehensive description of the knowledge, skills and attitudes that people need to be entrepreneurial and create financial, cultural, or social value for others.

In the learning contract, one has to carefully match the learning goals with the different modules and challenge phases, otherwise, the disconnection between the initial learning agreement and the challenge path can increase over time, generating frustration or disengagement from the students. The learning contract should be completed in class, with the direct support of the

team(c)her in order to keep all questions and doubts and to avoid misunderstandings, since some students are well independent enough from the start, but others need to be supported from the very beginning.

### 5.2. Learning diaries and outcomes

Learning diaries should be flexible tools, not too hard to be completed and they need to support teamwork, rather than merely being another task in the to-do list. In that sense, these diaries should be presented as a keystone in the teamwork improvements, having a strong influence in the final result.

Students sometimes do not understand the sense of the reflection work in a challenge; they are focused on the final step and the solution and have difficulties in understanding the process as a whole.

Learning diaries should be designed to force participants to break from the workflow and reflect not so much on the final work, but on the "way of getting there". Here is an example of this shift of mindset made by a team from the Healthcare Fund Challenge, concerning the question "What went well so far in your teamwork?". In the first diary, they described how they produced the required outcome. After the team(c)her feedback, they started to reflect on how they worked and the teamwork process. Here is a quote from their last learning diary: "*On several occasions we encountered difficulties and contrasting ideas, but thanks to good and timely mediation we were able to resolve them and find a solution that would accommodate all the team members. It wasn't easy and at the beginning there were some misunderstandings but because of persistence and resilience we were able to overcome all the challenges. For example, when we were stuck on the App architecture design and the time was running out, as it was past midnight, the group maintained its cohesiveness, took a step back and redid the brainstorming process in order to determine what was not working*.

### 5.3. Peer evaluation

Before proposing this tool, team(c)hers were doubtfully and a little bit worried about the students' reactions. Against these expectations, the peer evaluation was generally considered very useful by participants, particularly since the tool delivered feedback to the final recipients anonymously and in aggregated form.

For this first experimentation, we returned to students only the final votes, avoiding the open comment addressed to the teams. For that, students asked us to communicate not only the final votes for each teammate but also the comments, in order to be much more transparent and responsible for their feedback to individuals and to the team.

In fact, some comments, if communicated, can motivate more the entire team, such as the following: "*In my opinion, our team is working pretty well. We have a good flow of communication, mainly because of our WhatsApp group and our folder on google drive. In addition, we are helping each other by making some exceptions (i.e. changing the time of a meeting). The women are incredible. Hope to be up to them*". Others can measure the real temperature in the team and bring out conflicts or misunderstanding, such as the next one: "*I think we need to be as a team. Right now, I don't feel that compassion in the team where I am*".

### 5.4. The Reflection Report

The reflection report was a comprehensive tool to reflect and discuss the whole challenge experience. We proposed a textual report, but we envisage using a more flexible and schematic document, in order to help students to reflect upon the experience without tasking them with a more demanding assignment, and motivating them to do a step more, even after the

experience. Often, students close an experience and start another without having enough time to extract meaningful content and lessons learned. Self-reflection in this sense can help students to deal with upcoming learning experiences with more awareness and a sense of having learned something useful for their personal and professional development.
In order to turn this useful tool from a textual document to a more agile one, we could use some graphics, schemes, and tables. For example, one student in the step 5 related to conclusions and having the aim of matching the initial Learning Contract with the final Reflection Report, included a self-evaluation score for each learning goal: for Learning Goal 4 "How to effectively communicate your project, and how to present it in front of the company", he gave himself a score of 4 out of 5, explaining "*A few months before the beginning of the challenge I took the academic IELTS and I can say that my biggest difficulty was in the oral part. Going into the challenge I already knew that I would have great difficulty communicating in English and, on top of that, I would feel the pressure of communicating with a company in that language. Despite this, I believe that I was able to express myself minimally well. This occurred thanks to the hours of preparation I decided to do before each presentation to practice what I was going to speak. Had I not done them, this grade would have been much worse. In addition, my setting and clothing were in keeping with what the occasion required*".
With regard to the initial learning goals identified in the learning contract, we can say that students perceived that they had achieved them, each at different levels. Particularly, students were concerned with developing and improving their capacity to work in international and multidisciplinary teams. Here are some extracts from a reflection report: "*This experience made me develop my teamwork skills and developed my linguistic and vocab competencies*." Participants were generally very focused on finding viable solutions to the initial challenge, applying their own knowledge and taking advantage of their networks. They appreciated the fact they had the opportunity to improve their communication skills, as reported in this Reflection Report's extract: "*Thanks also to the time Sanifonds dedicated us, I was able to sharpen my knowledge a make specific questions. From my team I learned a lot, and I also got the change to enjoy debating and arguing with them on all the topics we disagreed. What makes me feel improved in my teamwork skills is the fact that we were always able to find a solution in a way or another. Also, my communication skills got better as I used some tricks to force myself to listen more or communicate more effectively. I challenged myself to use less words possible or to count after somebody was talking, to see if they had something else to add. I also improved my presentations skills as we trained as a team*". Finally, most of the students underlined that he or she succeeded in achieving his or her personal goal, as mentioned, for instance, in the following report excerpt: "*My fifth learning goal actually came true! Starting in July, I will do an internship […]. The ECIU challenge made me feel secure about my problem-solving techniques and will hopefully help me to get a good start in my internship*."

**5.5. Future directions**

The Healthcare Fund challenge was not only an opportunity to experiment of new way of learning, but also a laboratory for an innovative way of teaching too. Team(c)hers were interested in improving gradually their attitudes with students and the challenge provider. For that reason, this challenge helped in identifying these possible future directions for the improvement of the assessment structure:

- Introduce the assessment of teaching for instructors too: as already mentioned, the challenge is a learning experience for all learners, including team(c)hers. That is why a specific and agile assessment for instructors is recommended, starting from the identification of learning objectives in a learning contract designed for team(c)hers. The

team(c)her could do a self-reflection after the experience through a specific final reflection report. Moreover, the team(c)her might receive feedback from students, the challenge provider, and other instructors involved in the challenge, according to the principles of peer evaluation.

- Integrate the assessment for challenge provider: challenge providers are learners too and can be included in the assessment experience. In this respect, an initial learning agreement and a final reflection report might represent simple but effective tools to enable self-reflection and the adoption of a lifelong learner mindset for challenge providers.
- Push further the assessment co-design with students: it is recommended to enable more and more students to partly design their learning experience, giving them a learning and assessment toolkit. Team(c)hers should guide strictly this process, supporting the autonomy of students regarding their learning experience.
- Develop further the students learning assessment performed by externals and challenge providers: challenge providers and external experts could give useful feedback related not only to the final output but also to the personal and social competences. This kind of constructive feedback might improve the linkages of students with the job market and the professional dimension.
- Test the correlation between self-assessment and some personal skills such as the meta-cognitive ability (level of awareness that the student has about his/her knowledge and the techniques that allow him/her to learn better, such as: attention, memory, perception, reasoning). Another interesting skill to test with the introduction of self-directed learning could be the meta-affectivity which describes the ability to be aware of the emotional states experienced during learning and to use emotional regulation strategies to convert negative states to positive ones for better learning.

## 6. Conclusion

Challenge-Based Learning is a great opportunity to innovate the teaching and learning experience at Higher Education Institutions and their ecosystems. Experiential learning can be effective among all learners of the learning process, from traditional students to lifelong learners, from instructors to companies, stakeholders, and finally communities.

Much work can be done to push further this cultural shift from the traditional classroom to a more innovative way to teach and learn.

Evaluation in CBL is still an underdeveloped topic, but it is gathering consensus through various experimentations of different assessment approaches, related to self-reflection and critical thinking abilities. The aim of this chapter was not only to inspire but also to give suggestions and tools for novel ways of assessing the learning process in CBL and we welcome future research extending the range of instruments and validating the effectiveness of such an approach on participants engagement, motivation and learning.

## ACKNOWLEDGMENTS

The authors gratefully acknowledge a grant from the ECIU University project. We would like to express our very great appreciation to the partners' universities of ECIU for sharing the CBL, their best practices, and for pushing for innovative ways of teaching and learning.

We would like to express our special thanks to Sanifonds for getting involved as challenge provider and for showing motivation and support to students.

## REFERENCES

Bacigalupo, M., Kampylis, P., Punie, Y. and Van den Brande, G. (2016), EntreComp: The entrepreneurship competence framework. Luxembourg: Publication Office of the European Union.

Bovill, C., Cook-Sather, A., & Felten, P. (2011). Students as co-creators of teaching approaches, course design, and curricula: Implications for academic developers. International Journal for Academic Development, 16(2), 133–145. https://doi.org/10.1080/1360144X.2011.568690

Cook-Sather, A., Bovill, C., & Felten, P. (2014). Engaging students as partners in learning and teaching: a guide for faculty. San Francisco: Jossey-Bass.

Cooper, G., & Niu, R. (2010). Assessing international learning: A mixed methodological approach to assessing curricular and extracurricular international experiences. The Journal of General Education, 59(3), 159–171. https://doi.org/10.1353/jge.2010.0016

Dewey, J. (1933). How We Think: A Restatement of the Relation of Reflective Thinking to the Educative Process. Boston, MA: D.C. Heath & Co Publishers (original work published 1910).

Duffy, M. D., & Raymer, P. L, (2010). A Practical Guide and a Constructivist Rationale for Inquiry-Based Learning, Educational Technology, 50(4), 3-15. Retrieved from: https://www.jstor.org/stable/44429836

Gardner, H. E. (1999). Intelligence Reframed: Multiple Intelligences for the 21st Century, New York, NY: Basic Books.

Gibbs, G. (1988). Learning by Doing: A guide to teaching and learning methods. Further Education Unit. Oxford: Oxford Polytechnic.

Gupta, N. and Bharadwaj, S.S. (2013), Agility in business school education through the richness and reach: a conceptual model, Education and Training, Vol. 55 No. 4, pp. 370-384.

Hammond, M. & Collins, R. (1991). Self-directed learning: Critical practice. London: Kogan Page Limited.

Healey, M., Flint, A., & Harrington, K. (2016). Students as Partners: Reflections on a Conceptual Model, Teaching & Learning Inquiry, 4(2): 1-13. doi:10.20343/teachlearninqu.4.2.3

Knowles, M. (1986). Using learning contracts: Practical approaches to individualizing and structuring learning. London: JosseyBass Publications.

Kohn Rådberg, K., Lundqvist, U., Malmqvist, J., & Hagvall Svensson, O. (2020). From CDIO to challenge-based learning experiences–expanding student learning as well as societal impact? European Journal of Engineering Education, 45(1), 22-37. doi:10.1080/03043797.2018.1441265

Kolb, D.A., (2014). Experiential learning: Experience as the source of learning and development. FT press.

Malmqvist, J., Kohn Rådberg K., and Lundqvist U. (2015). Comparative Analysis of Challenge-based Learning Experiences. In Proceedings of the 11th International CDIO Conference, Chengdu University of Information Technology, Chengdu, Sichuan, PR China (pp. 87-94).

Membrillo-Hernández, J., & García-García, R. (2020). Challenge-Based Learning (CBL) in engineering: Which evaluation instruments are best suited to evaluate CBL experiences? 2020 IEEE Global Engineering Education Conference (EDUCON), 885-893. doi: 10.1109/EDUCON45650.2020.9125364.

Mercer-Mapstone, L., Dvorakova, S. L., Matthews, K. E., Abbot, S., Cheng, B., Felten, P., Knorr, K., Marquis, E., Shammas, R., & Swaim, K. (2017). A Systematic Literature Review of

Students as Partners in Higher Education. International Journal for Students as Partners. 1(1). doi:10.15173/ijsap.v1i1.3119.

Ní Bheoláin, R., Lowney, R., & O'Riordan, F. (2020). Students as partners in assessment (SaPiA): a literature scoping review. Dublin: Dublin City University. doi:10.5281/zenodo.4270579

Nichols, M., & Cator, K. (2008). Challenge Based Learning White Paper. Cupertino, California: Apple, Inc.

Nichols, M., Cator, K., & Torres, M. (2016). Challenge Based Learner User Guide. Redwood City, CA: Digital Promise.

O'Mahony, T. K., Vye, N. J., Bransford, J. D., Sanders, E. A., Stevens, R., Stephens, R. D., Richey, M. C., Lin, K. Y., & Soleiman, M.K., 2012. A Comparison of Lecture-Based and Challenge-Based Learning in a Workplace Setting: Course Designs, Patterns of Interactivity, and Learning Outcomes. Journal of the Learning Sciences 21(1), 182–206. doi:10.1080/10508406.2011.611775

Observatory Tecnológico of Educational de Monterrey (2015). Edu Trends: Challenge Based Learning, Oct. 2015, Observatory Tecnológico of Educational de Monterrey.

Pandy, M. G., Petrosino, A. J., Austin, B. A., & Barr, R. E. (2004). Assessing Adaptive Expertise in Undergraduate Biomechanics. Journal of Engineering Education, 93, 211–222. doi:10.1002/j.2168-9830.2004.tb00808.x

Piaget, J. (1950). The Psychology of Intelligence. New York: Routledge.

Sala, A., Punie, Y., Garkov, V. & Cabrera, M. (2020). LifeComp: The European Framework for Personal, Social and Learning to Learn Key Competence, Luxembourg: Publications Office of the European Union. doi:10.2760/922681

Secundo, G., Mele G., Del Vecchio P., Elia G., Margherita A., Ndou V. (2021), Threat or opportunity? A case study of digital-enabled redesign of entrepreneurship education in the COVID-19 emergency, Technological Forecasting and Social Change, 166(1): 120565.

Swiden, C. L. (2013). Effects of challenge-based learning on student motivation and achievement, Montana State University. Retrieved from: https://scholarworks.montana.edu/xmlui/bitstream/handle/1/2817/SwidenC0813.pdf;sequence=1

Vignoli, M., Balboni, B., Cotoranu, A., Dosi, C., Glisoni, N., Kohler, K., Mincolelli, G., Mäkinen, S., Nordberg, M., & Thong, C. (2021). Inspiring the future change-makers: reflections and ways forward from the Challenge-Based Innovation experiment. CERN IdeaSquare Journal of Experimental Innovation, 5(1), 1-4. doi:10.23726/cij.2021.1323

Vygotsky, L. S., & Cole, M. (1978). Mind in Society: Development of Higher Psychological Processes. Boston, Massachusetts: Harvard University Press.

World Economic Forum (2020), The Future of Jobs Report 2020. Retrieved from: http://www3.weforum.org/docs/WEF_Future_of_Jobs_2020.pdf

Yang, Z., Zhou, Y., Chung, J. W., Tang, Q., Jiang, L., & Wong, T. K. (2018). Challenge Based Learning nurtures creative thinking: An evaluative study. Nurse education today, 71, 40-47. doi:10.1016/j.nedt.2018.09.004