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EVALUATING EMPOWERMENT CHANGE OF STUDENTS IN A CHALLENGE-BASED LEARNING ENVIRONMENT

By

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Evaluating empowerment change of students in a Challenge-based Learning environment

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MASTER THESIS INFO	ABSTRACT
	New educational models are being adopted in higher education to prepare students for the future labor market. One example is Challenge-based learning. This educational model aims at empowering students and teaching them to acquire the 21st century skills needed. In this research, the empowerment change of students in a real CBL course in higher education institution is evaluated and discussed, using the "Learner empowerment measure" consisting of a survey. This survey has been taken at four different points in time, in which a set of items address the empowerment score of each student. Additionally, interviews have been carried out to study if and how the CBL course structure affected these scores throughout a real-life CBL experience. Results from the surveys show almost no change in the empowerment throughout the course, while during the interviews students expressed empowerment changes. From the interviews, in fact, it emerged that CBL characteristics such as dealing with a real-life challenge, real-life client and scoping their own work positively affected their empowerment over time, by sensitizing students' engagement and putting higher but constructive pressure. Nevertheless, the lack of technical guidance and the excess of freedom given to students, because of CBL, led the team to face team problems in the structurization of the working sessions. Once these problems were fixed, empowerment scores raised but not enough time was left to the end of the course, leading the CBL benefits to not be fully experienced by students.

1. Introduction

Nowadays, sustainability is recognized as one of the most important development drivers of current society and it is included in the international and national strategies of almost all organizations (Nilashi et al. , 2019). In fact, in the last decade, a frequent claim has been that the traditional economic models need to be reformed to address climate change, biodiversity losses, water scarcity, etc., while at the same time addressing key social and economic challenges (Soderholm, 2020). These, in turn, will lead companies to seek for new sustainability-related knowledge to be acquired among their employees and students seeking for a job. Nevertheless, sustainability is not the only current driver to be taken into consideration when getting prepared for future labor market. Today, many professionals work in a climate of continual change and innovation, and these are expected to keep being core characteristics of the future labor market. These characteristics reflect influential trends such as industry 4.0, interconnectivity, globalization, and the need for collaboration and cross disciplinary (Pompa, 2015). To meet all these challenges head on and remain competitive in the workplace, professionals and students need to be content experts, as well as highly skilled problem solvers, team players, and lifelong learners (Dunlap, 2005). According to the World Economic Forum, some other core skills that will be demanded in the future labor market will be complex problem-solving, cognitive abilities such as creativity, and process skills such as critical thinking (World Economic Forum, 2016). In brief, it becomes fundamental for students and professionals to acquire these skills that are considered as futureproof. For this reason, innovative courses are being adopted in the last decades, especially in higher education, with the aim of preparing students for the next decades. One way to design these innovative courses is to let students come across a challenge for a protracted period. This promising educational approach is called Challenge-based learning.

Challenge Based Learning provides an efficient and effective framework for learning while solving real-world Challenges (Torres et al., 2016). Through CBL, students have the opportunity to focus on deepening the

comprehension of a specific subject, clearly define a real-life problem and determine an open-ended solution to that problem, but also work in a multidisciplinary environment in which communication skills are ought to be strengthened, together with the relationship between the students themselves and real-life experts in the field (Escamila et al., 2015). Some studies discuss about CBL from a theoretical point of view. Torres et al. (2016), for instance, provide a user guide with background information, key concepts, and resources for getting started with Challenge based learning (Torres et al., 2016). A literature review has also been carried out by Leijon M. et al., mapping patterns in research on Challenge Based Learning (CBL) in higher education (HE) between 2009 and 2020. Two core questions are addressed, namely "How is CBL defined in Higher Education settings?" and "How is CBL in Higher education grounded scientifically in research?" (Leijon et al., 2021). Other studies investigate real CBL case studies given in different institutions, as in the case of Malmqvist J. et al., who compared four CBL experiences, providing an overview and a comparison among the main characteristics of these experiences and identifying also lacks and improvement strategies per each of them (Malmqvist et al., 2015). Each of these case studies is carried in a different structure between one and another. Some CBL courses, for instance, provide lectures while others comprise also interviews, or presentations, or discussion sessions etc. demonstrating that CBL course design can vary from one to another. In the same way, the assessment method for understanding the level of development of students is not unique. Some studies, in fact, propose new assessment methodologies, as the study case of Tecnologico de Monterrey (Caratozzolo & Membrillo-Hernandez, 2020). In general, traditional methods of assessment might prove inappropriate for measuring what students learn in a challenge-based learning project (Educase Learning Initiative, 2012). However, one possible efficient way to do so is by measuring the empowerment of its stakeholders.

Different definitions can be addressed to the concept of empowerment. For instance, it can be defined as a direct result of individuals learning to utilize appropriate skills (Brunton & Lynn, 2014) or as *the process of creating intrinsic task motivation by providing an environment and tasks which increase one's feeling of self-efficacy and energy* (Thomas & Velthouse, 1990)*. Empowered individuals, in this case students, can consider varied perspectives, negotiate with others, amend policies as needed as they can think independently, make their own decisions thoughtfully and with reference to relevant information, and act on that knowledge* (Broom, 2015). Empowerment can be divided into four dimensions, namely meaningfulness, competence, impact, and choice (Frymier et al., 1996). Given the aim of CBL to furnish the 21st century skills, through an evaluation of how an individual improves on these four dimensions, it might be possible to acknowledge the level of effectiveness of a CBL experience on that individual from an empowerment point of view. An empowered student is supposedly a student that benefitted from a CBL experience.

Nevertheless, it is not yet sure how and if CBL really empowers (and to which extent) the stakeholders involved in it, and what might cause the empowerment changes over time during the experience. In general, evidence on efficiency of CBL is scarce. In fact, CBL experiences have been tested in different scenarios within academic institutions, but these studies do not present results ought to measure in a direct way the empowerment levels, as defined by Frymier. Therefore, the present study investigates a real case study of CBL experience, a housing project, through the lenses of empowerment concept. By doing so, the study attempts to answer a main research question: "*What empowerment change in the stakeholders is observed in a Challenge based learning educational model?".* To answer this, it first should be first questioned "*To which extent can the housing project be considered as a Challenge base learning environment?".* Hence, scores should be assessed by questioning *"What is the change on empowerment scores of the stakeholders in the housing project?".* Finally, results are contextualized and explained by questioning *"Can a relation be observed between the empowerment change and the design of a Challenge based learning educational model such as the housing project? How can this relation be explained?".*

To address this aim, first a deeper theoretical overview of CBL and empowerment concepts is provided, then the housing project is assessed through the lenses of CBL, to understand to which extent, it can be considered as such. Subsequently, the empowerment levels of students involved in the housing project, assessed in four points in time through a proven tool called "Learner empowerment measure" (Frymier et al., 1996) are presented. The changes in these datasets are monitored and discussed. Finally, these results are evaluated against the main characteristics of the course structure design, finding possible explanations and links between empowerment scores and course structure.

2. Theoretical background

In this section, a more in-depth theoretical knowledge is provided in relation to CBL, empowerment and the connection between these two concepts. For this purpose, a thematic content analysis is carried out, using knowledge sources, namely papers and academic reports. A descriptive presentation of qualitative data is provided.

2.1 Challenge based learning

2.1.1 CBL: Definition

The concept of Challenge-based learning can be addressed to three main definitions in literature. Below, an overview is given in table 1 below.

Definition 1: (Torres et al., 2016)	*Challenge-based learning is an effective learning framework initiated at Apple, Inc. and used in universities, schools, and institutions around the world. The framework empowers Learners (students, teachers, administrators, and community members) to address local and global Challenges while acquiring content knowledge in math, science, social studies, language arts, medicine, technology, engineering, computer science and the arts.*
Definition 2: (Torres et al., 2016)	*Challenge-based learning is an approach providing an efficient and effective framework for learning while solving real-world challenges. The framework is collaborative and hands-on, asking all participants (students, teachers, families, and community members) to identify Big Ideas, ask good questions, discover, and solve Challenges, gain in-depth subject area knowledge, develop 21st-century skills, and share their thoughts with the world.*
Definition 3: (Leijon et al., 2021)	*Challenge Based Learning is an engaging multidisciplinary approach to teaching and learning that encourages students to leverage the technology they use in their daily lives to solve real-world problems. Challenge Based Learning is collaborative and hands-on, asking students to work with peers, teachers, and experts in their communities and around the world to ask good questions, develop deeper subject area knowledge, accept, and solve challenges, take action, and share their experience*

Table 1: Challenge based learning definitions

The first definition emphasizes the pedagogic purposes of CBL, focusing on the different academic disciplines that are supposed to be involved in the learning process of the participants. The second definition emphasizes the approach that participants are supposed to enact, focusing therefore on the pragmatic aspect of CBL. The third definition focuses, again, on the approach that is supposed to be enacted by participants.

Similarities and differences among these three definitions can be identified. All three definitions remark the presence of a multitude of stakeholders, belonging both to academic institutions, working sector or community. The concept of learning is clearly putted in the foreground as considered the main objective of CBL. In the same way, all three definitions highlight the presence of a problem or challenge belonging to the real world, which is ought to be the key factor fostering the learning process. In the first definition both words *local* and *global* suggest an application of CBL also on large-scale problems. The second and third definitions do not clarify this specific aspect but suggest that results from a CBL experience should be shared with the world. Another element to consider is the temporal contextualization. By introducing the word *21st century,*

the second definition includes the context for which CBL is ought to be applied, being it this new century. In fact, the demand for the skills to be acquired through CBL is tailor made on the new needs emerged in the working field. Finally, it should be noted how the third definition introduces the words *accept the challenge.* Although it should go without saying that participants should accept the challenge, remarking this aspect indicates how participants are supposed to put in place the right mental approach for fronting a challenge. Including all the elements constituting the definition of CBL in the three versions, the following definition in table 2 is proposed.

Proposed definition	*Challenge-based learning is a learning framework used in universities, schools, and institutions around the world. This framework aims at empowering Learners (students, teachers, administrators, and community members) to address local and global Challenges while acquiring content knowledge in math, science, social studies, language arts, medicine, technology, engineering, computer science and the arts. The framework asks participant to accept and solve a real-world challenge, by identifying Big Ideas, asking good questions, discovering, gaining in-depth subject area knowledge, developing 21st-century skills, and sharing their thoughts with the world.*

Table 2: Proposed definition of Challenge based learning

By proposing this definition, an alignment between possible different interpretations of CBL definitions is being attempted. The aim of proposing this alignment is to properly address, in one concise period, all the very basic ingredients that build up a challenge-based learning project/course, through the lenses of empowerment. Therefore, this definition results to be more functional and tailor-made for the study.

2.1.2   CBL: Origins

In literature, it seems to be not clear whether Challenge-based learning emerged from a specific event in a specific point in time or is a natural consequence of previous similar frameworks. Torres et al. address the origin of challenge-based learning to the "Apple Classrooms of Tomorrow-Today", a project initiated by Apple in 2008 whose objective was to identify the essential design principles of a 21st century learning environment. However, Torres et al. point out that, even in that case, still challenge-based origins could be addressed to experiential learning (Torres et al., 2016). Experiential Learning is an integrated holistic approach to learning, which combines experience, cognition, and behavior (Escamila et al., 2015). Escamilla J. et al. confirmed the relation between challenge-based learning and experiential learning, remarking the common aspects of these two pedagogic methodologies, being those 1) the opportunity for participants of learning from real-case contexts, 2) facing problems and 3) discovering solutions on their own (Escamila et al., 2015).

However, it should be noted that other pedagogic methodologies, such as problem-based learning, inquiry-based learning, entrepreneurial learning, self-regulated learning, organizational double-loop learning, and authentic learning have been considered as precursors of challenge-based learning. Leijon et al. pointed out, therefore, that challenge-based learning derives from these methodologies dealing with cognitive, constructive, and socio-cultural perspectives where learning is active, relational, practical, and situated within both the individual and the organization (Leijon et al., 2021).

Mamqvist et al., however, considered problem-based learning as the main precursor of challenge-based learning, with the last one addressing a higher level of challenges, namely challenges enriched with a societal perspective (Malmqvist et al., 2015). Another difference between challenge-based learning and problem-based learning is that the disciplines needed to solve a challenge, in CBL, are not known prior to the start of the project. Additionally, in CBL, the solution should not only be proposed, but also implemented.

2.1.3   CBL: Main distinctive characteristics

The main aspects that characterize a CBL experience, given the different literature sources, already presented in the previous chapters, can be summed up in the following elements:

1. Presence of a **real- life challenge** to solve: CBL environments originate from an authentic challenge, referring to resembling or being derived from activities of real-world professionals to allow also for challenges that could emerge in the future (Van den Beemt et al., 2022). In fact, the focus is on global ideas, meaningful challenges, and the development of local and age-appropriate solutions (Torres et al., 2016).

2. **Collaborative learning**: students, teachers, professionals, clients, companies, and other possible participants that might help in solving the challenge are not only welcome in the process but are supposed to be pro-actively included. However, the group of students is the one in charge of carrying out the workflow, being them the main learners. Ideally, CBL implies working in an iterative cyclical way in team, these cycles consist of divergent and convergent reasoning. Divergent reasoning includes a variety of perspectives and solutions, while convergent reasoning brings focus and priority to this variety (Van den Beemt et al., 2022). In fact, working in collaborative groups helps students acquire critical life skills, teacher who have implemented CBL in teams report that collaboration with other teachers is one of the most beneficial and enjoyable aspects of the approach (Torres et al., 2016).

3. **Open-ended solution**: in CBL environments, the challenges allow students to discover both a problem and a solution, allowing varying solution paths. These varying solution paths emerge from the complexity that arises when something is impossible to analyze with simple frameworks, which in turn can be understood as a call for bringing together multiple fields of expertise and epistemologies (Van den Beemt et al., 2022). What really matters is that the solution is developed, useable and implemented through feedbacks (Torres et al., 2016).

4. **Multidisciplinary approach**: CBL facilitates students from different (sub-)disciplines to learn to work in a team. Their interdisciplinary interactions can be seen as attempts to integrate heterogeneous knowledge bases and knowledge-making practices. Interdisciplinarity thus requires some level of integration between fields of expertise (Van den Beemt et al., 2022).

5. **Different way of coaching for the teacher:** CBL involves adaptive teacher and expert guidance of the construction of knowledge by students. Given the open-ended and ill-defined character of challenges, educators act most often as a coach rather than an instructor (Van den Beemt et al., 2022). Moreover, teachers are also supposed to become learners (part of the team) and demonstrate behaviors expected of students (Torres et al., 2016)

6. **Focus 21st century skills:** In CBL environments, students are supposed to get 21st century skills, being those: (1) Cognitive skills: nonroutine problem solving, critical thinking, systems thinking; (2) Interpersonal skills: complex communication, social skills, team-work, cultural sensitivity, dealing with diversity; and (3) Intrapersonal skills: self-management, time management, self-development, self-regulation, adaptability, executive functioning (Koenig, 2011). When analyzing the role of the teacher, in fact, the task is to facilitate students with standard-based content and connecting it to 21st century content skills throughout the process (Torres et al., 2016).

2.1.4   CBL: Main benefits

Challenge-based learning is acknowledged to be a pedagogic methodology bringing benefits to its participants. Torres et al. stress out the importance of challenge-based learning in meeting those major needs demanded from learners all over the world, being those the capacity of moving to the next level and eventually enter the world as a productive member of society. However, the benefits of participating to a Challenge-based learning are extended to the possibility of attaining the 21st century skills, achieving a long-life learning approach and making an immediate impact on the world (Torres et al., 2016).

Escamilla et al. described the major benefits of challenge-based learning, stressing out how CBL is ought to let students acquire a deeper comprehension of the subject they are studying, by fostering the capability to

diagnose and define problems prior to suggesting solutions, through creativity. In fact, more involvement in the definition and solution to the problem is supposed to be enhanced. While solving the problem, students in CBL experiences can develop research processes and create/implement models. Considering that in CBL participants come from a variety of study faculties, a better capability to work in multidisciplinary and collaborative environments is encouraged. As CBL experiences aim to solve real-life problems, students are likely to interact with experts and, in general, with people involved in their area, thus they get more involved in their local communities. This relationship with experts is also ought to contribute to their personal growth. Considering that a variety of interactions with different people is needed to solve the problem, communication skills are strengthened and overall, the relation between theory and practice gets more meaningful, with students being exposed to a better perception of the reality (Escamila et al., 2015).

Nevertheless, putting in practice a CBL course does not mean that these outcomes are automatically experienced by participants. A high level of success of a CBL experience, however, might indicate that these benefits can be experienced to a high extent. Thus, it is important to reflect on how a CBL can be considered as successful. A three-levels scheme can be used to address this aim: 1) implementation success, focusing on the process of using CBL, how well that went for teachers and students whether the challenge was completed, and how teachers and students perceived the impact of the solutions; 2) Instructional Success, which primarily focuses on how well the approach worked with the required curricula, the teacher's own teaching goals, and how well CBL meshed with the ebb and flow of the classroom; and 3) Student success, which is the most important and addresses the following questions: Did they develop or improve key 21st century skills such as media literacy, creativity, innovation, teamwork, collaboration, and critical thinking? Were they flexible and adaptable? Did they show leadership and assume responsibility? Did they effectively utilize technology? Did they learn more than was required? Did the solution impact their community? (Johnson & Adams, 2011).

2.1.5   CBL: Course structure

As far as the course/project characteristics are concerned, in challenge-based learning environments there is not a unique workflow or framework that is supposed to be mandatory adopted to consider it as challenge-based learning. However, different proposals of challenge-based environments can be identified. Torres et al., for example, described some characteristics of the course/project design that can be addressed to a challenge-based learning environment. For Torres et al., Challenge Based Learning environment should provide:

- A flexible and customizable framework that can be implemented as a guiding pedagogy or integrated with other progressive approaches to learning.
- A scalable model with multiple points of entry and the ability to start small and build big,
- A free and open system with no proprietary ideas, products, or subscriptions.
- A process that places all Learners in charge, and responsible for the learning.
- An authentic environment for meeting academic standards and making deeper connections with content.
- A focus on global ideas, meaningful Challenges, and the development of local and age-appropriate Solutions
- An authentic relationship between academic disciplines and real-world experience.
- A framework to develop 21st-century skills
- Purposeful use of technology for researching, analyzing, organizing, collaborating, networking, communicating, publishing, and reflecting.
- The opportunity for Learners to make a difference now.
- A way to document and assess both the learning process and products.
- An environment for deep reflection on teaching and learning.

(Torres et al., 2016).

In terms of workflow, Torres et al. argue that three main interconnected phases are put in place: engage, investigate, and act. These phases should be then documented and enriched with reflections and sharing of knowledge among participants. Below figure 1 shows the three phases.

Figure 1: Challenge based learning: phases.

While Torres et al. divide the challenge-based learning into three phases, when analyzing the project initiated by Apple in 2008, a precise framework can be identified, as highlighted by Escamilla et al. This framework can be divided into a set of tasks to accomplish by the participants. The tasks are the following:

- **General idea:** participants discuss about a topic that can be explored in multiple ways and has societal impact.
- **Essential question:** after brainstorming about a general idea, participants can determine a major question that is accepted by the community and can be furtherly investigated.
- **Challenge:** The challenge is designed to address the general idea and the essential questions using local actions.
- **Guiding questions:** They are generated by the participants and represent the necessary knowledge to develop a successful solution, and they provide a roadmap for the learning process.
- **Solution:** When it comes to the solution, participants are supposed to find unfold the problem in a thoughtful way, leading to a solution that is clearly stated and feasible
- Implementation: in this stage participants try to add value to the solution, depending on the resources at disposition.
- **Evaluation:** Results given from the solution should be evaluated both formally and informally. The teacher performs this phase.
- **Validation:** With the use of quantitative and qualitative methods, participants in this stage validate the solution. Typical methodologies for data collection are surveys and interviews. Teachers and experts play a vital role in this stage.
- **Documentation:** a learning portfolio is ought to record the whole process, with a particular emphasis on sharing the knowledge achieved with the world.
- **Reflection and discussion:** Much of the deeper learning takes places during this stage, as students reflect on their own learning, their relationship with the content, concepts and experience, and their interaction with other people.

Another framework that can be addressed to a challenge-based learning environment has been proposed by the Engineering Research Center VaNTH ERC, comprising the Vanderbilt, Northwetern Texas, Harvard and MIT universities. Cordray D. et al. discuss how in 2000 these institutions integrated two different frameworks,

named "How People Learn" and "Software Technology Action Reflection Legacy Cycle (STAR)", originating the "Challenge Based Instruction" (Cordray et al., 2013).

The HPL is based on four principles related to learning, namely:
1) Information given in an appropriate manner,
2) Content relevant to students,
3) Formative feedback between students and teacher, and
4) Environment being community centered.

The STAR is based on a cycle, whose elements are:
- Challenge
- Generate ideas
- Multiple perspectives
- Research and revise
- Test your mettle
- Go public.

The challenge-based instruction originated by these two frameworks founds its principles on inductive learning method with real challenges and is ought to empower participants and give them the capability to transfer their knowledge from one context to another (Escamila et al., 2015).

2.1.6   CBL: Reflections
Given the overview of Challenge-based learning, some reflections can be made in relation to the research objective.

With the world facing new global challenges, such as pandemics or geopolitical conflicts, the labor market is one of the very first societal components that (sensitively) gets transformed and re-designed, demonstrating that obsolescence can impend the working field very often. The new century workers, therefore, need to be not only technically, but also mentally prepared for a fast-changing and high level of uncertainty world. However, the productivity of people is the engine of the economical world system. Thus, making sure that future employees and employers will always be ready to re-invent themselves by learning fast and in uncomfortable conditions becomes fundamental in this new paradigm. As it is possible to acknowledge from the research presented in this section, challenge-based learning re-thinks and re-builds the whole process of learning, focusing also on the person's attributes rather than furnishing the simple technical knowledge needed for a specific course. In fact, Membrillo-Hernandez et al. (2019) discuss the components of CBL that make a real difference in the real world. By examining real case-studios, they found out that the main difference between having a school-controlled challenge and a highly undefined challenge developed at an industrial plant is the level of uncertainty about solving the problem(s). A lot of factors were evident in their study; for example, cross-disciplinary skills, such as teamwork (collaboration), critical thinking, ethics, problem-solving, planning ahead and resilience were observed (Membrillo-Hernandez et al., 2019). Given the evidence of CBL benefits, it becomes important to focus on every case-studies, evaluate how students perceive this new pedagogical experience, evaluate their empowerment level throughout the time and making reflections on how the course design affects the empowerment of students. In fact, the success of the CBL experiences studied by Membrillo-Hernandez et al. lies in how the process has been structured, with industrial companies acting as training partners. The same results might not have been accomplished without this aspect of the experience.

In conclusion, this theoretical background about challenge-based learning confirms, on the one hand, that there is a significant potential of this educational model, mainly for the following aspects that emerged:

- It has its roots in other proven educational models.
- Proposals have already been made on how to structure a possible CBL experience, facilitating its introduction and implementation in higher educations all over the world.
- Benefits that are expected to be experienced are clearly defined and supposedly effective for the new era.

However, on the other hand, it also emerged that in literature there is no clear alignment on how to uniquely define, conduct and design a CBL project, as different sources provide different points of view. This is confirmed by case-studies (analyzed and discussed in the next sections of the research), highlighting different approaches of CBL applications. Being it a newly designed educational approach, it is though reasonable that different perspectives are being considered, given the short academic history of CBL applications. However, the student housing project offers the context to investigate CBL from an empowerment perspective, as previously pointed out, and this content analysis about CBL theory can work as ground base for an appropriate contextualization of the empowerment results.

2.2 Empowerment

Empowerment is strictly related to the concept of power. When considering an empowering and an empowered subject, power can be distinguished in *power-over, power-with* and *power-to*, as argued by Sullivan (2015). Power-over can be considered as a negative force of power in form of domination that results in a sense of powerlessness on an individual, power-with is a positive force of power, established through an equal relationship between empowering and empowered subjects, power-to exists when an individual perceives he/she has the ability or capability to act (Ashcroft, 1987). Sullivan argues that power-over and power-with operate in interpersonal sphere, whereas power-to operates in intrapersonal sphere. *In the classroom, teachers by the very nature of their position have power-over students and are left to decide how they use or exert their power. Teachers who choose to enable student empowerment can share authority or power with students to establish positive forces of power, that is power-with and power-to* (Sullivan, 2002).

These definitions of power are important as they stress that empowerment originates in an environment in which there is a relationship between teacher and students or, if contextualized to the working field, manager-employees. The concept of empowerment can be addressed to different definitions in literature. Some definitions focus on the academic contexts whereas other definitions enrich its applicability to other contexts. An overview is below provided.

In broad terms, empowerment feelings can be addressed to those individuals who feel they *have the ability to enact social, political, economic, or other change; to manage or to influence others; and/ or to engage in actions that influence others* (Broom, 2015). This definition acknowledges empowerment as closely related to self-efficacy and can be contextualized not only to an academic environment, with a focus on the students, but mostly to the whole world's social context and, therefore, with the focus on (all) individuals. In fact, Broom (2015) argued that *empowered individuals can consider varied perspectives, negotiate with others, amend policies as needed as they can think independently, make their own decisions thoughtfully and with reference to relevant information, and act on that knowledge.* Hence, from this point of view, empowerment can be seen as a key driver towards a higher-level democracy, as stated by the author. In the same way, a broad definition of empowerment is *people or groups gaining control over their own lives and the decisions that affected them* (Kreisberg, 1992). In this case, the relationship between an individual and the community plays a main role, as the effects of empowerment are supposed to make sense only when contextualized within the society.

In 1990, empowerment has been defined as *the process of creating intrinsic task motivation by providing an environment and tasks which increase one's feeling of self-efficacy and energy* (Thomas & Velthouse, 1990). Empowerment has been acknowledged as *the humanistic process of adopting the values and practicing the behaviors of enlightened self-interest so that personal and organizational goals may be aligned in a way that promotes growth, learning, and fulfillment* (Luechauer & Shulman, 1993). This definition implies that a

communication relationship is necessary between empowering and empowered subjects and has been thought for being contextualized both to an educational environment, where there is a teacher-student relationship, but also to a working field environment, where there is a manager-employee relationship, as argued by Frymier et al. (1996).

Brunton et al. argue that empowerment *is a direct result of individuals learning to utilize appropriate skills*, basing this definition upon the idea that *as individuals gain control and mastery over their lives and learn to utilize skills for influencing life events, they become empowered* (Zimmerman, 1990). However, the authors evaluated the concept of empowerment in relation, specifically, to a study concerning the empowerment of international students in academic institutions. In this study, they acknowledge that empowerment is directly associated with factors such as prior knowledge, relevance, belongingness, and cultural distance.

Taking into consideration the different definitions of empowerment, it should be noted that in all cases empowerment derives from intrinsic and long-life "improvements" acquired from an individual, and the consequences of these improvements have a direct effect on the society's facets, such as political or economic ones. These effects triggered by empowered learners are ought to bring positive change, leading to the idea that the more empowered learners there are, the better for the societal advancement.

In relation to challenge-based learning the effects of empowerment that mostly should be emphasized are the ones concerning the impact of students on the working field, considering that challenge-based learning is ought to empower students and prepare them for the 21st century skills to be acquired in the professional field. It should be noted that the study conducted by Frymier builds its foundations on an empowerment definition that has been previously conceived within the working field. For this reason, the concept of empowerment as it is investigated by Frymier, based on the previous study conducted by Thomas and Velthouse, matches the context of challenge-based learning, being it an educational model highly connected to the working field.

In Frymier's study, empowerment has been conceptualized as a four-dimensional phenomenon referred to job tasks, namely meaningfulness, competence, impact, and choice. Meaningfulness considers the value of a task in relation to one's own beliefs, ideals, and standards. The stronger a task fits into an individual's or group's value system, the more conviction will be brought to bear in accomplishing it. If the work is not meaningful now or not deemed to be useful later, learners will not be motivated to generate high quality work (Frymier et al., 1996). Competence means that the person feels qualified and capable to perform the necessary activities to achieve the goal. The feelings of empowerment are lessened when individuals lack self-confidence in their skills and feel intimidated by the task or goal. Impact means that the accomplishment of a task is perceived to make a difference in the scheme of things. The more impact individuals believe they have, the more internal motivation they should feel. Choice refers to the degree to which persons self-determine their task goals or methods for accomplishing them (Frymier et al., 1996).

In his study, Frymier developed the "Learner Empowerment measure". This instrument is based on Schultz and Shulman's (1993) empowerment scale and then refined and optimized. It consisted, initially, of thirty-eight Likert-type items questionnaire. These items are addressed to the four dimensions of empowerment, namely impact, choice, competence, and meaningfulness. Specifically, ten items reflecting meaningfulness, ten items reflecting competence, ten items reflecting impact and eight items reflecting choice. Participants were asked to address a score per each item, from "never" to "very often", and a factor analysis was carried out to observe what correlations exist between the four dimensions. As a result of a factor analysis, it was found out that only three of the four dimensions emerge as factors, these being impact, meaningfulness, competence. These dimensions resulted to be positively correlated between each other and results proved that are interdependent and summative. Additionally, it emerged that three of the a priori items did not load to the factors (one on competence and two on choice) and could therefore be excluded from the list. Thus, the total amount of items to take into consideration is thirty-five. In conclusion, it is possible to establish that a person does not have to experience all three dimensions to gain some level of empowerment: low in one

and high in other two would indicate a moderate level of empowerment. This means that, to draw a conclusion about the empowerment level of participants, it can be observed how participants score on these different dimensions. Below, figure 1 presents the original "Learner empowerment measure".

EMPOWERMENT MEASURE FACTOR ANALYSIS

Impact
1. I have the power to make a difference in how things are done in this class.
*2. I have a choice in the methods I can use to perform my work.
3. My participation is important to the success of this class.
*4. I have freedom to choose among options in this class.
5. I can make an impact on the way things are run in this class.
*6. Alternative approaches to learning are encouraged in this class.
7. I have the opportunity to contribute to the learning of others in this class.
*8. I have the opportunity to make important decisions in this class.
9. I cannot influence what happens in this class.
10. I have the power to create a supportive learning environment in this class.
11. My contribution to this class makes no difference.
*12. I can determine how tasks can be performed.
13. I make a difference in the learning that goes on in this class.
*14. I have no freedom to choose in this class.
15. I can influence the instructor.
16. I feel appreciated in this class.

Meaningfulness
1. The tasks required of me in this class are personally meaningful.
2. I look forward to going to this class.
3. This class is exciting.
4. This class is boring.
5. This class is interesting.
6. The tasks required of me in this class are valuable to me.
7. The information in this class is useful.
8. This course will help me achieve my future goals.
9. The tasks required in this course are a waste of my time.
10. This class is not important to me.

Competence
1. I feel confident that I can adequately perform my duties.
2. I feel intimidated by what is required of me in this class.
3. I possess the necessary skills to perform successfully in class.
4. I feel unable to do the work in this class.
5. I believe that I am capable of achieving my goals in this class.
6. I have faith in my ability to do well in this class.
7. I have the qualifications to succeed in this class.
8. I lack confidence in my ability to perform the tasks in this class.
9. I feel very competent in this class.

*Indicates an *a priori* choice dimension item.

Figure 2: Learner empowerment measure by Frymier et al. (1996)

The "learner empowerment measure" can therefore be considered as a proven instrument for evaluating the empowerment levels of students involved in a project.

2.3 Challenge based learning and empowerment

Empowerment is not a concept to be addressed solely to CBL but, in general, to all environments in which there is an "empowering-empowered" phenomenon-type among participants. Hence, the relation between empowerment and CBL is not explicit and exclusive. However, it can be inferred by analyzing CBL experiences through the lenses of empowerment, and connections between these two concepts can be detected. Below, three significative examples of CBL experiences are discussed with the aim of understanding the connection between CBL and empowerment.

Case one: University of Western Australia's Global Challenges in Engineering

The University of Western Australia sets a challenge-based learning course, in Civil Engineering, named "Global Challenges in Engineering". Students are asked to carry out a real project within geopolitical context in collaboration with a non-government organization.

The course aims to develop a large number of learning outcomes including communication, enquiry & literacy, teamwork & project management, cultural and gender diversity, critical thinking related to environmental, legal, ethical, health and safety impacts of engineering, environmental, social and economic context in which engineering is practice, and design processes including creative thinking, evaluation, failure modes assessment (Malmqvist et al., 2015). The course design has been structured over lectures, workshops, presentations, and reports. In summary, the Global Challenges in Engineering course demonstrate that first-year engineering students can successfully take on projects with both technical and societal components in faraway countries (Malmqvist et al., 2015).

From an empowerment point of view, assuming that learning outcomes of this CBL course are met, as declared by the author, participants are then supposed to have become better communicators and team workers, as more critical in their thinking and they are also supposed to get more inclusive in their way of relating to colleagues. Considering the items of the learner empowerment measure (figure 1), some reflections can be made. In fact, communication and teamwork might be connected to the impact, as improvements on these characteristics might have made it possible for participants to progress on their way of influencing the others and, therefore, be more impactful on a project. Considering the impact items, students of this CBL study would likely have experienced a progress in the scores. Nevertheless, this cannot be demonstrated because, as already pointed out, the relation between CBL and empowerment is not exclusive and explicit. In the same way, teamwork and gender diversity might be addressed to meaningfulness items, as building relations with colleagues/acquaintances, and getting involved in an inclusive way might have positively affected how participants perceive the time spent on the project, and the project itself, as meaningful for them. Critical thinking and inquiry can be addressed to competence, as these are typical skills that might have improved the qualification of a student for carrying out tasks.

Case two: Purdue University's EPICS program

The EPICS (Engineering Projects in Community Services) program has been operated by Purdue University in the US since 1995. The program offers a framework by which teams of undergraduates from different disciplines collaborate to "design, build, and deploy real systems to solve engineering-based problems for local community service and education organizations" (Malmqvist et al., 2015).

The course aims to develop design-build-test skills, teamwork and communication, project planning & leadership, customer-awareness and understanding of ethical, economic, and legal issues. The course design has been structured over weekly lectures on design, ethics, empathy, interviewing & observation, leadership and prototyping/craftsmanship and deliverables per week.

As for case one, reflections can be made assuming that learning outcomes have been met. In fact, improvements on teamwork, communication and leadership might positively affect the impact of a student on the project. By acquiring good communicational skills, coupled with better teamworking approach and leadership, a student might have more possibility to influence the progress of a project. Teamwork, however, can also be important for engaging the students and let them perceive the project as more meaningful for them. Finally, getting knowledge related to project planning or customer awareness, coupled with the understanding of legal, ethical, and economic issues certainly raises the competence in students for accomplishing the tasks required.

Case 3: Tec21 of Tecnologico de Monterrey

The Tec21 is an educational model carried out by the Tecnologico de Monterrey University. This educational model is based on challenge-based learning and the objective is to prepare students for 21st century skills required in the working field. The programme consisted in students managing and monitoring the electrical energy efficiency in smart microgrids, in collaboration with experts in the energy sector. The activities are divided into four stages, namely 1) theoretical training, 2) visit the site, 3) work session, and 4) final presentation (Caratozzolo & Membrillo-Hernandez, 2020).

Students participating to the Tec21 are supposed to acquire both hard skills and soft skills. The hard skills concern tasks related to the energy management and assessment such as preliminary energy diagnoses, scheduling and operations or analysis of data. The soft skills developed are teamworking, leadership and communication.

Caratozzolo et al. (2020) developed an evaluation system for measuring the level of competences acquired by the students. The competences, in this study, are 1) problem-solving, 2) collaborative work, and 3) disciplinary competence of Engineering in sustainable development. Different evaluation instruments have been used and results have been presented and, per each competence, different indicators for their development on students have been identified. For instance, the indicators for collaborative work are effective communication of ideas and proposal, and active participation of the phased of the group work.

A satisfaction survey showed that more than 80% of students appreciated that they could test their abilities, knowledge, resistance to frustration and teamwork. This result proves that the project has been meaningful to students, engaging their attention and interest. Furthermore, the competences evaluated might be related to all the dimensions of empowerment. In fact, problem solving development might affect how a student impacts on the project and furnishes a competence useful for solving the tasks required. Collaborative work, in the same way, affects how meaningful the project could be for a student and disciplinary competence of engineering in sustainable development concerns the technical knowledge required, therefore it is closely related to the competence dimension of empowerment.

In conclusion, these case-studies highlight how empowerment and CBL can be related to each other, however they confirm that further research needs to be carried out to make this connection more explicit. The absence of a common way of evaluating CBL experiences makes it difficult to really understand and measure its benefits on students. Nevertheless, literature gives the opportunity, as shown, to use these case studies as examples of how empowerment, and its measurement, can strengthen the validity of CBL, furnishing a methodic and proven criteria of assessment through tools such as the "Learner empowerment measure".

3. Method
3.1 Research overview

The present study is an ethnography research-type, conducted in three steps and focusing on small-scale study that yields knowledge that can be generalized to a lesser extent, aiming at achieving a depth typology of knowledge. Both quantitative data and qualitative data are needed to accomplish the objective. Considering that the results are based on a real case-study, empirical data are furnished. To sum-up, the0020following overall characteristics of the research are addressed, as shown in table 3 below.

RESEARCH BOUNDARIES	RESEARCH APPROACH	RESEARCH TYPOLOGY	RESEARCH STRATEGY
Depth view of the research objective	Qualitative/quantitative	Empirical	Ethnography research

Table 3: Main research characteristics

A Challenge-based course related to a housing project, being it part it of a wider educational program constituted the context of the study. In this project, the Executive Board of a Public Higher Education Institution is the client, whereas another Higher Education institution carried out project. Further information about the project context and method used for data retrieval and data analysis in the three phases is below provided.

3.2 Study case: The new Smart academic program and the housing project

A new course with a duration of a semester and twenty-five ECTS is an academic program run by a Higher Education Institution, consisting in groups of students, tutors, researchers, and professionals tackling the sustainability issue by working on real-case challenges and, at the same time, improving useful skills to be more prepared to impact with the labor market. The academic ambitions of this new academic program, in fact, are:

- Letting students get more familiar with sustainability.
- Developing research skills.
- Fostering interdisciplinary collaboration.
- Building and sharing knowledge.
- Developing entrepreneurial capacity.

The activities are coordinated and carried out by a Learning Community, made of labor professionals, tutors, researchers, and students. The learning community is divided into sub-communities, each of them dealing with a specific sector from the labor market, such as: circularity in infrastructure and living environment, circularity and digitalization for assets, smart energy transition etc. Every learning sub-community focuses on different projects every year. In the academic year 2021/2022, the learning community "circularity in infrastructure and living environment" collaborated with the client on the following projects:

- Housing project.
- Sustainable bridge.

A third project, still related to the Civil Engineering field, has been carried out by the community but without the participation of the client. Each of these projects presents a challenge to tackle, it being related to sustainability and circularity issue within the construction industry. The students participating in these projects have been chosen from different study programs. As open-ended projects, the participants have been given the freedom to propose the planning of the project, choose their own approach to tackle the challenge and choose what typology of deliverable to hand in by the end of the semester (meeting, though, some minimum requirements set by the clients). These aspects are supposed to be beneficial for the stimulation of the students, together with their personal development and preparation for the labor market. Students have been divided into three groups, each of them addressed to one of the three abovementioned projects. Within this study, the focus has been only on the housing project, below introduced.

3.2.1 The housing project: overview

The client requested support in looking for a possibility to realize a modular, easy to change, multifunctional facility to be placed permanently at the Campus of the client. The motivation for this housing facility is the shortage of student housing that occurred in the last years, and which is expected to increase in the coming years if no action is taken. The Executive Board of the client works both on a structural supply of student housing and on flexible solutions for the peak period. The shortage is highest in the period of mid-August till mid-October (the peak period). The facility is meant for temporary housing for students in these peak months. In addition, the client organizes several big events during the year such as lustrum festivities, Christmas receptions for staff, and festivals. For these events, large tents are temporarily placed on campus and taken down again after the event. Possibly, the housing facility can be used for these activities as well. The minimum requirements to be met for the project are the following:

- Definition of project Plan, intended use, location advice and concept design.
- The facility should meet Circularity principles.
- Estimation of the investment costs (CAPEX) and operational costs (OPEX).
- Accommodation purposes of the housing facility should satisfy a demand of 50/200 people in the peak period.

- In non-peak period, the housing facility should be used for the following activities: academic meetings, exams spaces, recreational activities, social and cultural projects, and other possible uses.

The housing project is characterized by a bilateral nature: a technical one and an academic one. The technical nature is related to the deliverables to be handed in by the end of the semester (advisory report and concept design), whereas the academic one is aligned to the goal of the Smart academic program, introduced in the previous paragraph. In this study, only the academic aspect of the housing project is taken into consideration, in the sense that the deliverables and their content do not fall within the scope. Therefore, from an academic point of view, the following major characteristics can be observed in the housing project:

- The housing project aims at solving a real-world challenge.
- The participants of the housing project are students, tutors, active client, and professionals deriving from different study fields (multidisciplinary environment).
- The housing project aims at making participants learn from each other.
- The participants of the housing project have the freedom to think creatively and bring their personal ideas in.
- The participants of the housing project are invited to reflect on their personal academic growth.
- The housing project is an open-ended project.

The housing project has been carried out in twelve weeks by a team of six students, comprising the researcher. The researcher, acting as a team leader, is enrolled at client's institution, while the rest of the team is enrolled at another Higher Education Institution. The team is multidisciplinary as students come from different academic backgrounds.

3.2.2   Housing project: pre-start settings

Before the project start, two online meetings have been set between all students and tutors of the community. Every team has been addressed to one tutor. Tutors provided the basic information to students for getting started with the project and introduced them to the Microsoft Teams environment, showing how it should have been used for internal communication among team members, file sharing and external communication between team members and tutors/experts/community.

Online meetings have been set as the main form of communication between students, except for a fixed scheduled weekly face-to-face meeting between students and the assigned tutor, at Higher Education institution facility in the Netherlands. The researcher and one of the team members did not have the possibility to ever be part of the face-to-face meetings, being them resident respectively in Italy and in another city in the Netherlands. Therefore, their relationship with tutor and other team members has been limited to online meetings. Once the set-up concluded, the team officially started working on the housing project.

3.3 Data collection and data analysis

This study is conducted in three practice-oriented steps, each of them addressing a research question. Further information about the methodology used to collect and analyze data in these three steps is below provided.

3.3.1   Step one: The housing project as CBL

Phase one of the study addresses the question *"To which extent can the housing project be considered as a Challenge base learning environment?".* To answer this question, the study focuses on CBL main distinctive characteristics, listed in section 2.1.3, and through an observation of the housing project structure, a qualitative reflection is proposed. This observation aims at qualitatively assessing if and to which extent the housing project reflects those six detected characteristics, namely real-life challenge, collaborative learning,

open-ended solution, multidisciplinary approach, newly teaching/coaching approach, focus on 21st skills. To do so, the housing project is assessed using the six characteristics as criteria and a qualitative score is addressed per each criterion. The scores are "low", "medium-low"," medium"," medium-high", and "high". Finally, a general reflection based on the overall average score is proposed.

3.3.2   Step two: Empowerment measurement

Step two of the study addresses the question "*What is the change on empowerment scores of the stakeholders in the housing project?".* In the case of the housing project, Frymier's Learner empowerment measure is given to the participants in three points in time, namely after the scheduled group presentations to the community. An additional fourth questionnaire is given at the start of the new academic year, to evaluate possible long-term effects. The questionnaire is integrated with four open-ended questions related to some characteristics of the course such as the presence of a real-life client or the own scoping of the project. In this way, more insights can be retrieved by letting students express themselves in a more personal and open way, and more reflections can arise in the analysis of results. In general, the questionnaire refers to the level of empowerment experienced until the time in which the questionnaire is given, therefore it is addressed to an entire period and not to a specific time shot or class as in the original instrument proposed by Frymier. Hence, the first three surveys are addressed to periods marking the completion of achievements in the project progress. Considering that students have been asked to deliver an advisory report and a 3D model, these three moments are identified as follows:

1. Completion of a draft version of the advisory report, in which students are supposed to have worked on a first significant part of the final deliverable, but still without complete feedback and from the tutor and client. In this way, the first assessment refers to the period in which students are free to propose the product they think is best.

2. Completion of full advisory report, in which the work has been assessed based on client's and tutor's opinions, and students are supposed to have confronted their work with the expectations of the client and tutor. In this second scenario, the period refers to students realizing the mistakes done and reflecting on improvements to apply.

3. Completion of 3D model, for which a visualization of the advisory report is brought to life, and students can better present and discuss their ideas to the client, tutors, and the rest of the learning community (students and other tutors from the semester course). This third assessment refers to the period in which the final step must be done, with supposedly a pick of pressure felt in the last few days, and then cleared away after the final presentation to the community.

Since the housing project does not consist in classes, the word "class" has been changed in "course". Moreover, since the role of instructor is not contemplated, the closest figure, being a guidance in a similar way of an instructor is the researcher himself, acting as team leader for the project and explaining/assigning the tasks to be accomplished along the process. Therefore, the word "instructor" has been changed in "team leader". The Learner Empowerment measure, adapted to the housing project environment, is shown in table 5 below.

Item 1: impact	I have the power to make a difference in how things are done in this course.
Item 2: impact	I have a choice in the methods I can use to perform my work.
Item 3: impact	My participation is important to the success of this course.
Item 4: impact	I have freedom to choose among options in this course.
Item 5: impact	I can make an impact on the way things are run in this course.
Item 6: impact	Alternative approaches to learning are encouraged in this course.
Item 7: impact	I have the opportunity to contribute to the learning of others in this course.
Item 8: impact	I have the opportunity to make important decisions in this course.
Item 9: impact	I cannot influence what happens in this course.
Item 10: impact	I have the power to create a supportive learning environment in this course.
Item 11: impact	My contribution to this course makes no difference.

Item 12: impact	I can determine how tasks can be performed.
Item 13: impact	I make a difference in the learning that goes on in this course.
Item 14: impact	I have no freedom to choose in this course.
Item 15: impact	I can influence the team leader.
Item 16: impact	I feel appreciated in this course.
Item 17: meaningfulness	The tasks required of me in this course are personally meaningful.
Item 18: meaningfulness	I look forward to participating to the meetings of this course
Item 19: meaningfulness	This course is exciting.
Item 20: meaningfulness	This course is boring.
Item 21: meaningfulness	This course is interesting.
Item 22: meaningfulness	The tasks required of me in this course are valuable to me.
Item 23: meaningfulness	The information in this course is useful.
Item 24: meaningfulness	This course will help me achieve my future goals.
Item 25: meaningfulness	The tasks required in this course are a waste of my time.
Item 26: meaningfulness	This course is not important to me.
Item 27: competence	I feel confident that I can adequately perform my duties.
Item 28: competence	I feel intimidated by what is required of me in this course.
Item 29: competence	I possess the necessary skills to perform successfully in this course.
Item 30: competence	I feel unable to do the work in this course.
Item 31: competence	I believe that I am capable of achieving my goals in this course.
Item 32: competence	I have faith in my ability to do well in this course.
Item 33: competence	I have the qualifications to succeed in this course.
Item 34: competence	I lack confidence in my ability to perform the tasks in this course.
Item 35: competence	I feel very competent in this course.
Item 36: open-ended	How do you experience the fact that there is a real-life client in this course?
Item 37: open-ended	This course is a complex open-ended project, in which there is not a unique and correct solution to the problem. How do you experience this aspect?
Item 38: open-ended	In this project the teacher does not steer on the content to be delivered, but he/she acts only as a coach that oversees the process. How do you experience this aspect?
Item 39: open-ended	In this course, students have to scope their own project through a self-guidance approach. How do you experience this aspect?

Table 4: Learner empowerment measure adapted to the housing project.

By using Microsoft forms, it is possible to collect the responses in an Excel file. To investigate the change in the scores for each participant, graphs have been elaborated. In each graph, the scores "never", "rarely", "sometimes", "very often" have been addressed, respectively, to the numbers 1,2,3, 4 to simplify a quantitative comparison of the data set in the different points in time. Nevertheless, it should be noted that not all the items from the tool are positively correlated to the concept of empowerment. Items 9, 11, 14, 20, 25, 26, 28, 30, 34 are, in fact, negatively related to the concept of empowerment, meaning that a higher score results in a lower empowerment. Therefore, the scores from these items have been inverted, with "very often" addressed to the value 1, and "never" addressed to the value 4. Finally, graphs are presented and discussed in the results section.

3.3.3   Step three: interviews

Step three of the study addresses the question "*Can a relation be observed between the empowerment change and the design of a Challenge based learning educational model such as the housing project? How can this relation be explained?".* With this question, the study attempts to find possible explanations to the change of empowerment scores of participants over time (from results of step two), investigating whether the causes of empowerment variation can be addressed to how the housing project, being it a challenged based learning environment, has been designed. To accomplish this task, two interviews with the participants are set, through an online meeting, after the second and third questionnaires being given.

The overall strategy is to start with an open question to let the participant feel free to give his/her personal explanations, and then, in case the participant furnished a very limited answer or was not able to elaborate any answer, the researcher guided the participant towards possible explanations related to the characteristics of the course structure. Below, an example is provided:

- **Introduction**: The researcher starts the interview with a brief introduction on what changes on empowerment level have been observed in the two data sets retrieved. For example, "I saw your empowerment has changed on meaningfulness/impact/competence dimension.

- **Explanation of the change**: After the introduction, the researcher, based on the change observed, explains what the practical implication of that change observed means. In this way, the participant can properly understand what the change is about with user-friendly words. For instance, if a change has been observed on the impact dimension, the introduction is complemented with "…Due to this change, it means that you find yourself more impactful on the project, in the sense that you felt more able, with the time, to make the difference and contribute more to the project".

- **Open question:** Once highlighted the change observed and its' implications, the researcher formulates a broad and simple open question, namely "Why do you think this happened? What do you think an explanation might be to this change?"

- **Guiding the participant:** If the participant is not able to elaborate an answer, or his/her answer is very limited and vague, the researcher suggests possible explanations to that change, related to the course design, for example with the question "does this have to do with the face-to-face meetings with the tutor over the last month?".

- **Getting more insights:** Based on the answer of the participant, the researcher tries to get more insights by letting the participant elaborate more, for instance by asking "How the face-to face meetings with the tutor over the last month made you feel?".

Being this an open question interview, it is not possible to predict all the possible answers and prepare specific a priori questions to ask, per each of the possible answers given. However, by keeping in mind the objective of the interview, the guidance questions that could arise from every answer, keep the focus in finding possible connections with the course design. Findings are presented in the results section.

4. Results
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5. Discussion
Given results of step two and step three, some considerations can be provided. Explanations to the empowerment change have been identified in relation to the CBL characteristics. Nevertheless, these explanations are followingly confronted with literature about CBL and empowerment, already summed up in the theoretical background section, to understand the meaning of results.

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6. Limitations
Results of empowerment scores have been analyzed and discussed in the previous section. Although some explanations arose, still some limiting factors should be putted into account.

The first limitation is given by the fluctuations of the empowerment. It should be noted, in fact, that the fluctuations might be considered as too little to be really contextualized to what emerged from the

interviews. In fact, fluctuations at group level show almost no change. Hence, it should be questioned if empowerment scores can really be relevant, given the objective of the research.

A second limitation is represented by the very low number of students observed and monitored in the research. Statistically speaking, in fact, five students represent a very restricted pool of subjects to work on and retrieve statistically relevant results.

A third limitation is represented by the bias of the researcher. Being this ethnography research, all the observations and interpretation of results are inevitably affected by the researcher point of view, which might not be close enough to the reality and, also in this case, validity of results can be contested.

A fourth limitation is represented by the team leader considering himself as a teacher. This might supposedly have affected results of the surveys as one of its' items deals with the relationship with the teacher. However, the relationship between students and the university teacher did not diverge form the relationship between students and the team leader. Thus, upon agreement and opinion of students, results have not been compromised.

One last limitation is represented by the time spawn occurred between surveys. In fact, the first survey has been given after eight weeks, but the second and third surveys have been given just with a two-week difference from one to another, raising doubts whether these periods could be considered as enough for the validity of results.

7. Conclusions

Given that challenge-based learning and empowerment are two relatable concepts, the present study aimed at assessing (and monitoring) the empowerment levels of students in a real CBL case-study and identifying possible relations between course design and empowerment. Four surveys provided the data sets to identify possible explanations to the empowerment levels experienced, furtherly investigated through one-on-one interviews explaining the causes of some patterns observed at group level.

Results from the surveys show almost no change, on every dimension and in every phase of the project. However, from the interviews it emerged that students felt important changes throughout the course, that have not been consistently expressed in the surveys. The explanation to these changes shows that Challenge-based learning characteristics such as real-life challenge (and real-life client), collaborative learning and open-end solution can stimulate students by putting constructive pressure and giving them the freedom to figure out on their own the aspects to improve in the way of organizing the work. However, the time limits of the course and the lack of practice, from students, to work in this new educational model resulted to be a limiting factor in their overall empowerment, raising the question whether CBL can be efficient if experienced in only one course, rather than being experienced in more courses, so that students can get really used to it.

This study showed that the real-life challenge positively contributed to student perception of the possible real-life application of the report to be delivered, whereas dealing with a real-life client raised the pressure in the pre-presentation periods. Both these aspects positively contributed to the impact and the engagement perceived during the course, explaining an increase in impact and meaningfulness scores. Collaborative learning contributed to the understanding of how to relate to other people and structure a working session based on an efficient share of knowledge, namely optimizing the time spent in working individually and the time spent in group for aligning all team members on the new findings. Also in this case, improvements on empowerment level have been experienced in consequence of a better application of CBL characteristics. In fact, in result of this better collaboration, also the open-end solution and scoping the own project, typical characteristics of CBL experiences, assumed more sense and offered the possibility to figure out the best way

of accomplishing tasks and bring more value to the project. This fostered empowerment feelings on all dimensions. Finally, the better structurization of working sessions raised the level of multidisciplinary environment, avoiding a sense of dependency on technical guidance by the university, fostering an empowering environment.

8. Recommendations

The housing project highlighted some gaps that could be bridged with further research. The first gap is represented by lack of a tailor-made tool that could evaluate, in a schematic way, the empowerment specifically in relation to CBL characteristics. As the learner empowerment measure by Frymier has been designed for a generic course, interviews and open-end questions had to be integrated. However, it should be questioned *"Is a new tailor-made tool needed to assess empowerment level in CBL participants? If so, how would this tool look like? What is the direct relation between empowerment dimensions and CBL characteristics?".* The tool helped only until a certain extent. A bridge, in fact, had to be built between the objective of the tool (measuring the simple empowerment) and the objective of the research (explain the empowerment through CBL lenses). This bridge is represented mainly by the researcher intuition who led the interview based on his idea of the link between CBL and empowerment. Nevertheless, this represents an obstacle to research as the bias of the researcher might lead to wrong results.

Another gap is represented by the lack, in CBL literature, of a proper investigation about the relation between lectures, workshops etc. and the concept of challenge. Therefore, some questions arise: "*Should the presence of technical guidance from the institution be considered as mandatory in a CBL experience? I the absence of technical guidance to be considered as part of the challenge itself? ".* In the housing project, the lack of technical guidance represented an obstacle to students' advancements and empowerment. Although in the final phase of the project students managed their work in the way that technical guidance was not needed anymore, the time left to the end of the course was too little for getting more benefits from this new way of working.

This leads, in turn, to the final gap to be possibly investigated, namely the lack of a consistent CBL experience throughout a whole academic path in Higher Education. In fact, results from the research show that students needed a lot of time, in proportion to the time-length of the course, to get used to this new educational model. Nevertheless, when they finally got used to it, they started showing improvements in their empowerment. Therefore, it should be investigated what could possibly be the empowerment changes, given by CBL, if students experience it not only in one course, but in several courses throughout a whole academic path in Higher Education.

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