ENTER-CBL

Boosting Entrepreneurial Mindset of Students with Challenge-Based Learning

CBL Methodology explained

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Boosting Entrepreneurial Mindset
of Students with Challenge-Based Learning

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CHALLENGE BASED LEARNING

This booklet provides an overview of Challenge Based Learning (CBL) methodologies, diverse application fields, collaborative practices, and essential steps in executing successful CBL projects.

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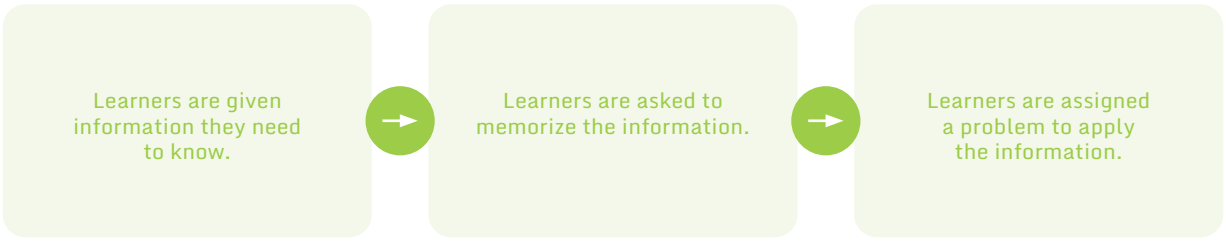
1. CHAPTER 1 Introduction to Challenge-Based Learning

Presently, educational models often lag behind real-world requirements, prompting educators to seek new methodologies. CBL diverges from traditional teaching approaches by embracing a multi-disciplinary, collaborative, and experiential methodology. It empowers learners to actively engage with real-world issues, leveraging technology as a tool to devise solutions.

CBL is collaborative and hands-on, asking students to work with other students, their teachers, and experts in their communities and around the world to develop a deeper knowledge of the subjects' students are studying, accept and solve challenges, take action, share their experience, and enter into a global discussion about important issues (Apple, 2008). CBL, a derivative of problem-based learning (PBL), prompts learners to employ their acquired knowledge in addressing authentic real-world problems.

Most importantly, for CBL, the objective is not to solve the problem itself but to use it for the development of learning, competencies, and the final product, it can be tangible or, a proposal for a solution to the challenge.

Traditional Learning



Challenge-Based Learning at ToU

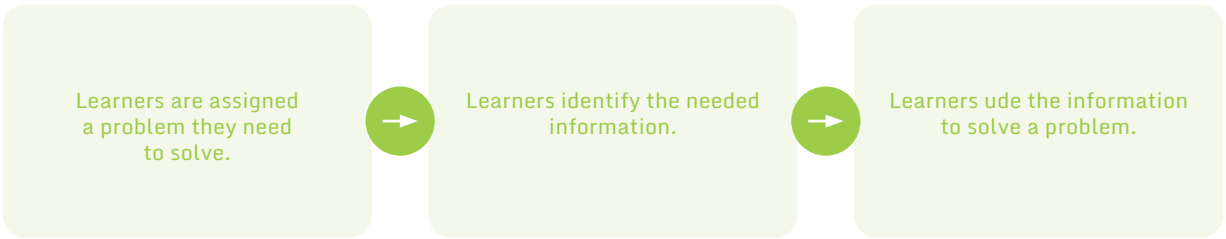


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Table 1 Differences between CBL, PrBL and PBL

Technique/characteristic	Project based learning	Problem based learning	Challenge based learning
Learning	Students build their knowledge through a specific task [17]. The knowledge acquired is applied to carry out the assigned project	Students acquire new information through self-directed learning, using designed problems [18]. The knowledge acquired is applied to solve the problem at hand	Students work with teachers and experts in their communities on real-world problems in order to develop a deeper knowledge of the subjects they are studying. It is the challenge itself that triggers the generation of new knowledge and the necessary tools or resources
Focus	Confronts the students with a relevant situation and redefined problematic for which a solution is required [12]	Confronts students with a relevant problematic situation, often fictional, for which a real solution is not needed [19]	Confronts students with an open, relevant, problematic situation, which requires a real solution
Product	Requires the students to generate a product, a presentation or an implementation of the solution [19]	Focuses more on the learning processes than the resulting products of the solutions [12]	Focuses more on the learning processes than the products of the solutions [21]
Process	Students work on the assigned project so that their engagement generates products, and they learn as a result [20]	Students work with the problem in a way that tests their ability to reason and apply their knowledge to be evaluated according to their learning level [21]. Students analyze, design, develop and execute	Students analyze, design, develop and execute the best solution in order to tackle the challenge in a way they and other people see and measure
Teacher's role	Facilitator and project Manager [22]	Facilitator, guide, tutor or professional adviser [23]	Coach, co-researcher and designer [24]

Source: Membrillo-Hernández et. al. (2019).

1.1. Importance of Interdisciplinary Collaboration in CBL Initiatives

CBL was inspired by the 21st-century work environments. Students come together to work collaboratively, and, through the use of innovative technologies, solve problems that directly affect them in their society or their school. The teacher needs to adapt to encourage creativity in this new reality and to instruct students with knowledge of varying levels and in multiple different areas. Several authors studied the benefits of a CBL environment as an educational technique in several areas of engineering; as an interdisciplinary and creative approach to solving public health problems; for English language learning; for the training of students in mobile applications development; for development of an effective, controlled teaching environment in an Intelligent Mechatronics course; in contexts of interaction between people and information, for employment of gamification and CBL in the process of engineering, among many others.

In this context, interdisciplinary learning focused on authentic and real-life learning content and experiences can be supported through different course designs and teaching approaches. Challenge-Based Learning (CBL) is one of those approaches enabling interdisciplinary learning. With CBL complex real-life challenges can be approached in the classroom and interdisciplinary teaching and learning settings (Nichols et al. 2016; Bohm et al., 2020; Barynienė et al. 2022). To provide even more contrasting perspectives and thus stimulate boundary-crossing, higher education institutes increasingly join forces to address global issues in the form of interdisciplinary courses that are co-developed and co-taught (Brudermann et al. 2017; Uthrapathi Shakila et al. 2021).

Moreover, the encouragement and development of critical thinking skills, via teamwork and discussion, is one of CBL's primary goals, which is used to good effect on students' skills. In addition to this, the approach is a way of working with learners to augment their ability to solve problems and to work efficiently as part of a team (Gokhale, 1995).

2. CHAPTER 2 Methodologies in CBL

2.1. Design thinking and action research in addressing challenges.

The CBL and Design Thinking (DT) frameworks are based on three action steps: engagement, investigation, and action. The goal of CBL and DT are to develop a generation of engaged learners equipped to identify challenges and develop innovative solutions. Participants in this self-paced course will be armed with the tools to help prepare students for today's challenges.

The CBL Framework is divided into three interconnected phases: **Engage** (in which the Learners move from an abstract big idea to a concrete and actionable challenge), **Investigate** (in which Learners conduct research to create a foundation for actionable and sustainable solutions) and **Act** (in which evidence-based solutions are developed and implemented with an authentic audience and the results evaluated).

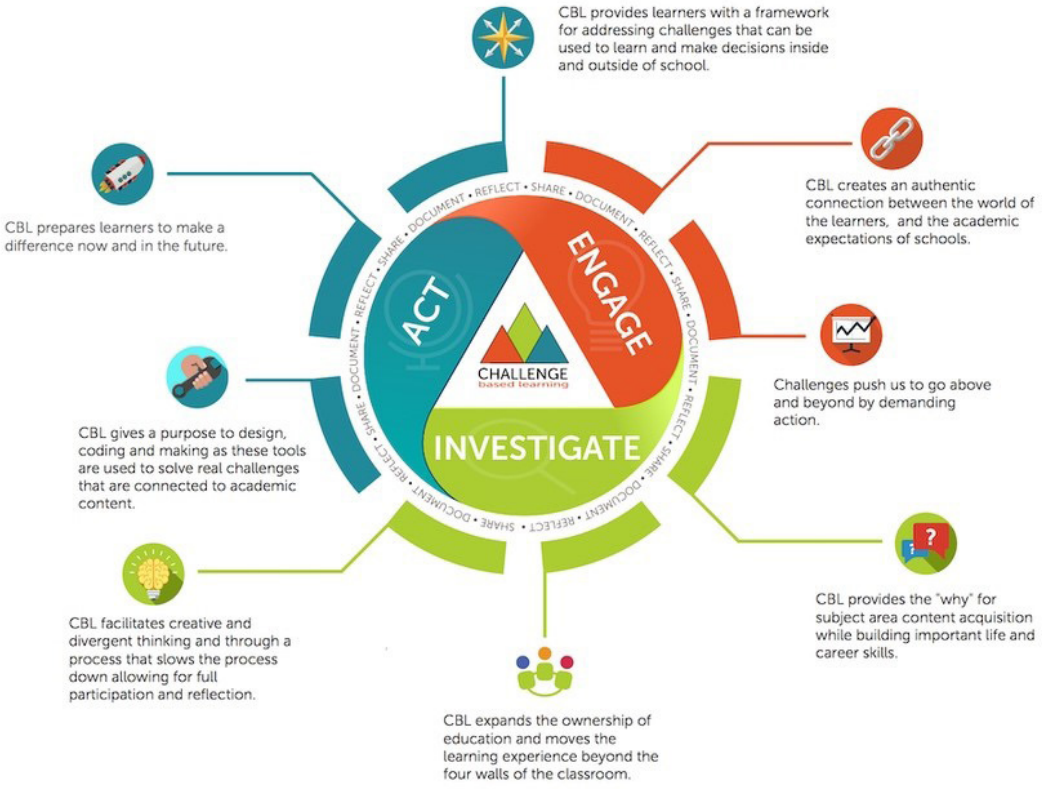
Source: https://www.utwente.nl/en/cbl/what-is-cbl/#cbl-framework-three-main-phases

- **Engage:** The Engage phase in CBL is the initial phase. In this phase, participants delve into a broad societal issue or challenge. They collaborate to refine and narrow down this broad concept into a specific, actionable problem that serves as the focal point for their project. Through discussion, research, and dialogue, they identify key questions that will direct their exploration and solution-building efforts in the following phases of the CBL process.
- **Investigate:** In this phase, building from the Challenge Learners develop contextualized learning experiences and conduct rigorous, content and concept-based research to create a foundation for actionable and sustainable solutions. The Investigation phase begins with generating questions related to the Challenge. The questions develop the course of study needed to devel-

op an informed solution to the Challenge. The questions are categorized and prioritized, creating an outline for the learner's journey.

- **Act:** In the Act phase, evidence-based solutions are developed and implemented with an authentic audience, and the results are evaluated. The learners combine a desire to make a difference with a demonstration of content mastery. After completing the Investigation phase, the learners have a solid foundation to develop solution concepts. Solution concepts may involve plans for a campaign to inform or educate, school or community improvement projects, product development, or other activities.

In this context, a visual summarizing the above information is shared below.



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2.2. Integrating project-based learning into CBL frameworks

In the Engage phase, The challenge turns the essential question into a call to action to learn deeply about the subject. A challenge is actionable and builds excitement. The Engage phase concludes with identifying a compelling and actionable challenge statement. Then, with the Investigate phase, after answering the guiding questions and identifying insights, the learners analyze the accumulated data and identify themes. The Investigation phase concludes with reports and presentations demonstrating the learners have successfully addressed all the guiding questions and developed clear conclusions, setting the foundation for the solution while meeting learning goals and objectives. Finally, during the Act phase, after developing their solutions, the learners implement them, measure outcomes, reflect on what worked and what didn't, and determine their impact on the challenge. When

implementation is complete, learners can continue to refine the solution or develop a completion report and share their work with the rest of the world (Source: https://www.challengebasedlearning.org/2023/03/22/essential-questioning/).

3. CHAPTER 3 Fields and Applications of CBL

4. CHAPTER 4: Collaborative Practices

4.1. Establishing effective teams in CBL: Roles and communication

The teams should be cross-disciplinary. Teachers guide and facilitate team culture, help students manage their tasks, and enable students to move towards innovative thinking. At the same time, student needs to have traditional teacher skills; this has been discussed more deeply in the study by Eldebo et al. (2022). As the teacher role is different, the term "teamcher" is suggested (Gunnarsson & Swartz, 2021) as a label. Eldebo et al. (2022) show that the teamcher role includes both the enabling of knowledge and skills and the ability to set the scene for this. They define a teamcher "as any individual that, either on its own or as a part of a team, arranges, leads, and supports CBL activities." When beginning, teams need to identify, explore, and define a real problem according to the problem conditions.

Roles one of the biggest differences between CBL and more traditional approaches to teaching and learning are the roles of schools, teachers, and students. With CBL, schools evolve from being information repositories to creative environments where all Learners can acquire real-world knowledge, address real world challenges, and develop skills they can use to solve complex problems for the rest of their lives. Teachers become more than information experts: they become collaborators in learning who leverage the power of students, seek new knowledge alongside students, and model positive habits of mind and new ways of thinking and learning.

The roles of collaborator and co-Learner can be a difficult one for teachers who are accustomed to guiding the entire experience and being the expert. You may be tempted to rush the process, over-engineer the activities, and point out Solutions to students. However, it is vital to provide space and time to make mistakes, follow false paths, and course correct. You do not need to know all of the information or even the location of the information ahead of time, but you must work alongside the students to find answers. The Challenges will be real and not be simple to solve, and at times things will get "messy". Many "correct" answers will exist, and the role of the teacher in CBL is to find the Solutions with the students, not for them. Trust that this will happen and resist the temptation to do take over the process. Keep in mind that while students focus on each discrete part of the CBL process, they may find it difficult to keep the larger picture in mind, especially when first starting out. As the "senior Learner", you will help them identify the learning goals and curriculum standards, create plans, and manage their time. You will use your expertise as an educator to manage the boundaries of adventure and to make sure the journey stays on track. Over time the students will take on more and more responsibility and ownership over the learning process. CBL emphasizes exploring topics from many angles and through the lens of multiple disciplines, which allows Learners to appreciate the natural connections between content areas that might not always be evident. As a result, it works especially well when teachers from different disciplines work together. Just as working in collaborative groups help students acquire critical life skills, teachers who have implemented CBL in teams report that collaboration with other teachers is one of the most beneficial and enjoyable aspects of the approach.

Source: https://www.challengebasedlearning.org/wpcontent/uploads/2019/02/CBL_Guide2016.pdf.

4.2. Tools facilitating remote and in-person collaboration

In remote learning, students often interact with one another without engaging in collaborative work. Here, they are cooperating rather than collaborating. Cooperation begins with mutual respect while collaboration begins with mutual trust. Cooperation requires transparency but collaboration requires vulnerability. Cooperation includes shared goals, but collaboration includes shared values. Cooperation is independent but collaboration is interdependent. Cooperation is often short-term while collaboration is often long-term. Cooperation involves the sharing of ideas as a group. However, collaboration involves generating entirely new ideas together. Both collaboration and cooperation are necessary in remote and hybrid learning. Cooperation without collaboration can lead to disunity while collaboration without cooperation can lead to groupthink and a loss of individual agency.

In addition, benefits of using collaboration tools for remote learning can be summarized as follows:

- Interactive Learning: Collaboration tools encourage active participation and interaction among students, fostering a deeper understanding of the subject matter.
- Engaging Learning Experiences: Through gamification and interactive features, collaboration tools make learning enjoyable, motivating students to actively participate in remote learning sessions.
- Real-time Feedback: Collaboration tools enable immediate feedback from teachers, allowing students to address misconceptions and make necessary adjustments in their learning process.
- Student-Centered Collaboration: Collaboration tools facilitate peer-to-peer collaboration, encouraging students to work together, share ideas, and learn from one another.

Source: https://spencerauthor.com/remote-collaboration/

5. CHAPTER 5 Identifying Challenges

5.1. Techniques for defining clear problem statements suitable for CBL

CBL is naturally very challenging to implement, as it requires a lot of planning and hard work.

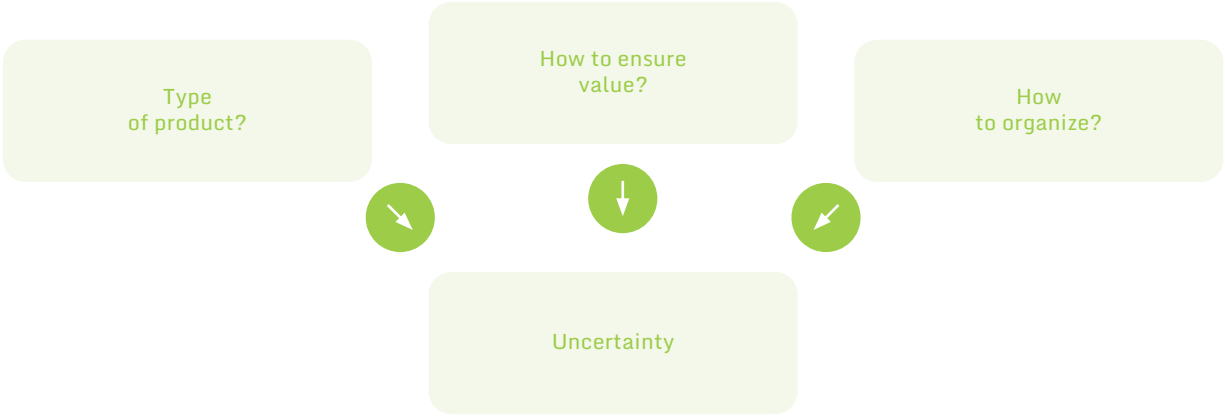
- The challenge must motivate students to seek out a deeper understanding of concepts.
- The challenge should require students to make reasoned decisions and to defend them.
- The challenge should incorporate the content objectives in such a way as to connect it to previous courses/knowledge.
- If used for a group project, the challenge needs a level of complexity to ensure that the students must work together to solve it.
- If used for a multistage project, the initial steps of the problem should be open-ended and engaging to draw students into the problem.

In addition, a problem statement is a concise and clear description of an issue or challenge that needs to be addressed. It serves as a roadmap for problem-solving and decision-making, helping individuals and teams define the scope of their work and focus on the most critical aspects of a problem.

In the CBL context, for instance, the problem statement underscores the need for exploring viable solutions and potential solutions to tackle the rising energy consumption in our community.

Therefore, a well-crafted problem statement should be:

- Specific: Clearly define the problem, avoiding vague or general descriptions.
- Measurable: Include criteria to assess the success or completion of the solution.
- Achievable: Ensure that the problem can be solved or improved within reasonable constraints.
- Relevant: Align the problem statement with your goals and objectives.
- Time-bound: Set a timeframe for solving the problem or achieving progress.



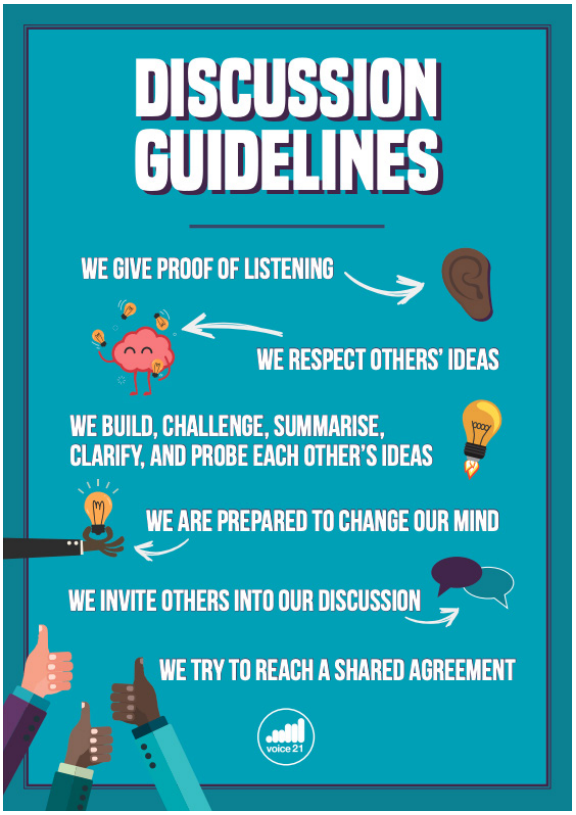
Source: https://citl.illinois.edu/citl-101/teachinglearning/resources/teachingstrategies/problem-based-learning-(pbl).

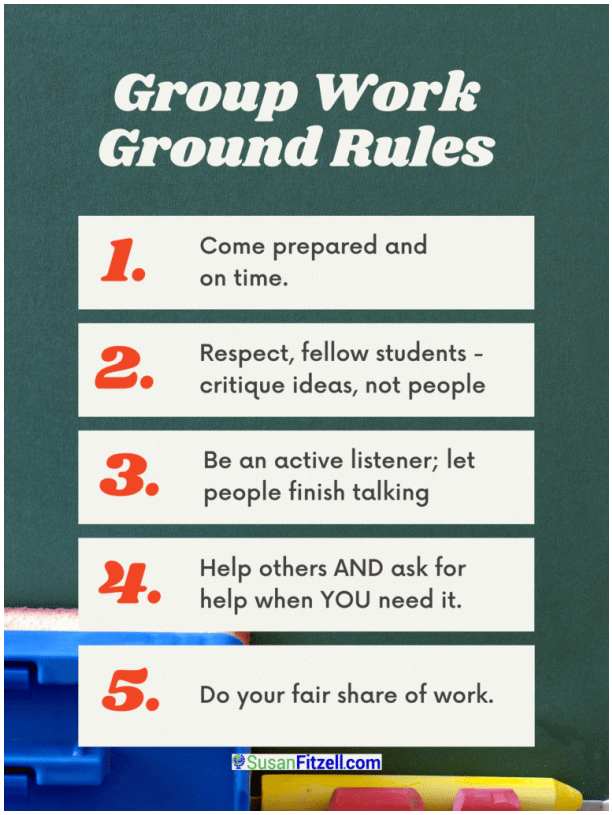
Some Real CBL Examples:

- How can we create understanding and appreciation between ourselves and students in a different community?
- How can we plan a sustainable practices garden within a budget?
- How can we reduce prejudices?
- How can a truck be designed to maximize its load capacity?
- How can we reduce the speed of vehicles that drive on the street in front of our school?
- How can we help immigrants in our community or state acclimate and thrive?
- How can we design bags/backpacks that meet our customers' needs?
- How can we help a local business or non-profit market their service or product?
- How can we help combat climate change?
- How can we predict our community's future population, so best plans can be made?

5.2. Ethical considerations when selecting challenges for CBL projects

The CBL environment exists to empower learners to analyze a problem in its own and the learner's context (Coles, 1991). For this to succeed, and for the learner to construct a method of arriving at a detailed analysis, the educator must be cautious not to impose his or her system of idiosyncratic ethics, or even beliefs. Learners must not be forced to follow one pre-trodden path to a conclusion that the educator has already drawn (Jabobs & Keegan, 2018).





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6. CHAPTER 6 Research and Analysis in CBL

Analytical tools used in CBL projects vary based on the nature of the challenge being addressed, the available resources, and the specific goals of the project. Commonly utilized analytical tools encompass a range of frameworks and methods:

- **SWOT Analysis:** This framework helps identify the strengths, weaknesses, opportunities, and threats related to a specific challenge. It allows teams to assess the internal and external factors affecting their project.
- **Root Cause Analysis:** This method helps in identifying the underlying causes of a problem rather than just addressing the symptoms. It involves asking 'why' multiple times to get to the root issue.

- **Fishbone Diagram (Ishikawa Diagram):** It's a visual tool used to explore and categorize potential causes of a problem, enabling teams to investigate various contributing factors.
- **Qualitative Analysis Methods:** Techniques such as thematic analysis, content analysis, or discourse analysis assist in examining qualitative data gathered from interviews, observations, or focus groups.
- **Surveys and Questionnaires:** Analyzing responses from structured surveys or questionnaires using statistical analysis methods provides quantitative insights into opinions, preferences, or behaviors related to the challenge. Data Analysis Tools: Utilizing statistical software like Excel, SPSS, Stata, R or specialized tools for data analysis helps in interpreting quantitative data collected during research phases.
- **Benchmarking and Comparative Analysis:** Comparing the project's performance or solutions against industry standards or similar initiatives helps in evaluating effectiveness and identifying areas for improvement.
- **Decision-Making Matrices:** Matrices such as cost-benefit analysis, decision trees, or weighted scoring models assist in evaluating alternative solutions or options.

7. CHAPTER 7: Implementation and Assessment

7.1. Strategies for implementing solutions derived from CBL projects

1. Step: Building Team

Team Characteristic

1.1. Team member characteristic

Personality (some personal characteristic: such as extraversion, conscientious)

Abilities (Skillful students can enhance group performance)

Experience (previous experience on teamwork can increase the likelihood for smooth process

Motivation (motivated students can enhance learning of others by sharing feedback and information

1.2. Team diversity and size

Heterogeneity

Large groups may lead to coordination difficulties while small groups have higher delivery cost.

2. Step: Identifying Problem/Task Characteristic

Problem Formulation

2.1. Clarity

Clear and understandable problem. Thanks to problem, teams can discuss details. For this reason, problem should be interesting and increase team motivation.

2.2. Task Execution

Interdependent and interconnected tasks can enhance knowledge sharing among students.

3. Step: The Learning Context

3.1. Learning and Teaching Culture

Authoritarian directed and competitive classroom can hinder team performance. Therefore, students should feel there is an autonomous learning in the class.

3.2. Tutor characteristic: The tutor's professional expertise in the given discipline and facilitation skills enhance the tutoring quality and team's performance

3.3. Time allocation: Time pressure or lack of sufficient time decrease the quality of discussion and thus, learning.

Source: https://unlimited.hamk.fi/ammatillinen-osaaminen-ja-opetus/building-effective-student-teams-in-problem-based-learning / (Fonteijn & Dolmans (2019), Huitt et al. (2015) and Hoegl & Gemuenden (2001)).

7.2. Monitoring and evaluating the impact of CBL initiatives.

An important task is to improve an evaluation methodology appropriate for the challenge-based learning technique, it is difficult to have a single form of evaluation and this is complicated when there are training partners involved in the teaching process. Compliance and development of both cross-disciplinary and disciplinary competences is necessary, so developing a methodology that can collect evidence in this regard is a task that is constantly developing. the use of deliverables, such as written reports, exams by training partners, or skills tests can be preferred. However, the application of CBL at the undergraduate level is still under development and implementation (Caratozzolo & Membrillo-Hernández, 2021).

Effective communication of CBL outcomes to stakeholders

Students work in groups and actively connect to stakeholders and other parties to explore the challenge and then specify their projects within the scope of the challenge. During the course, the emphasis on direct contact of students with stakeholders is quietly important.

- Engaging visual presentation techniques for diverse audiences

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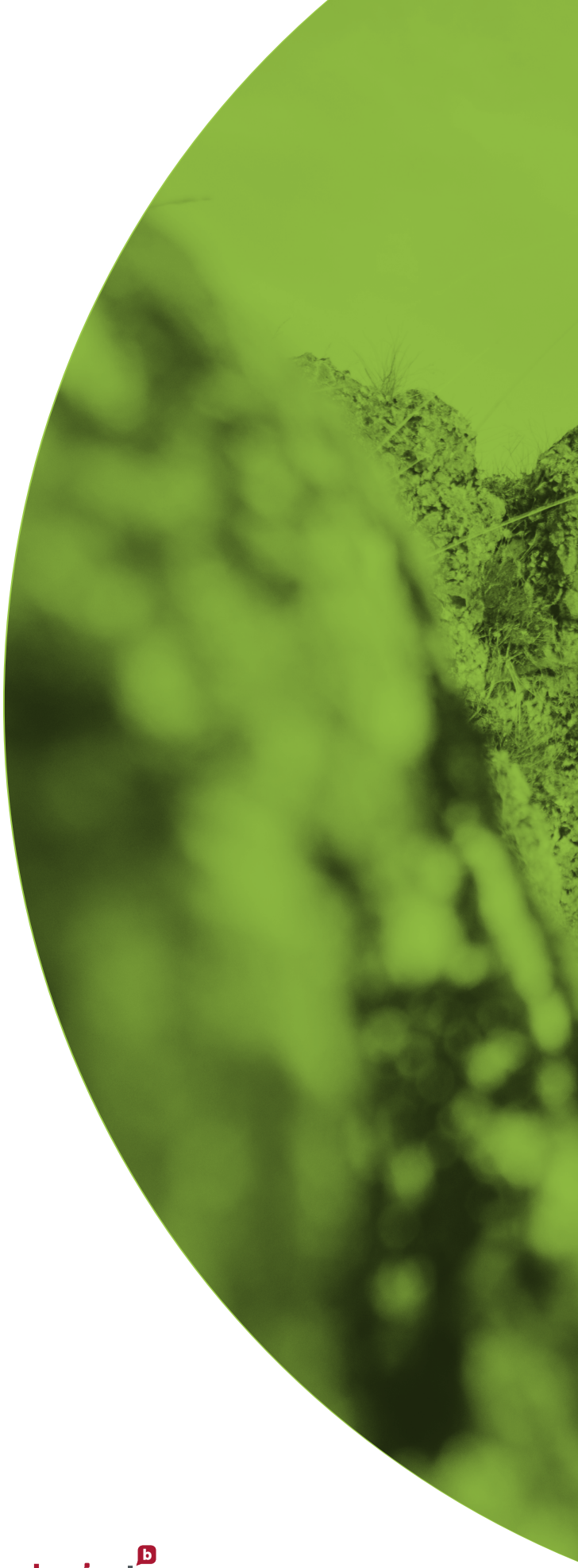
Links

- https://citl.illinois.edu/citl-101/teachinglearning/resources/teachingstrategies/problem-based-learning-(pbl)
- https://www.challengebasedlearning.org/
- https://www.tomorrow.university/post/what-is-challenge-based-learning-and-why-does-it-matter
- https://unlimited.hamk.fi/ammatillinen-osaaminen-ja-opetus/building-effective-student-teams-in-problem-based-learning/



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