ENTER-CBL

Boosting Entrepreneurial Mindset of Students with Challenge-Based Learning

CBL Methodology explained

ENTER CBL

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of Students with Challenge-Based Learning

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WP 2.1 CBL Implementation Manual: A Practice-Oriented Guide to Challenge-Based Learning for Higher Education

This manual is a practice-oriented guide to Challenge-Based Learning (CBL), designed for educators, facilitators, and students who aim to develop rigorous, real-world projects. It combines the philosophy of CBL with actionable methods and tools, demonstrating to readers how to plan, execute, and evaluate challenge-driven learning experiences across various disciplines. The first chapter lays the foundation by explaining the core concepts of CBL and highlighting why interdisciplinary collaboration is essential for addressing authentic and high-impact challenges. The second chapter presents the workflow of CBL through the Engage–Investigate–Act model, illustrating how Design Thinking and Action Research approaches enhance iterative inquiry and solution building. The third chapter outlines diverse application fields, including sustainability, health, entrepreneurship, social sciences, and the arts, while providing literature-based insights and case illustrations. Chapter 4 focuses on collaborative practices, describing how to form effective and diverse teams, define roles clearly, and maintain communication in on-site, online, and hybrid settings. Chapter 5 explores techniques for framing ethical, precise, and solvable challenges, including strategies for crafting strong problem statements. Chapter 6 provides a versatile toolbox of research and analysis methods—such as SWOT, Root-Cause/5 Whys, Fishbone diagrams, qualitative approaches, surveys, data analysis tools, benchmarking, decision-making aids, Design Thinking lenses, Business Model Canvas, Empathy Maps, and Six Thinking Hats—that can be adapted to different projects. The final chapter presents an implementation roadmap and outlines practical strategies for monitoring, evaluation, and assessment, with a focus on enhancing both learning processes and tangible outcomes. Newcomers to CBL may focus first on Chapters 1 and 2 to understand the approach and workflow before moving to Chapter 5 to design a local challenge and Chapter 6 to select the right analytical tools. More experienced instructors can use Chapter 4 to refine their team-building practices and Chapter 7 to enhance evaluation and reporting.

CHAPTER 1 INTRODUCTION TO CHALLENGE-BASED LEARNING

Experiential learning serves as the foundation for numerous educational frameworks that are applied globally, not only in academic contexts but also in practical real-world problems or projects. Among these approaches are Problem-Based Learning (PBL), Project-Based Learning (PrBL), Task-Based Learning (TBL), and Challenge-Based Learning (CBL). These methodologies emphasize learning through direct experience and active involvement in solving real-world challenges.

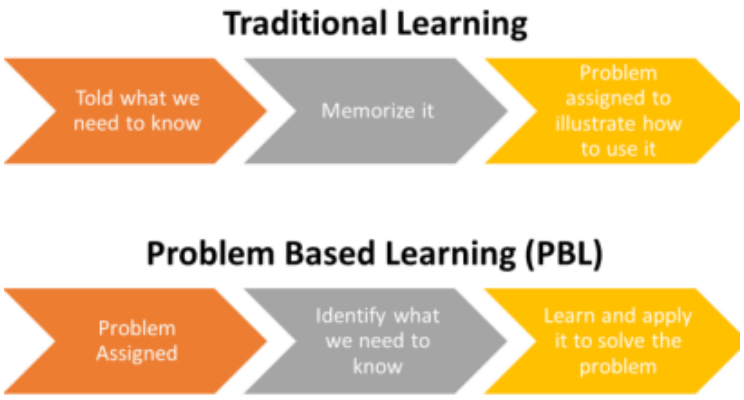
Presently, educational models often lag behind real-world requirements, prompting educators to seek new methodologies. CBL diverges from traditional teaching approaches by embracing a multidisciplinary, collaborative, and experiential methodology. It empowers learners to actively engage with real-world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

The CBL approach equips learners (students) with a dynamic and complex work environment, making it an ideal method to integrate into classroom settings. By adopting this approach, students collaborate in multidisciplinary teams to tackle real-world challenges, enhancing their teamwork and problem-solving skills. Within the classroom, they take responsibility for identifying the knowledge required to address the problem and applying this acquired understanding to design effective solutions. This process not only fosters self-directed learning but also strengthens their ability to navigate complex tasks independently. Furthermore, since the solutions are designed to be environmentally, socially, and economically sustainable, implementing CBL in courses helps students develop the ability to integrate diverse disciplinary perspectives, preparing them for both academic and professional success.

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 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. Figure 1 illustrates a brief comparison between traditional learning and PBL, highlighting the shift towards more interactive and student-centered approaches. Such educational models are crucial as they foster critical thinking, collaboration, and real-world problem-solving skills.

Figure 1. Comparison Between Traditional Learning and PBL



Source: Oliveira, 2016.

CBL is based on experiential learning and shares some features with both PrBL and PBL. Table 1 outlines the key differences between CBL, PrBL, and BL. These three educational approaches, while similar in their emphasis on student-centered learning, differ significantly in their structure, goals, and implementation methods.

Table 1. Differences Between PrBL, PBL, and CBL

Technique Characteristic	**PrBL**	**PBL**	**CBL**
Learning	Students build their knowledge through a specific task. The knowledge acquired is applied to carry out the assigned project	Students acquire new information through self-directed learning, using designed problems. 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 necessary tools or resources.
Focus	Confronts students with a relevant situation and redefined problematic for which a solution is required.	Confronts students with a relevant problematic solutions, often fictional for which a real solution is not needed.	Confronts students with an open, relevant, problematic situation which requires real solution.
Product	Requires the students to generate a product, a presentation or an implementation of the solution.	Focuses more on the learning processes than the resulting products of the solution.	Focuses more on the learning processes than the products of the solutions.

Process	Students work on the assigned project so that their engagement generates product, a presentation, or an implementation of the solution	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. Students analyze, design, develop and execute.	Students analyze, design, develop and execute the best solutions in order to tackle the challenge in a way they and other people see and measure.
Teacher's Role	Facilitator and Project Manager	Facilitator, guide, tutor, or professional adviser	Coach, co-researcher and designer

Source: Membrillo-Hernández et al., 2019.

PBL has been widely adopted in fields like medicine and engineering education. This is largely due to its expected benefits in improving students' critical thinking, self-directed learning, general skills, and long-term retention (Lund & Jensen, 2020; Strobel & Van Barneveld, 2009).

1.1 Importance of Interdisciplinary Collaboration in CBL Initiatives

Interdisciplinary collaboration in CBL initiatives is essential as it brings together diverse perspectives and expertise, enhancing the problem-solving process. By integrating knowledge from various disciplines, students can develop more comprehensive and innovative solutions to complex challenges. This collaborative approach not only enriches the learning experience but also better prepares students for real-world scenarios or problems where multifaceted skills and teamwork are crucial.

CBL was inspired by the 21st century work environments. Students come together to work collaboratively, and, using innovative technologies, solve problems that directly affect them in their society or their school. The teacher needs to adapt to encouraging 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. 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 have a 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).

1.2 Competence Model for Teachers in CBL

The implementation of CBL requires teachers to exercise professional capacities that extend beyond conventional instruction. While CBL positions students as active owners of their learning, teachers assume pivotal roles as facilitators, mentors, and co-learners who design authentic challenges, scaffold inquiry across the Engage-Investigate-Act cycle, and cultivate psychologically safe, inclusive collaboration. They also coordinate partnerships with community and industry stakeholders, align formative and summative assessment with real-world outcomes, and sustain iterative reflection that turns evidence into improvement. A clear competence model is therefore needed to articulate expectations for effective practice and to guide preparation, ongoing development, and evaluation of teachers implementing CBL.

1. **Knowledge**: For teachers engaged in CBL, the knowledge dimension represents a robust integration of theoretical, disciplinary, technological, and evaluative foundations that underpin effective facilitation. First, teachers are expected to demonstrate a solid grasp of the theoretical underpinnings of experiential learning, particularly Kolb's (1984) experiential learning cycle and subsequent refinements, which explain how active inquiry, reflection, and iterative practice enhance students' capacity for deep learning. Equally crucial is an understanding of student-centered pedagogical approaches such as PBL, PrBL, and Design Thinking, and how these approaches align with or diverge from CBL in terms of learner agency, authenticity of challenges, and iterative solution development (PBLWorks, n.d.). Second, teachers need to maintain interdisciplinary content knowledge that is directly relevant to the challenges students address. This breadth enables them to scaffold inquiry across diverse domains such as STEM fields, environmental sustainability, ethics, or civic engagement while helping learners draw conceptual connections across disciplinary boundaries (Schutte, 2025). Third, teachers must cultivate fluency in digital tools and collaborative platforms that support the entire CBL cycle, including online investigation, data collection, visualization, prototyping, and dissemination. Such digital competence enables teachers to integrate hybrid and remote learning environments effectively and guide students in leveraging the appropriate technological affordances (Helker et al., 2025). Finally, teachers require knowledge of assessment frameworks that integrate process- and outcome-oriented evaluation, recognizing not only the final deliverable of a project but also intermediate phases such as inquiry design, teamwork, creativity, and stakeholder engagement. Competency-based and formative assessment models are particularly relevant to capturing the learning processes inherent in CBL (National Science Foundation, 2020).

   A comprehensive knowledge base in these areas allows teachers to design authentic, developmentally appropriate challenges; scaffold student inquiry across disciplines; select and deploy suitable technological tools; and employ rigorous assessment practices that reflect both the quality of learning processes and the impact of project outcomes.

2. **Skills:** The successful implementation of CBL depends not only on teachers' knowledge base but also on a versatile set of practical and interpersonal skills that enable them to guide students through authentic, open-ended challenges. At the forefront are facilitation skills, which involve orchestrating the learning environment so that students can take ownership of their inquiry. Teachers must be able to guide students in formulating relevant questions, scaffold learn-

ing processes, and employ strategic questioning techniques to stimulate deeper reasoning and creativity (Hmelo-Silver et al., 2007). Closely related to facilitation is the ability to encourage reflection, helping learners to analyze their progress, recognize misconceptions, and adapt their strategies—a hallmark of the iterative nature of CBL (Kolb, 1984).

Equally important are collaboration skills, which encompass fostering teamwork among diverse learners, managing group dynamics, mediating conflict constructively, and promoting inclusivity and psychological safety within student teams. In many CBL settings, teachers also engage in co-teaching or cross-disciplinary facilitation with colleagues; therefore, they require interpersonal communication and leadership skills that foster productive partnerships among educators and external stakeholders (Goodyear et al., 2021). Given that CBL projects often rely on hybrid or technology-enhanced environments, teachers are also expected to demonstrate advanced digital literacy. This includes integrating audiovisual tools, selecting suitable online collaboration platforms, utilizing data-analysis applications, and assisting students in using digital technologies for investigation, prototyping, and presenting their findings (OECD, 2021).

Finally, teachers must possess robust assessment skills tailored to the dual focus of CBL: the process and the outcomes of learning. This entails designing transparent rubrics aligned with both disciplinary and transversal competencies, providing formative feedback that supports ongoing improvement, and conducting multi-criteria evaluations of interdisciplinary outputs in ways that are authentic and fair (Darling-Hammond & Adamson, 2014). Collectively, these skills enable teachers to act as facilitators of inquiry, co-creators of collaborative knowledge-building, mediators of digital learning spaces, and evidence-informed evaluators, ensuring that CBL projects achieve their intended impact on both student learning and real-world problem solving.

3. **Mindset:** A fundamental shift in mindset is essential for teachers seeking to implement CBL effectively, as it reshapes their professional identity from the traditional role of a content deliverer to that of a facilitator, collaborator, and co-learner. Central to this shift is the adoption of the "teamcher" perspective, viewing the teacher not only as an instructional leader but also as an active team member who learns alongside students (Larmer & Mergendoller, 2015). This approach underscores the importance of shared responsibility and the reciprocal nature of knowledge construction in authentic challenges. CBL further demands a mindset characterized by openness, flexibility, and tolerance for ambiguity, as challenge-driven projects often involve ill-structured problems with unpredictable pathways and outcomes (Jonassen, 1997). Teachers must be willing to embrace uncertainty, adjust plans responsively, and see incomplete or failed attempts as opportunities for learning rather than as setbacks. An additional hallmark of the CBL mindset is a commitment to risk-taking, creativity, and iterative improvement. Teachers should model and encourage experimentation, allowing space for prototyping, reflection, and revision, so that students experience learning as a dynamic and evolving process (Sawyer, 2014).

   Equally critical is a mindset that promotes inclusivity, learner autonomy, and critical thinking, emphasizing respect for diverse perspectives and empowering students to make decisions about their own inquiry paths. By fostering psychological safety and equitable participation, teachers create conditions where all learners feel encouraged to contribute and to challenge assumptions constructively (Edmondson, 2019). Cultivating such dispositions enables teachers to sustain a classroom culture that is adaptive, learner-centered, and innovation-oriented, ultimately aligning with the ethos of CBL as a collaborative, inquiry-driven approach to solving real-world challenges.

Table 2. Competence Framework for CBL

Dimension	Core Competencies	Illustrative Practices in CBL
Knowledge	• Pedagogical foundations of experiential, inquiry-based learning (CBL, PBL, PrBL, Design Thinking) • Interdisciplinary content expertise • Digital tools & collaborative platforms • Process- & outcome-based assessment design	• Aligning the Engage–Investigate–Act phases with curriculum standards • Selecting cross-disciplinary resources for authentic challenges • Choosing appropriate digital platforms for research, prototyping, and sharing
Skills	• Facilitation of inquiry and reflection • Collaboration & group-dynamics management • Digital literacy for hybrid/online teamwork • Designing rubrics & formative feedback	• Guiding students with Empathy Maps and Root-Cause Analysis • Moderating group discussions to ensure equitable participation • Designing rubrics that integrate creativity, teamwork, and feasibility
Mindset	• Openness, curiosity, and tolerance for ambiguity • Learner-centered stance and inclusivity • Risk-taking, creativity, and iterative improvement • Valuing student autonomy & critical thinking	• Acting as a "teamcher" (teacher + team member) • Embracing multiple possible solutions and learning from failure • Supporting student-led decision-making and reflective critique

Note. This table synthesizes the competence dimensions discussed by Kolb (1984), Hmelo-Silver et al. (2007), Larmer & Mergendoller (2015), Sawyer (2014), and Edmondson (2019), adapted for the CBL context.

This competence model offers a systematic and evidence-informed framework for supporting teachers' professional growth in CBL contexts. Beyond functioning as a descriptive guide to essential competencies, it provides a practical foundation for designing structured training curricula, digital support toolkits, mentoring schemes, and continuous professional-development workshops. By aligning teacher preparation with the model's three core dimensions— knowledge, skills, and mindset—institutions can cultivate educators who are not only proficient in the theoretical underpinnings of CBL but also adept at facilitating interdisciplinary collaboration, leveraging digital platforms, and fostering inclusive, learner-centered classroom cultures. In doing so, the model serves as both a roadmap for capacity-building in higher education and a benchmark for assessing teachers' readiness to integrate CBL effectively into diverse courses and programs.

Example from Business and Management Education

An illustrative example of applying the Competence Model for Teachers in CBL can be drawn from business and management programmes. Consider a challenge such as: "How can a local small and medium-sized enterprise (SME) enhance its financial sustainability while adopting environmentally responsible business practices?" This type of challenge exemplifies the interdisciplinary nature of CBL, where teachers must mobilize all three competence dimensions—knowledge, skills, and mindset—to guide authentic learning.

From the knowledge perspective, the teacher integrates concepts from finance, sustainability, operations, and strategic management, ensuring that students can understand and connect the economic implications of green initiatives with broader corporate sustainability goals. They also identify appropriate digital tools (e.g., collaborative spreadsheets, data visualization software) to support students in analyzing real SME data. In terms of skills, the teacher orchestrates the process by facilitating collaborative teamwork, encouraging students to apply strategic analysis tools such as SWOT or the Business Model Canvas, and guiding them to synthesise evidence-based insights into actionable strategies. Facilitation also entails moderating discussions so that all team members contribute meaningfully, resolving group dynamics constructively, and helping students refine their prototypes or solution pitches. The mindset dimension is equally central. Rather than providing prescriptive solutions, the teacher acts as a co-learner and mentor, encouraging students to explore multiple pathways, test their assumptions, and embrace the iterative nature of innovation. By cultivating a climate of psychological safety and valuing diverse perspectives, the teacher supports students in generating creative yet feasible proposals that address both financial sustainability and environmental responsibility.

This example highlights effective CBL facilitation in business, economics, and management education requires more than disciplinary expertise. Teachers must embody the Competence Model's holistic approach, functioning as designers of authentic challenges, skilled facilitators of collaborative inquiry, and promoters of a growth-oriented, learner-centered mindset. In doing so, they prepare students to tackle real-world, interdisciplinary problems with both analytical rigor and practical innovation—key attributes for future business leaders operating in increasingly complex socio-economic contexts.

1.3 Advantages and Disadvantages in Implementing CBL

The integration of CBL into higher education offers a broad spectrum of pedagogical, professional, and institutional advantages, making learning more student-centered, authentic, and competency driven. These benefits include stronger learner engagement, closer alignment with real-world problems, and the cultivation of 21st-century skills that enhance employability and lifelong learning. CBL also strengthens collaboration between universities and external stakeholders—such as industry partners, NGOs, and local communities, thereby increasing the societal impact of higher education and aligning curricula with international quality frameworks, including the Bologna Process, EQF, and various accreditation standards.

However, the adoption of CBL is not without its challenges and limitations. Integrating authentic, interdisciplinary challenges into existing curricula often requires significant curriculum redesign, faculty training, and institutional support, which may be resource intensive. Instructors may encounter increased workload and assessment complexity, as evaluating both the process and outcomes of learning can demand more time and sophisticated rubrics compared to traditional courses. Additionally, the need for cross-disciplinary collaboration can reveal gaps in faculty expertise or lead to coordination difficulties among departments. From the learner perspective, some students may initially experience uncertainty, anxiety, or resistance when shifting from structured lectures to open-ended inquiry, especially in cultures with strong traditions of teacher-centred instruction. Furthermore, without adequate digital infrastructure or stakeholder partnerships, equity and access issues may arise, limiting students' opportunities for authentic engagement.

Acknowledging both the advantages and the potential barriers is essential for institutions aiming to implement CBL in a sustainable and equitable way. Understanding these two sides of CBL adoption helps universities design professional-development programmes, allocate resources strategically, and establish supportive policies that amplify its benefits while mitigating foreseeable challenges.

Advantages of CBL

- **Student-Centered Learning:** Students CBL repositions students from passive recipients of knowledge to active co-creators of the learning process. By engaging in inquiry, investigation, and solution design, students build a sense of ownership over their progress, which fosters deeper cognitive processing and long-term retention of knowledge (Kolb, 1984). This participatory approach also encourages self-regulation, reflective thinking, and metacognitive skills, enabling students to become autonomous learners who can adapt to future challenges.

- **Real-World Relevance:** Unlike traditional lecture-based instruction, CBL situates learning in the context of authentic, real-world problems that reflect societal, environmental, and professional priorities (Barron & Darling-Hammond, 2008). By collaborating with community stakeholders, companies, or NGOs, students encounter constraints, trade-offs, and ethical considerations similar to those in professional practice. This relevance ensures that academic knowledge is transferable beyond the classroom, increasing its practical value for both students and society.

- **21st Century Skills:** CBL is inherently aligned with transversal skills frameworks promoted by organizations such as OECD and the European Commission, including critical thinking, collaboration, communication, leadership, problem-solving, creativity, and digital literacy (OECD, 2021). The collaborative nature of CBL challenges students to negotiate ideas, resolve conflicts, and co-create solutions, thereby cultivating both technical and socio-emotional skills that enhance employability and lifelong learning.

- **Motivation and Engagement:** Research consistently shows that students demonstrate higher levels of intrinsic motivation and engagement when learning activities are personally meaningful and socially relevant (Deci & Ryan, 2000). By inviting students to address tangible problems with visible impact, CBL strengthens their sense of purpose, agency, and accountability. The iterative, hands-on nature of challenge cycles sustains curiosity and encourages perseverance, even in the face of complexity or setbacks.

- **Alignment with Quality Standards:** CBL supports international and regional higher-education frameworks such as the Bologna Process, the European Qualifications Framework (EQF), and program accreditation systems (e.g., AACSB, ABET, EQUIS) that prioritize student-centered pedagogy, measurable learning outcomes, and the development of transferable skills. By linking assessment rubrics to competency-based outcomes, CBL facilitates evidence-based quality assurance, strengthening both curriculum relevance and institutional accountability.

- **Stakeholder Engagement:** Through collaboration with companies, NGOs, public institutions, and local communities, CBL enriches students' educational experiences by providing exposure to authentic professional contexts, mentoring networks, and industry-informed insights (European Commission, 2020). Such multi-stakeholder partnerships enhance the credibility, scalability, and impact of student projects, while increasing the institution's connection to regional innovation ecosystems and its contribution to the Sustainable Development Goals (SDGs).

Despite its numerous benefits, the integration of CBL into higher education presents several practical and systemic challenges that institutions must address to ensure effective and sustainable implementation:

Disadvantages / Barriers of CBL

- **Time-Consuming:** Authentic challenges often span multiple stages—problem identification, stakeholder engagement, research, ideation, prototyping, and evaluation—which require extended timelines beyond traditional lecture-based courses. This makes it difficult to fit CBL activities into rigid academic calendars, semester constraints, or credit-hour systems. Without flexible scheduling or modular course designs, teachers may be forced to shorten or oversimplify challenge cycles, potentially compromising both learning depth and project outcomes.

- **Need for Resources and Infrastructure:** Effective CBL relies on adequate infrastructure, including digital tools for online collaboration, research databases, prototyping equipment, audiovisual materials, and dedicated spaces for teamwork. Furthermore, strong partnerships with industry, NGOs, and community stakeholders are often required to provide authentic data, mentorship, and feedback. In many institutions, particularly those with limited budgets or in developing regions, such resources may not be consistently available, creating inequities in access and limiting students' opportunities to work on high-impact projects.

- **Teacher Readiness:** CBL requires teachers to transition from traditional lecturers to facilitators, mentors, and co-learners—a shift that demands pedagogical retraining, ongoing professional development, and a willingness to adopt new instructional roles (Larmer & Mergendoller, 2015). Some faculty members may resist this shift due to established teaching habits, lack of institutional incentives, or concerns about increased workload. Without adequate support and recognition, teacher readiness becomes a critical barrier to scaling CBL across programs.

- **Assessment Challenges:** The multi-dimensional nature of CBL projects—where learning outcomes include not only knowledge acquisition but also collaboration, creativity, and problem-solving—renders conventional exams insufficient. Teachers need to design authentic assessment methods, such as rubrics for teamwork, reflective journals, prototypes, presentations, and stakeholder feedback. These alternative assessments are often time-intensive, complex to administer, and perceived as more subjective, which can raise concerns about reliability and fairness if clear criteria and training are lacking (Darling-Hammond & Adamson, 2014).

- **Adaptation for All Students:** Not all students adapt easily to the open-ended, uncertain, and collaborative nature of CBL. Learners who are more accustomed to teacher-centered, lecture-driven instruction or who experience high anxiety in ambiguous situations may initially struggle with self-directed inquiry, teamwork, or conflict resolution. Without targeted scaffolding, mentorship, and inclusive facilitation strategies, these students may feel disengaged or overwhelmed, leading to uneven participation and potential achievement gaps.

- **Institutional Limitations:** CBL implementation requires strong administrative support, including policy adjustments, curriculum redesign, allocation of financial and human resources, and consistent access to professional-development opportunities for faculty. Institutions lacking such systemic support often struggle to move beyond small-scale pilot projects, resulting in fragmented adoption with limited long-term impact. Sustainable scaling of CBL also depends on embedding it into institutional strategies and accreditation pathways, rather than treating it as an isolated teaching experiment.

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).

Figure 2. CBL Framework

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.

The purpose of this phase is to spark students' interest and curiosity, motivating them to explore and address the challenge. The process begins with presenting a broad, overarching challenge that is relevant and meaningful to students. This big idea should be something that has a significant impact on society or the environment, making it engaging and important. Next, the big idea is narrowed down to a specific, open-ended question that guides the inquiry. This essential question should be thought-provoking and designed to encourage deep thinking and exploration. It serves as the focal point for the entire challenge. Teachers facilitate an initial discussion where students share their thoughts, experiences, and prior knowledge related to the big idea and essential question. This helps in identifying students' interests and any preconceived notions they might have. Students are shown the relevance of the big idea and essential question to the real world. This might involve case studies, guest speakers, field trips, or multimedia resources that highlight real-world implications and applications.

Based on the essential question, students collaboratively formulate a clear and actionable challenge statement. This statement outlines what they aim to investigate or solve, providing a specific direction for their inquiry.

Table 3 illustrates some examples of the Engage phase. As can be observed, "**Essential Questions**" are always formulated as questions, whereas "**Challenges**" are statements.

Table 3. Engage Phase in CBL

Big Idea	Essential Question	Challenge
Tourism	What do people look for when going abroad?	Deliver a great experience for people visiting Brazil
Charity	What makes people engage in charity events?	Make donation easier
Finance	How does the use of cash impact the life of students?	Make payment easier
Health	How do people buy organic food?	Make organic food affordable
Entertainment	What do people look for when going out?	Deliver the best venue option according to your taste

Source: Detoni et al., 2019.

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 develop an informed solution to the Challenge. The questions may range from broad inquiries about the root causes and implications of the challenge to specific inquiries about potential solutions and strategies for addressing it. The questions are categorized and prioritized, creating an outline for the learner's journey. In other words, learners categorize and prioritize the questions they have generated, creating an outline for their learning journey. By organizing questions into thematic categories and determining their relative importance, learners gain clarity on the key areas of inquiry and focus their efforts on addressing the most critical aspects of the challenge.

To ensure a comprehensive investigation, it is essential to ask and address the following questions (O'Riordan & Gormley, 2021):

1. What does the team need to know? The team must first identify what they already know about the challenge and, more importantly, what they don't know. This involves pinpointing the specific information and knowledge gaps that need to be filled. The team must also clearly define the objectives of the research. What are the key questions that need answering to understand the challenge fully? This might include understanding the root causes of the challenge, its context, and its impact on different stakeholders. Additionally, the team needs to determine the scope of the investigation, including which areas require in-depth exploration and which can be addressed with a more general understanding.

2. How will they find this information? To answer this question, the team must decide the most appropriate methods for gathering information. This can include primary or secondary research. The team must critically evaluate the sources of information to ensure they are credible, up-to-date, and relevant. This might include knowing how to reach and use digital databases, research software, data analysis tools, and collaborative platforms.

3. What does the analysis of information tell the team? To answer this question, the team must analyze the collected data to extract meaningful insights. This can include knowing the statistical methods to analyze numerical data, identifying correlations, averages, distributions, and other significant metrics.

Additionally, the team needs to know how to interpret non-numerical data such as interview transcripts, open-ended survey responses, and observational notes to identify patterns, themes, and trends.

Website Source: https://www.utwente.nl/en/cbl/documents/dcu-futures-cbl-implementation-guide-for-those-who-teach.pdf

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.

These questions are pivotal in the Act phase, as they guide the team towards actionable solutions and recommendations. By addressing what solutions and recommendations are viable, how they can be implemented, and how their effectiveness will be assessed, the team ensures a systematic approach to problem-solving and a clear path towards achieving their objectives (O'Riordan & Gormley, 2021).

Website Source: https://www.utwente.nl/en/cbl/documents/dcu-futures-cbl-implementation-guide-for-those-who-teach.pdf

In this context, Figure 3 provides a visual summary of the information above, offering a clear and concise overview of the key points discussed.

Figure 3. Detailed Version of CBL Framework

Website Source: https://www.challengebasedlearning.org/project/why-challenge-based-learning/

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.

Website Source: https://www.challengebasedlearning.org/2023/03/22/essential-questioning/

Video Links to Phases of CBL:

- **Video 1: CBL Framework: Three Main Phases | 3:20 min |**

  https://www.utwente.nl/en/cbl/what-is-cbl/#cbl-framework-three-main-phases
- **Video 2: Challenge-based learning in practice (CBL)| 4:03 min |**

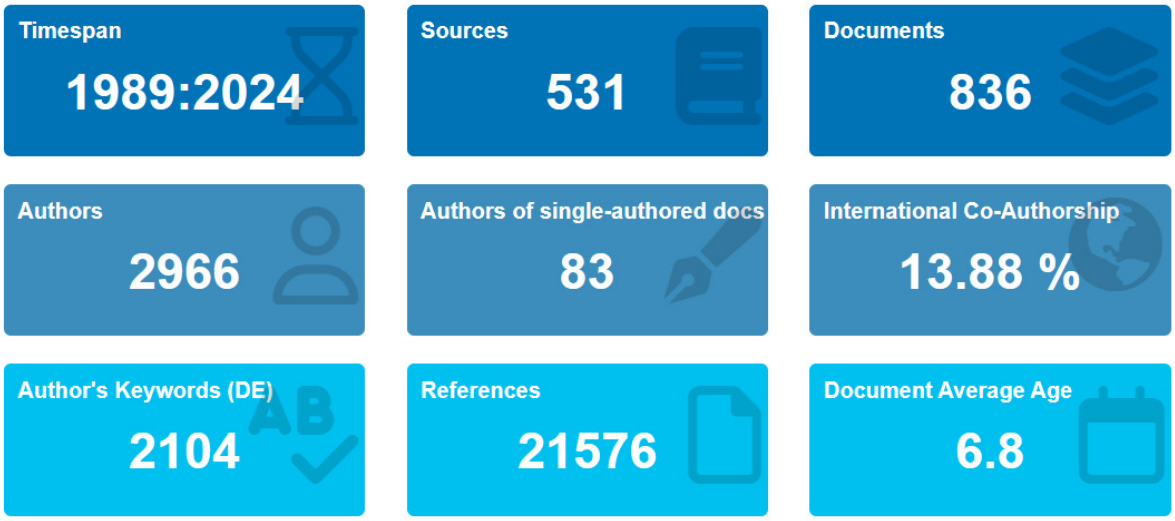
  https://www.youtube.com/watch?v=CFCSvvsPWUA&ab_channel=UniversityofTwente%2FUniversiteitTwente

CHAPTER 3 FIELDS AND APPLICATIONS OF CBL

CBL is an educational approach that encourages students to engage with real-world problems and develop innovative solutions. It is a framework that blends academic rigor with hands-on problem-solving, making learning interactive and directly applicable to the world around us. Here's an overview of the fields and applications where CBL can be particularly effective.

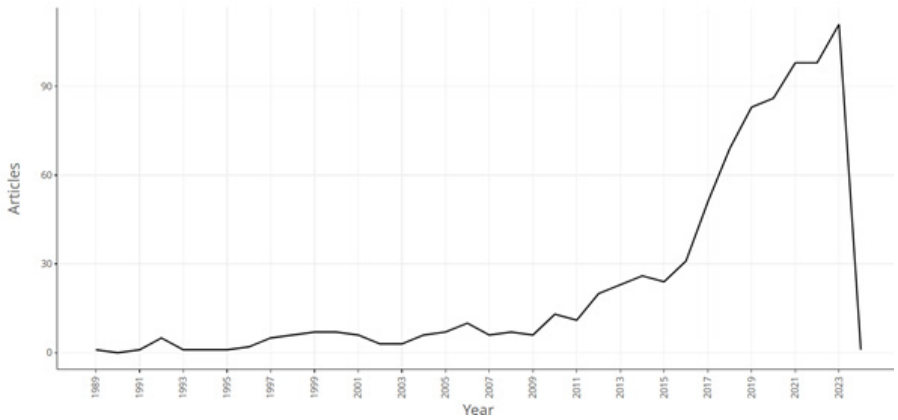
We have examined studies related to Challenge-Based Learning (CBL) in the Web of Science (WoS) database. General information regarding these studies is provided below.

Figure 4. General Information: CBL Studies



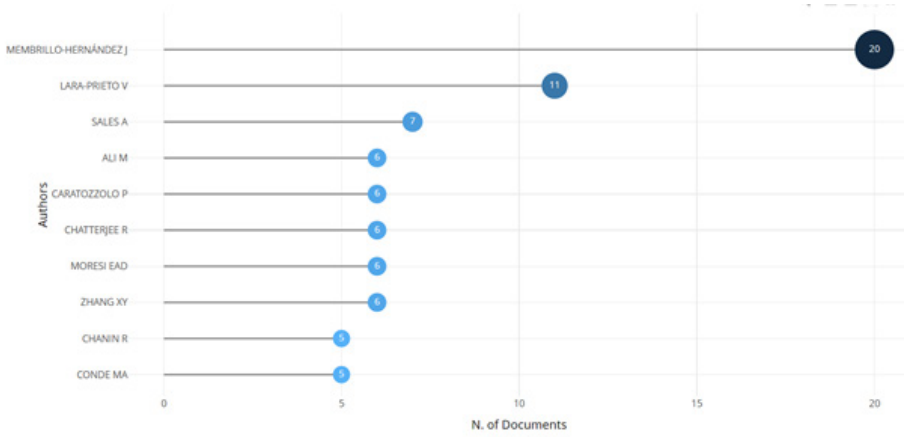
The Annual Scientific Production graph is shown below. The recent decline is due to the data set being limited to the specific period we analyzed.

Graph 1. Annual Scientific Production



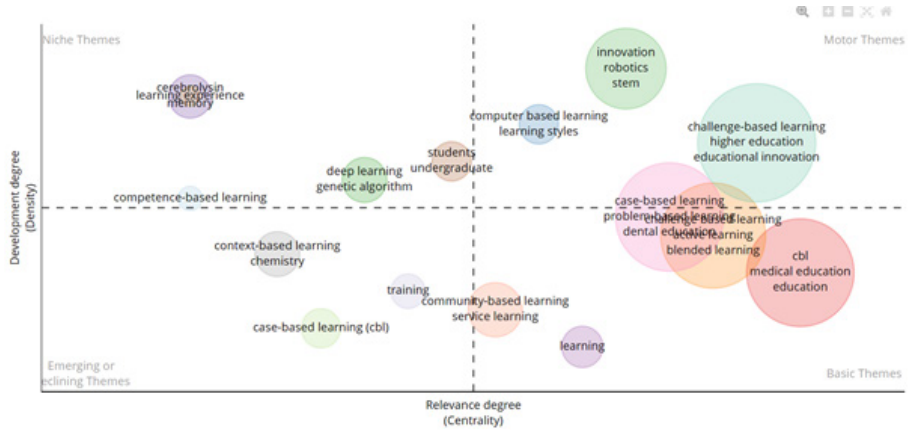
Graph 2 illustrates the most relevant authors for studies related to CBL. This graph highlights the leading researchers who have made significant contributions to the field, showcasing their impact and influence on the development and dissemination of CBL methodologies.

Graph 2. Most Relevant Authors



A thematic map depicting the key themes and topics within the realm of CBL would provide valuable insights into the diverse facets of this educational approach. By visualizing the interconnectedness of various concepts and ideas, the thematic map offers a comprehensive overview of the evolving landscape of CBL research and practice.

Graph 3. Thematic Map: CBL



In the WoS database, there are a total of 24 studies related to the intersection of CBL and entrepreneurship. These studies explore the integration of entrepreneurial principles and practices within the context of CBL, examining how CBL can foster entrepreneurial mindset, skills, and innovation among learners.

Environmental Studies: CBL in environmental studies empowers students to tackle urgent issues like climate change, sustainability, and conservation. It encourages them to come up with creative solutions to these global challenges (Martínez-Acosta et al., 2022; Membrillo-Hernández, 2018). By integrating CBL into environmental education, students not only deepen their understanding of ecological issues but also develop practical skills to address them effectively.

Business and Entrepreneurship: In business studies, CBL can help students learn to identify market needs, develop business plans, and understand the dynamics of starting and running a business (Colombelli et al., 2022; Detoni et al., 2019; Martínez & Crusat, 2017; Pérez-Sánchez et al., 2023; Portuguez Castro & Gomez Zermeno; 2020). By engaging in real-world challenges, students gain valuable entrepreneurial skills and insights that prepare them for success in the business world.

Healthcare and Public Health: Applying CBL in healthcare education helps students explore solutions for complex issues such as disease prevention, healthcare accessibility, and public health crises (Eraña-Rojas et al., 2019; Nizami et al., 2023; Lam, 2016; Tang & Chow, 2021). Through CBL, future healthcare professionals develop critical thinking skills and a holistic understanding of healthcare systems, preparing them to address the diverse challenges of the healthcare field.

Social Sciences and Humanities: CBL can be used to explore social issues, historical events, and cultural studies, allowing students to develop deeper understanding and empathy by engaging directly with community challenges (Rodríguez-Chueca et al., 2020). By integrating CBL into social sciences and humanities education, students gain practical experience in applying theoretical concepts to real-world situations, fostering a sense of social responsibility and civic engagement.

Art and Design: In creative fields, CBL can help students develop original art and design projects that address real-world needs (Putri et al., 2021). By incorporating CBL into art and design education, students not only hone their creative skills but also learn how to use their talents to make a positive impact on society.

CHAPTER 4 COLLABORATIVE PRACTICES

This chapter explores collaborative practices in CBL. It examines how effective teams can be established through well-defined roles and clear communication strategies and discusses the use of tools that facilitate collaboration in both remote and in-person contexts.

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, students need 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.

One of the biggest differences between CBL and more traditional approaches to teaching and learning is 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.

In other words, in the CBL methodology, the role of the teacher undergoes a significant transformation. Rather than acting as a traditional teacher, the teacher becomes a guide and facilitator, providing students with knowledge and practical advice. While the teacher offers relevant content expertise, their primary responsibility is to serve as a coach for the student team, supporting them through the various steps of the CBL process and fostering their learning journey. Additionally, teachers can define learning outcomes at both the course and curriculum levels, provided these outcomes remain flexible enough to accommodate the individual choices and needs of the students. Although CBL places significant responsibility on students, the teacher's role remains critical in ensuring successful outcomes. By closely monitoring each group's progress and the feedback they receive, teachers can provide timely guidance, address challenges, and make necessary adjustments to support student learning and project success.

The roles of collaborator and co-learner can be difficult 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 correct courses. 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.

Website Source: https://www.challengebasedlearning.org/project/cbl-guide/_

Collaboration among teachers is best practice in CBL. It supports the creation of multidisciplinary content by blending expertise from various subject areas. This approach enables students to explore knowledge more deeply, develop critical thinking, and make meaningful connections across disciplines. Although collaboration is highly beneficial, a single teacher with one class can also run a successful CBL project. Virtual collaboration with teachers from other schools, locally or internationally, can further enrich the process and broaden learning opportunities. This aligns with Nichols, Cator, and Torres (2016), who stress flexibility and collaboration for effective CBL implementation.

4. 2 Tools facilitating remote and in-person collaboration

In the context of remote and hybrid 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 environments. Cooperation without collaboration may result in disunity whereas 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. Through features such as shared digital workspaces, real-time feedback, and interactive discussions, learners move beyond passive reception and instead co-construct knowledge. This process not only fosters a deeper understanding of the subject matter but also develops critical thinking, problem-solving, and communication skills. Furthermore, interactive learning environments create opportunities for peer-to-peer support, encourage multiple perspectives, and enhance motivation by making the learning experience more engaging and dynamic.
- **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. In addition, it fosters a more supportive and responsive learning environment where dialogue between teachers and students is ongoing rather than limited to formal assessments.
- **Student-Centered Collaboration:** Collaboration tools facilitate peer-to-peer collaboration, encouraging students to work together, share ideas, and learn from one another.

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

By leveraging collaboration tools, educators (temachers) can create dynamic and engaging remote learning experiences that enhance student learning outcomes and foster a sense of community among learners, regardless of physical distance.

CHAPTER 5 IDENTIFYING CHALLENGES

This chapter focuses on the critical process of identifying and framing challenges in CBL. It outlines practical techniques for defining clear and actionable problem statements and discusses the ethical considerations that educators must address when selecting and shaping challenges to ensure inclusivity, fairness, and academic integrity.

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.

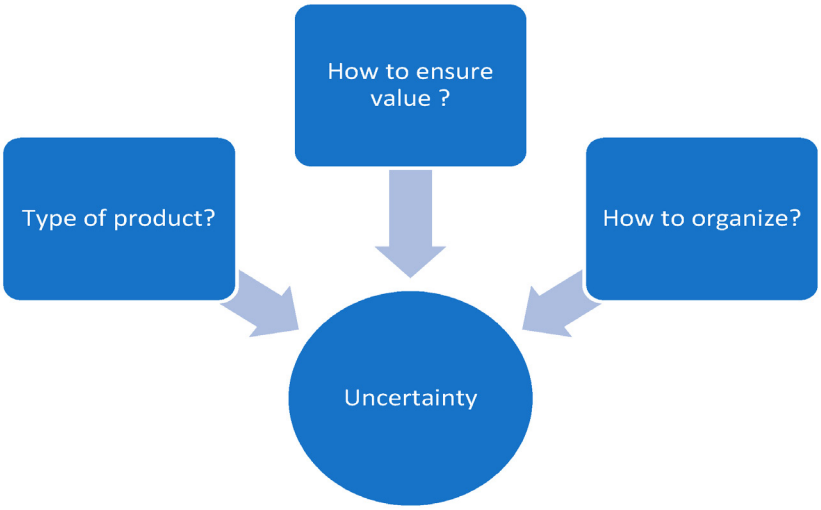
In addition, a problem statement is a concise and clear description of an issue or challenge that needs to be addressed. It serves as a roadmap for problem-solving and decision-making, helping individuals and teams define the scope of their work and focus on the most critical aspects of a problem.

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.

Figure 5. Aspects of Uncertainty in the Project Assignment



Source: Hussein, 2021.

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?
- How can we foster empathy and understanding among students from different cultural backgrounds?
- How can we create a more inclusive and accessible school environment for individuals with disabilities?
- How can we assist elderly individuals in adapting to new technologies?
- How can we reduce bullying and discrimination in our school?
- How can we decrease social media addiction among young people?
- How can we improve waste management efficiency on our school campus?
- What innovative methods can we implement to reduce energy consumption in our school?
- How can we organize community events to protect local ecosystems?
- How can we support local farmers and promote organic agriculture?
- How can we encourage water conservation practices in our school?
- What digital tools can we develop to help students work more efficiently in their educational processes?
- What technological solutions can be applied to enhance school security?
- How can we improve health and fitness tracking by designing wearable technology products?
- How can we use virtual reality to learn about historical events more effectively?
- How can we make coding education more engaging and accessible?
- How can we promote healthy eating habits in the school cafeteria?
- How can we increase physical activity levels among students?
- What mindfulness and meditation techniques can be used to reduce school-related stress?
- How can we improve mental health services in our school?
- What awareness campaigns can we organize to prevent smoking and alcohol use?
- How can we develop sustainable funding methods for school events?
- How can we provide local businesses with more effective social media strategies?
- How can we establish an entrepreneurship club for students within the school?
- How can we teach financial literacy to young people?
- How can we encourage green entrepreneurship projects in our school?

An illustrative example of CBL can be found in the work of García-Zambrano and Ruiz-Roqueñi (2024), who applied the methodology in a university setting to address sustainability challenges. In this case, students were invited to explore the issue of plastic waste and recycling within their campus environment. The CBL framework guided them through identifying the problem, conducting an analysis of current waste management practices, and designing practical solutions aimed at reducing plastic usage and promoting zero-waste strategies. The findings showed that, beyond generating innovative proposals, students developed essential competencies such as collaboration, critical thinking, and the ability to apply theoretical knowledge to real-world contexts. The case also demonstrated how CBL can contribute to raising environmental awareness and embedding sustainability into higher education curricula. By combining academic content with real challenges, the project not only enhanced learning outcomes but also produced tangible improvements for the university community.

Similarly, Martínez-Pérez et al. (2023) explored CBL in an engineering and urban-planning course where students tackled the challenge of reducing traffic-related air pollution in mid-sized cities. The teams collaborated with municipal data offices to collect and visualise air-quality and traffic-flow metrics, prototyped alternative traffic-routing strategies, and presented evidence-based recommendations to policy stakeholders. Findings showed measurable gains in data-driven decision-making, interdisciplinary communication, and stakeholder-engagement skills, highlighting the role of CBL in preparing students for complex socio-technical problem-solving.

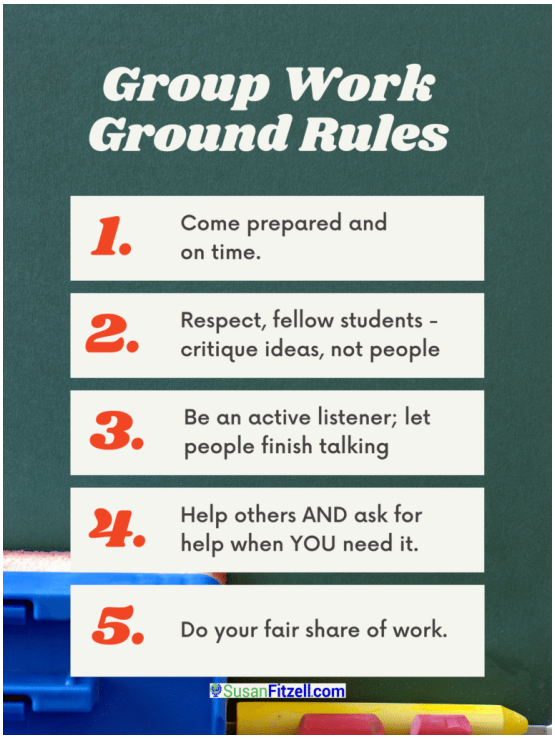
Another example is provided by Singh and Adebayo (2022) in the context of business and entrepreneurship education, where students were challenged to propose financially sustainable "green logistics" solutions for local SMEs. Working in multi-disciplinary teams, they performed SWOT analyses, life-cycle assessments, and Business-Model-Canvas mapping, then developed prototypes such as eco-friendly packaging options and incentive-based waste-return schemes. Their participation not only improved entrepreneurial literacy and negotiation competencies but also underscored how CBL can bridge academic curricula with regional economic and environmental priorities.

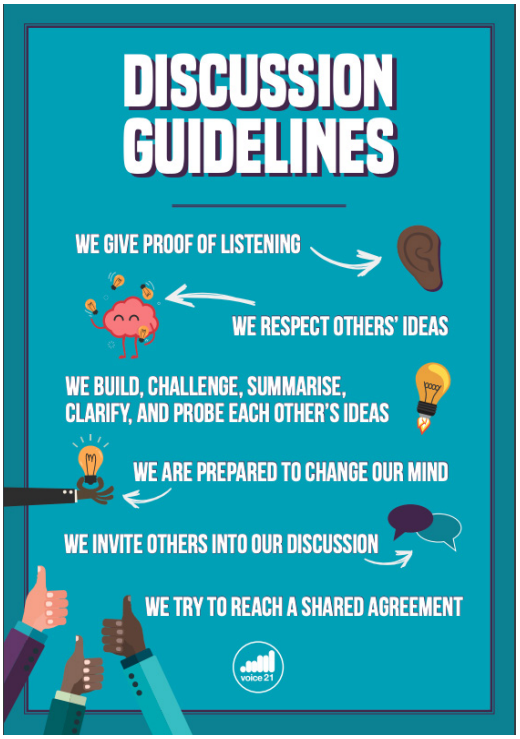
Collectively, these studies underline that CBL's effectiveness lies in connecting disciplinary knowledge to authentic societal challenges while cultivating 21st-century competencies such as collaboration, creativity, adaptability, and civic responsibility. The variety of contexts—from sustainability initiatives on campuses to urban environmental planning and SME-focused innovation—demonstrates CBL's flexibility across disciplines and its capacity to generate both meaningful learning outcomes and real-world impact when guided by strong facilitation and stakeholder partnerships.

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 arrival 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). This means that challenges should be framed in a way that invites multiple perspectives, allowing learners to explore diverse solutions rather than being constrained by the educator's assumptions. In practice, this requires educators to act as facilitators who guide the process without dictating outcomes, ensuring that students have the freedom to question, interpret, and construct their own pathways of inquiry. Moreover, it emphasizes the importance of respecting learner autonomy, promoting inclusivity, and encouraging critical thinking, all of which are central to the ethical foundation of CBL. When challenges are selected and presented with such sensitivity, students are more likely to develop independent judgment, engage in authentic problem-solving, and connect their learning to meaningful real-world contexts.

Figure 6. Depicting Discussion Guidelines and Group Work Ground Rules





Website Source: https://susanfitzell.com/strategies-for-effective-group-processes-establish-ground-rules/

Website Source: https://voice21.org/how-to-develop-independent-student-discussion/

Ethical Do's and Don'ts in CBL

When selecting and framing challenges in CBL, educators must adhere to certain ethical principles. First, it is essential to encourage learner autonomy and ownership, rather than imposing personal beliefs or predetermined conclusions (Coles, 1991; Jacobs & Keegan, 2018). Challenges should also be culturally sensitive and inclusive, avoiding topics that may marginalize or stereotype particular groups (UNESCO, 2015).

Equally important is the creation of an environment that facilitates open dialogue and multiple perspectives. Restricting discussion to a single viewpoint not only limits critical thinking but also diminishes learner engagement (Brookfield & Preskill, 2012). Educators should further ensure transparency and consent, particularly when projects involve external stakeholders or sensitive data. Ignoring these aspects may violate ethical standards in educational research (BERA, 2018).

Another key principle is to promote critical thinking and independent analysis. Educators should act as facilitators, supporting learners' inquiry processes without steering them toward a "correct" answer defined solely by the instructor (Savery, 2015).

Taken together, these ethical considerations provide a framework for empowering learners to engage with meaningful challenges in ways that respect diversity, autonomy, and inclusivity, while maintaining academic rigor and integrity.

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.

6.1 SWOT Analysis

In the context of CBL, SWOT Analysis is a practical tool that enables students to examine the strengths, weaknesses, opportunities, and threats connected to their chosen challenge. By assessing both internal and external factors, students gain a clearer understanding of what supports or hinders their project. This structured reflection helps them design more effective and strategic responses to real-world problems.

When applied within CBL, SWOT encourages students to build on their existing assets and resources while also recognizing limitations that may restrict their solution. At the same time, identifying opportunities allows them to take advantage of favorable conditions, whereas acknowledging potential threats helps them anticipate risks and prepare contingency strategies. For instructors, guiding students through a SWOT exercise ensures that learners not only generate creative ideas but also develop critical skills in planning, risk management, and adaptive problem-solving—skills directly transferable to professional and academic contexts.

In a CBL project, instructors can use SWOT Analysis as a structured classroom activity to help students critically evaluate their chosen challenge. After defining the challenge, students can work in teams to create a SWOT matrix with four quadrants: **Strengths, Weaknesses, Opportunities, and Threats**.

- **Step 1 – Define the Challenge:** Begin by clearly restating the challenge question the team is working on.
- **Step 2 – Brainstorm Strengths and Weaknesses:** Ask students to identify internal factors that support (strengths) or limit (weaknesses) their project—such as skills, resources, time, or technology.
- **Step 3 – Explore Opportunities and Threats:** Guide them to consider external conditions. Opportunities may include new policies, emerging technologies, or community support, while threats could involve competition, lack of funding, or logistical barriers.
- **Step 4 – Reflection and Action Plan:** Have students present their SWOT results to the class and discuss how the insights will shape their project strategies. Encourage them to propose specific actions, such as building on a strength, addressing a weakness, or developing contingency plans for anticipated risks.

By completing this exercise, students connect creative problem-solving with strategic thinking. For instructors, the SWOT framework offers a simple but powerful way to teach students how to analyze real-world challenges and design more resilient, sustainable solutions within the CBL process.

Video Links to SWOT Analysis:

- **Video 1: How to Conduct a SWOT Analysis| 2:14 min |**

  https://www.youtube.com/watch?v=goxMsPCs_z0&ab_channel=DecisionSkills

- **Video 2: SWOT Analysis: How to Perform It & Why It Matters| 14:53 min |**

  https://www.youtube.com/watch?v=qNeMAuu1llw&ab_channel=LYFEMarketing

- **Video 3: A SWOT Analysis of Nike, Inc. | Explained | Why Nike is so successful? |3:08 min |**

  https://www.youtube.com/watch?v=zR6s3SWPVkQ&ab_channel=AssignmentPrime

Suggested Classroom Prompt (optional): State your CBL challenge in one measurable sentence. Create a 2×2 SWOT grid and populate each quadrant with at least 4 items: Strengths (internal), Weaknesses (internal), Opportunities (external), Threats (external). Tag every item as *Evidence* (cite source: data/observation/stakeholder) or *Assumption* (specify missing data). Use quick dot-voting to prioritize 2 items per quadrant, then craft three strategic moves (e.g., S-O, W-O, S-T or W-T). For each move, define success metrics (what will change, by how much, by when), note the baseline, and propose a 1-week or 2- weeks pilot. Identify any key risks from the T quadrant and add a short mitigation. Submit a one-page SWOT + a brief 5-sentence reflection on which evidence shifted your thinking and what data you still need.

6.2 Root Cause Analysis (RCA)

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. RCA is crucial in CBL because it ensures that students identify and address the fundamental issues underlying a problem rather than just its symptoms. By repeatedly asking "why" and probing deeper into the problem, students can uncover the core causes. This process not only prevents the problem from reoccurring but also leads to more effective, long-lasting solutions. RCA encourages critical thinking, requiring students to analyze situations thoroughly and base their conclusions on evidence, which is essential for solving real-world challenges.

Video Links to RCA Analysis:

- **Video 1: Root Cause Analysis: Fundamentals - RCA 101| 12:08 min |**

  https://www.youtube.com/watch?v=7RzxGLIp468&ab_channel=TheKaizenTribe

- **Video 2: Root Cause Analysis Fundamentals| 21:13 min |**

  https://www.youtube.com/watch?v=E0ugNjOa0sw&ab_channel=TapRooT%C2%AE

- **Video 3: What are the 5 Whys? Root Cause Analysis Explained for Business Problem Solving| 6:21 min**

  https://www.youtube.com/watch?v=bt2g2ONqcq4&ab_channel=ShipmateFulfillment

Within CBL, applying RCA after the challenge is clearly defined and initial observations/data are gathered. Begin with a measurable, observable problem statement (who/what/where/when). Ask students to distinguish evidence (data, observations, stakeholder input) from assumptions (claims not yet supported), explicitly noting information gaps. Using the 5 Whys technique, teams ask why after each answer and support every step with evidence; when evidence is missing, they mark it as an assumption and specify what data would validate it. Candidate root causes are briefly validated through micro-data tasks (e.g., a one-day count, a short stakeholder check, a mini-survey). Students then convert validated insights into a concise root-cause statement

with clear success metrics (what will change, by how much, and by when). Finally, they design small pilot countermeasures aligned to the root cause and track their effects (e.g., short A/B or before–after comparisons over one to two weeks). Close the loop with a short reflection where students explain which evidence shifted their thinking, what they will adjust next, and how the agreed metrics will be monitored over time.

Suggested Classroom Prompt (optional): State your problem in one measurable sentence. List your top three facts (with sources) and three assumptions (with missing data). Run a 5-Whys chain to at least level 5, validate one candidate root cause with a micro-test, and propose a 1- or 2-weeks pilot with success metrics.

6.3 Fishbone Diagram (Ishikawa Diagram)

This method helps students systematically explore and categorize the potential causes of a problem. This visual tool allows learners to break down complex issues into more manageable parts, making it easier to identify underlying factors and their interrelationships. By organizing causes into categories such as people, processes, materials, and environment, students can see the bigger picture and pinpoint specific areas that need attention. This structured approach ensures thorough analysis, leading to more effective problem-solving and innovative solutions. To sum up, it is a visual tool used to explore and categorize potential causes of a problem, enabling teams to investigate various contributing factors.

Video Links to Fishbone Diagram:

- **Video 1: What is a Fishbone Diagram (Ishikawa Diagram)? | 1:28 min |**

  https://www.youtube.com/watch?v=4eteSMuum6k&ab_channel=EyeonTech

- **Video 2: Fishbone Diagram Explained With an Example| 7:06 min |**

  https://www.google.com/search?sca_esv=137e48d954afa8b7&sxsrf=ADLYWIL77pkr9JyQD-JciiEFzUkHhx7qr5w:1716187830777&q=fishbone+diagram&tbm=vid&source=lnms&prmd=ivnbtz&sa=X&sqi=2&ved=2ahUKEwifvpXw0ZuGAxWB9gIHHQCqAhcQ0pQJegQIDhAB&biw=1396&bih=632&dpr=1.25#fpstate=ive&vld=cid:30af5093,vid:JbRx5pw-efg,st:0

- **Video 3: Fishbone Diagram - Ishikawa Diagram - Cause and Effect Diagram| 3:40 min |**

  https://www.youtube.com/watch?v=xkey1qByic4&ab_channel=LeanVlog

Within CBL, use the Fishbone (Ishikawa) diagram when the team clearly sees the *effect* (the problem outcome) but needs to surface and organize all plausible *causes* before testing them. Start by writing a measurable, observable effect at the fish "head" (who/what/where/when). Draw the spine and brainstorm primary cause categories (e.g., *People, Process, Policy, Place/Environment, Technology/Tools, Materials/Supplies, Measurement/Data, Incentives*). Under each category, add secondary/tertiary causes as branches. Require students to label each cause as evidence-based (with source) or assumption (missing data specified). Cluster duplicates, note interactions across categories, and then prioritize 2–3 high-impact, high-control causes (quick dot-voting or an impact-likelihood grid works well). Convert the top items into testable hypotheses and, if needed, run a short 5 Whys on each to verify depth. Validate candidates with micro-data tasks (a one-day count, brief stakeholder check, mini-survey), then craft a concise cause statement linked to success metrics (what will change, by how much, by when). Design small pilots aligned to the prioritized causes and track effects (short A/B or before–after comparisons over 1–2 weeks). Conclude with a brief reflection ex-

plaining which evidence changed the team's view, what they will adjust next, and how metrics will continue to be monitored. Cross-reference to 6.2 RCA (drilling down on a specific branch) and 7.2/7.3 (using metrics for impact tracking and assessment).

Suggested Classroom Prompt (optional): Draw a Fishbone with your problem effect at the head. Add 6–8 primary categories (e.g., People, Process, Policy, Place/Environment, Technology/Tools, Materials/Supplies, Measurement/Data, Incentives). For each category, list secondary causes and tag each as evidence (with source) or assumption (state missing data). Prioritize the top 2–3 causes, validate one with a micro-test (data in 24–48 hours), and propose a 1- or 2-weeks pilot with success metrics. Include a 5-sentence reflection on what evidence shifted your thinking.

6.4 Qualitative Analysis Methods

The knowledge of Qualitative Analysis Methods is vital in CBL because it equips students with the skills to deeply understand complex issues through non-numerical data. Qualitative methods such as interviews, focus groups, and content analysis allow learners to gather rich, detailed information about people's experiences, perceptions, and motivations. This in-depth understanding is crucial when addressing multifaceted challenges that involve human behavior and social dynamics. By employing qualitative techniques, students can uncover insights that are not apparent through quantitative data alone, leading to more comprehensive and empathetic solutions.

Moreover, qualitative analysis fosters critical thinking and effective communication skills. As students analyze qualitative data, they learn to identify patterns, draw connections, and interpret nuanced information. This process enhances their ability to think critically about the issues at hand and to articulate their findings clearly and persuasively. Additionally, qualitative methods often involve interacting with diverse stakeholders, which helps students develop strong interpersonal skills and cultural competence. These abilities are essential for working collaboratively and effectively in real-world settings, where understanding and addressing the perspectives of various stakeholders is key to successful problem-solving.

Video Links to Qualitative Research:

- **Video 1: Fundamentals of Qualitative Research Methods: What is Qualitative Research (Module 1) | 13:51 min |**

  https://www.youtube.com/watch?v=wbdN_sLWl88&list=PLqHnHG5X2PXCsCMyN3_EzugAF7GKN-2poQ&ab_channel=YaleUniversity

- **Video 2: Qualitative research methodology qualitative research methods an overview |1:51 min |**

  https://www.youtube.com/watch?v=jkwuc-vIhnI&ab_channel=DrDee

- **Video 3: Overview of Qualitative Research Methods | 12:09 min |**

  https://www.youtube.com/watch?v=IsAUNs-IoSQ&ab_channel=PHILO-notes

6.5 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.

CBL projects often involve collecting data from various sources, such as surveys, interviews, observations, or experiments, to better understand the problem at hand and evaluate potential solutions. Data analysis tools enable students to analyze this data systematically, identify patterns, trends, and relationships, and derive actionable insights to inform decision-making.

Video Links to Surveys and Questionnaires:

- **Video 1: 4.7 Survey, questionnaire and test | Quantitative methods | Measurement | 4:43 min |**

  https://www.youtube.com/watch?v=13O4B0gPC4M&ab_channel=ResearchMethodsandStatistics

- **Video 2: Surveys in Statistics| 2:07 min |**

  https://www.youtube.com/watch?v=Y_EQfy-uk0Y&ab_channel=LearnFree

- **Video 3: Writing Good Survey Questions - Statistics Help | 3:27 min |**

  https://www.youtube.com/watch?v=n34OnLnKzIg&ab_channel=DrNic%27sMathsandStats

6.6 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.

In CBL, students are encouraged to develop hypotheses about the problem they are addressing and test these hypotheses using empirical data. Data analysis tools provide students with the means to conduct hypothesis testing, validate assumptions, and draw evidence-based conclusions about the effectiveness of proposed solutions.

Data analysis tools often include features for visualizing data in charts, graphs, or dashboards, which help students communicate their findings effectively and interpret complex data sets more intuitively. Visualization enables students to identify patterns, outliers, and relationships within the data, facilitating deeper insights and understanding.

Video Links to Data Analysis Tools:

- **Video 1: Data analytics challenges for business: UNSW Business Insights Institute | 1:46 min**

  https://www.youtube.com/watch?v=WmNHY1YePyk&ab_channel=UNSWBusinessSchool

- **Video 2: How statistics can be misleading - Mark Liddell| 4:19 min |**

  https://ed.ted.com/lessons/how-statistics-can-be-misleading-mark-liddell

- **Video 3: Quantitative Data Analysis 101 Tutorial | 28:13 min |**

  https://www.youtube.com/watch?v=EUeQRE5UJpg&list=PLvcb33xNTVUmCUnhQxtizmm8hOGP-vdTIF&ab_channel=GradCoach

6.7 Benchmarking and Comparative Analysis

In CBL, benchmarking and comparative analysis are valuable tools for evaluating student projects and guiding improvement. By comparing their solutions with established industry standards or similar initiatives, students are able to measure the effectiveness of their outcomes in a realistic context. This process not only provides a clear sense of achievement but also highlights areas where refinement is needed. Moreover, comparative analysis enables students to identify and learn from successful case studies, gaining insights into strategies and approaches that can strengthen their own work.

For instructors, encouraging students to benchmark their projects against best practices creates opportunities for deeper and more reflective learning. When students examine how other organizations or teams address similar challenges, they develop critical thinking, adaptability, and an understanding of how classroom projects connect with real-world practices. In this way, benchmarking goes beyond comparison; it becomes a formative learning exercise that fosters both academic growth and practical problem-solving skills.

In educational contexts, benchmarking and comparative analysis not only serve as evaluation tools but also as learning methodologies. They help students understand that problem-solving is rarely isolated; most challenges have been addressed in some form by others. By examining industry standards and parallel projects, students learn to situate their own work within a larger professional and societal framework. This perspective encourages them to think critically about the originality, feasibility, and long-term impact of their solutions—skills that are essential for both academic development and professional practice.

Instructors can incorporate practical exercises into their CBL sessions by guiding students through benchmarking and comparative analysis activities. For example, after students complete a project or develop a prototype solution, they can be asked to compare their work with existing industry standards or similar initiatives. This can be done in four simple steps: first, students conduct a brief self-assessment of their project outcomes; second, they benchmark their results against established guidelines or best practices; third, they analyze at least one case study or comparable project to identify effective strategies; and finally, they write a short reflection on what they have learned and how they might improve their work. By engaging in such activities, students not only evaluate their own solutions more critically but also learn from real-world examples, develop problem-solving skills, and strengthen their ability to transfer knowledge across contexts.

Video Links to Benchmarking and Comparative Analysis:

- **Video 1: What is Benchmarking? | 5:08 min |**

  https://www.youtube.com/watch?v=AkGwJSlkpfY&ab_channel=TheFinanceStoryteller

- **Video 2: What Are Competitive Analysis & Competitive Benchmarking? | 1:21 min |**

  https://www.youtube.com/watch?v=BZzdN1ynAIo&ab_channel=Meltwater

- **Video 3: How to benchmark a business or process | 1:17 min |**

  https://www.youtube.com/watch?v=8t-7dGYF5zs&ab_channel=YouExec

6.8 Decision Theory

This theory equips students with tools to make informed and effective decisions when tackling real-world problems. In CBL, students are often presented with complex, open-ended challenges that require a structured approach to problem-solving. Decision Theory provides a framework for evaluating options, understanding potential outcomes, and making choices that are logically sound and well-justified. This theoretical underpinning helps students systematically consider the trade-offs and uncertainties inherent in real-world scenarios, thereby enhancing their critical thinking and decision-making skills.

Additionally, decision matrices such as cost-benefit analysis, decision trees, or weighted scoring models assist in evaluating alternative solutions or options.

Video Links to Decision Theory:

- **Video 1: Decision Theory: Overview| 8:27 min |**

  https://www.youtube.com/watch?v=5eyb7itRd48&ab_channel=LindaWilliams

- **Video 2: Introduction to Decision Theory| 5:25 min |**

  https://www.youtube.com/watch?v=qys2ZmsUhcw&ab_channel=RaihanaZainordin

- **Video 3: Solve Decision Tree for a bidding problem | Bid High or Low| 4:17 min |**

  https://www.youtube.com/watch?v=N_1S422E2Ak&ab_channel=JoshuaEmmanuel

6.9 Design Thinking

Design Thinking (DT) integrates the principles of design into problem-solving and organizational development, offering a structured yet flexible methodology. Its parallels with CBL present numerous opportunities to combine the strengths of both approaches for deeper learning and innovation. DT is not a teaching method but rather a framework that lays down a process to design students' thinking, and it is well established at the industrial level (Gerardou et. al., 2022).

The traditional DT stages—**Empathize, Define, Ideate, Prototype, and Test**—align closely with the phases of CBL. These stages find resonance within the **Act Phase** of CBL. Once a potential solution concept has been identified, applying the iterative design cycle facilitates the refinement and implementation of the solution. This iterative approach encourages continuous improvement by enabling the development of new guiding questions, fostering deeper inquiry, and ultimately leading to more impactful outcomes.

Website: https://www.challengebasedlearning.org/learn/cbl-frequently-asked-questions/

While CBL centers on student motivation to drive engagement and foster learning, Design Thinking focuses on crafting feasible, practical, and desirable outcomes (Gama et al., 2018).

Video Links to Design Thinking:

- **Video 1: The Explainer: What Is Design Thinking? | 2:17 min |**

  https://www.youtube.com/watch?v=_WI3B54m6SU&ab_channel=HarvardBusinessReview

- **Video 2: Design Thinking in 90 Seconds| 2:11 min |**

  https://www.youtube.com/watch?v=vQytKCT563I&ab_channel=TheStrategyGroup

- **Video 3: Design Thinking Process| 3:56 min |**

  https://www.youtube.com/watch?v=_r0VX-aU_T8&t=42s&ab_channel=Sprouts

Classroom Prompt: Applying Design Thinking in CBL: Objective: Help students use Design Thinking as a structured, human-centered process to tackle real-world challenges in CBL.

Activity Steps:

- Empathize – Ask students to observe or interview potential users and note their needs.
- Define – Guide teams to reframe their findings into a clear problem statement (e.g., "How might we…?").
- Ideate – Encourage brainstorming of as many ideas as possible without judgment.
- Prototype – Have teams create quick models, sketches, or storyboards.
- Test – Let them gather peer/user feedback and refine their solutions.

Discussion Questions:

- What surprised you during the empathy stage?
- How did reframing the problem change your ideas?
- What did you learn from testing your prototype?

Instructor Tip: Emphasize iteration—students should see testing and even failure as part of the innovation process. Collaboration and diverse perspectives are key to unlocking creativity.

6.10 Business Model CANVAS

The Business Model Canvas (BMC) can serve as a powerful tool within CBL projects, especially when the challenge involves entrepreneurship, innovation, or strategic problem-solving. While CBL encourages students to identify real-world problems and design creative solutions, the BMC provides a structured framework to test the feasibility and sustainability of those solutions. By mapping out customer segments, value propositions, revenue streams, and resources, students are able to evaluate not only the creativity of their idea but also its potential for real-world impact.

For instructors, integrating the BMC into CBL ensures that students move beyond generating ideas to building comprehensive and actionable strategies. This combination fosters both critical and entrepreneurial thinking: CBL drives the problem-based discovery process, while BMC structures the solution into a viable model. Instructors can guide students in using the BMC as a reflective and iterative tool-encouraging them to refine their strategies based on feedback, evidence, and collaborative insights. In this way, BMC strengthens the practical dimension of CBL and equips learners with skills directly applicable to business and innovative contexts.

Beyond its use in CBL, it is also important to understand the broader role of BMC as a strategic management tool. Entrepreneurship involves turning innovative ideas into successful business ventures. However, a solid foundation is necessary for ensuring sustainability and long-term growth. The Business Model Canvas (BMC) is a strategic framework (Osterwalder & Pigneur, 2010) designed to help startups and established businesses structure their business models efficiently. It provides a visual representation of key elements that drive a business, making it easier to analyze, design, and refine business strategies.

The BMC is widely used by entrepreneurs, business analysts, and educators (Blank & Dorf, 2012) to map out the core aspects of a business model in a simple yet effective manner. By breaking down

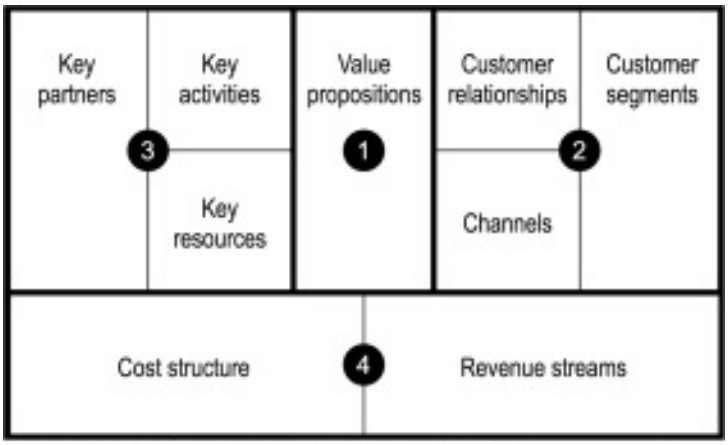
complex business elements into nine fundamental building blocks, companies can identify strengths, weaknesses, opportunities, and potential risks early in the process.

The BMC consists of nine interrelated components, each playing a vital role in shaping a business's operational and strategic direction. These components work together to create a comprehensive overview of how a company delivers value, engages with customers, generates revenue, and sustains its competitive advantage. By systematically analyzing each of these components, businesses can identify opportunities for growth (Gassmann, Frankenberger & Csik, 2014), optimize resources, and refine their strategies to ensure long-term sustainability.

Each component serves a unique function within the business model. For instance, customer segments define who the business serves, while the value proposition highlights what makes the business unique. The channels and customer relationships determine how the company interacts with and delivers products to its audience. On the financial side, the revenue streams and cost structure reveal how the company makes money and where its major expenses lie. Meanwhile, key resources, key activities, and key partnerships define the essential operations and collaborations needed to maintain success.

By understanding and optimizing these components, businesses can build a robust, adaptable model that not only meets current market demands but also prepares for future challenges and opportunities.

Shortly, BMC is a strategic management tool that helps organizations visualize and analyze their business model. The diagram below categorizes key business components into four main areas: product, customer interface, infrastructure management, and financial aspects.



Note: 1 = Product; 2 = Customer interface; 3 = Infrastructure management; and 4 = Financial aspects.

Source: (Keane et al., 2018)

Video Links to Business Model CANVAS:

- **Video 1: Introduction to Business Model CANVAS | 6:51 min |**

  https://www.youtube.com/watch?v=I8nwNcCfyig&ab_channel=OptimaTraining%28UK%29Limited

- **Video 2: The Business Model Canvas - 9 Steps to Creating a Successful Business Model - Startup Tips | 9:41 min |**

  https://www.youtube.com/watch?v=IP0cUBWTgpY&ab_channel=TheBusinessChannel

- **Video 3: Lean Canvas Example| 3:56 min |**

  https://www.youtube.com/watch?v=2nW9lg-fenY&ab_channel=ChannelX

6.11 Empathy Map Analysis

In CBL, the **Empathy Map** serves as a powerful tool to better understand the perspectives, needs, and motivations of stakeholders involved in the challenge. By systematically analyzing what stakeholders *say, think, feel, and do*, learners develop deeper insights into the human dimension of the problem. This process fosters empathy, which is essential for designing solutions that are both relevant and sustainable.

Through Empathy Map Analysis, students move beyond surface-level assumptions and uncover hidden concerns or opportunities. For example, identifying emotional drivers, frustrations, or unspoken expectations can reshape the way a challenge is framed and addressed. This not only strengthens critical thinking but also ensures that proposed solutions are inclusive, user-centered, and grounded in real-world contexts.

Ultimately, incorporating Empathy Maps into the CBL cycle encourages students to approach challenges with sensitivity, creativity, and ethical awareness—skills that are indispensable for both academic and professional success.

Classroom Prompt: Students Using an E-Learning Platform

Use the Empathy Map to explore the experiences of students who rely on e-learning platforms. Invite learners to reflect on the following perspectives:

- **What they say:** “Course materials are sometimes incomplete or outdated.” / “There are technical issues during live classes.” / “The platform interface is complicated and difficult to use.”
- **What they think:** “Is the quality of education lower compared to face-to-face learning?” / “Technical issues make it hard to follow lessons.” / “Being able to learn at my own pace is a great advantage.” / “Lack of interaction reduces my motivation.”
- **What they do:** Download course materials and study offline, seek alternative sources, connect with peers on forums or social media, and contact instructors by email for support.
- **What they feel:** Loss of motivation, frustration due to technical issues, stress when support is lacking, but also confidence in managing their own learning process.

Discussion task for students: Based on these perspectives, identify the key needs and pain points of e-learning users and propose innovative solutions that could improve both the platform’s usability and the overall learning experience.

Classroom Prompt: Women in Leadership – Challenges in International Trade

Use the **Empathy Map** to better understand the experiences of women aspiring to leadership roles in international trade. Encourage students to discuss and reflect on the following perspectives:

- **What they say:** Many note the difficulty of finding female role models or express frustration with the lack of gender equality in senior positions.
- **What they think:** They wonder whether they will have equal opportunities, whether their contributions are taken seriously, or if there is a “glass ceiling” blocking career progression.
- **What they do:** They actively seek out leadership programs, attend conferences, and engage in advocacy for inclusive business practices.

- **What they feel:** While they often feel pressure and frustration, they also experience determination and empowerment when supported by inclusive communities.

Discussion task for students: Based on these insights, identify the main challenges women face in international trade and propose practical strategies that could foster a more inclusive and supportive business environment.

Video Links to Empathy Map Analysis

- **Video 1: How to Use Empathy Maps | 4:11 min |**

  https://www.youtube.com/watch?v=Tz0dpeqcO60.

- **Video 2: UX Design For Beginners: Empathy Maps Exercise 101 | 5:30 min |** https://www.youtube.com/watch?v=TWrY5NkaUKY

- **Video3: Empathy Maps Exercise | 6:11 min |**

  https://www.youtube.com/watch?v=v5E3DkK4Ybo

- **Video 4: Building Relationships With Empathy Maps | 2:31 min |**

  https://www.youtube.com/watch?v=quX-YZ48Zlg

6.12 Six Thinking Hats

The **Six Thinking Hats** framework developed by Edward de Bono is a structured thinking tool that helps learners explore challenges from multiple perspectives-facts, emotions, risks, opportunities, creativity, and process. Within **Challenge Based Learning**, this method is particularly valuable because it ensures that student teams do not limit themselves to a single viewpoint. Instead, they engage in **holistic thinking**, which deepens critical analysis, encourages creativity, and supports the development of balanced, actionable solutions.

By adopting this method in CBL projects, students learn to:

- Examine a challenge objectively (White Hat).
- Recognize emotional and motivational aspects (Red Hat).
- Identify risks and weaknesses (Black Hat).
- Highlight benefits and opportunities (Yellow Hat).
- Generate innovative ideas (Green Hat).
- Organize their process and next steps (Blue Hat).

This structured, multi-angle approach helps students transform complex challenges into **well-rounded and implementable solutions**, while also promoting collaboration and inclusivity in decision-making

Classroom Prompt 1: Six Hat Analysis – E-Learning Platforms

Scenario: Students are asked to analyze the challenges of using e-learning platforms.

- **White Hat (Facts):** What do we know about usage statistics, common technical issues, or instructor challenges?

- **Red Hat (Feelings):** How do students and teachers feel when facing technical or interaction problems?
- **Black Hat (Risks):** What could go wrong if these issues are not addressed?
- **Yellow Hat (Benefits):** What are the potential advantages of improving e-learning systems?
- **Green Hat (Creativity):** What innovative solutions can we propose to make e-learning more engaging and effective?
- **Blue Hat (Process):** What action steps should be taken to improve the system and support both students and instructors?

Task for students: Discuss each hat in groups and create a summary of findings. End with **3 concrete recommendations** to improve the e-learning platform.

Classroom Prompt 2: Six Hat Analysis – Women Leadership and Sustainability in International Trade

Scenario: Students explore the intersection of gender, leadership, and sustainability in global trade.

- **White Hat (Facts):** What data do we have about women's representation in leadership and sustainability initiatives?
- **Red Hat (Feelings):** What emotions do women entrepreneurs and leaders express about their experiences?
- **Black Hat (Risks):** What barriers and systemic challenges make progress difficult?
- **Yellow Hat (Benefits):** What positive outcomes could come from stronger female leadership in sustainable trade?
- **Green Hat (Creativity):** What new programs, technologies, or solutions could empower women leaders in this space?
- **Blue Hat (Process):** What practical steps and policies should be implemented globally to support women-led sustainable businesses?

Task for students: Use each hat to build a **holistic picture of the challenge** and design a **strategic plan** with actionable steps to foster both gender equality and sustainability in international trade.

Video Links to Six Thinking Hats

- **Video 1: What Is Six Thinking Hats? | 1:58 min |**

  https://www.youtube.com/watch?v=UZ8vF8HRWE4

- **Video 2: An introduction to the Six Thinking Hats | 5:19 min |**

  https://www.youtube.com/watch?v=oHiwpz7r4wY

- **Video 3: Six Thinking Hats By Edward De Bono: animated Summary | 5:36 min |** https://www.youtube.com/watch?v=W3aWduLGM5I

CHAPTER 7: Implementation and Assessment

Imanbayeva et. al. (2023) examines the integration of the CBL methodology into courses and presents a framework to facilitate its implementation. The study highlights the complexity of embedding CBL into existing curricula and emphasizes the importance of maintaining quality, coherence, and consistency throughout the process. In this context, the researchers categorize the application of CBL into three levels: **"Mild," "Moderate," and "Full-Scale" CBL levels**. To implement CBL into courses, teachers can start by presenting a "**big idea**" that addresses a complex problem. This idea should enable students to design actionable solutions and engage with communities. In **Mild CBL** courses, students only provide recommendations, while implementation and evaluation are handled by others, resulting in a passive impact. The goal is to encourage students to analyze problems and develop effective solutions. To achieve this, the instructor should emphasize the importance of both passive influence and the active involvement of other stakeholders in implementing these solutions. Additionally, when presenting the Big Idea, consider guiding students to explore a relevant societal or industry challenge that they can help address. For example, the instructor might ask, "What can we do to reduce global food waste?" Sharing case studies or statistics can significantly enhance their understanding of the problem's context. As further steps, the instructor can have students research the literature on the issue in groups and encourage them to use a SWOT analysis or other strategic tools to develop potential solutions. Finally, students can prepare reports or visual presentations to communicate their findings.

In **Moderate CBL** courses, students take on a more active role, prototype solutions, and address challenges with personal relevance.

The goal is to have students prototype solutions and make individual connections. This approach encourages more active participation, allowing students to test the validity of their own suggestions. The instructor poses a solution-focused question, such as, "How can we innovate to reduce carbon emissions in urban transportation?" Additionally, the instructor shares examples that illustrate how the problem affects their individual lives. Students are then tasked with developing their solutions into a prototype, design, or small-scale service model. Examples of these can include a mobile app, a product mock-up, or a marketing campaign design. For testing and evaluation, the instructor encourages them to test their prototypes on a small audience and gather feedback using methods such as surveys, focus groups, or field tests. Finally, students present their results to the class or stakeholders and are asked to revise their prototypes based on the feedback they received. The objective is to empower students to create prototypes of innovative solutions while fostering meaningful connections. This method promotes active participation, enabling students to evaluate their suggestions critically.

Full-scale CBL experiences empower students to design and implement solutions with direct societal impact and evaluate their real-world effects.

Here, the aim is to empower students to design and implement impactful projects that make a difference in society. The instructor focuses on evaluating these projects' societal impact and real-world outcomes. The instructor provides a broad theme to foster creativity and encourages students to explore and refine specific societal issues. For instance, a theme may be "How can we enhance energy access in rural areas using sustainable energy solutions?" Students have the opportunity to collaborate with local stakeholders, experts, and members of the communities they aim to serve. By taking the lead in designing and executing their projects, they gain valuable hands-on experience. Additionally, students collect and analyze data to assess the real-world impact of their efforts. To share their findings, students create both written reports and visual presentations. These projects are presented to the public, media, and other interested community members, allowing for broader engagement. Finally, students reflect on and evaluate their projects through both academic and societal lenses, fostering a deeper understanding of their contributions.

For a successful implementation process, it is beneficial to equip students with resources such as templates, tools, and guide documents tailored to each level of learning. Assigning mentors, whether they are faculty members or industry professionals, can provide invaluable guidance and support throughout the journey. Additionally, creating interdisciplinary student groups can encourage the sharing of diverse perspectives, leading to innovative and effective solutions. It is also advisable to begin the first implementation at the Mild or Moderate level, allowing students to gain experience and build familiarity with the processes involved. This approach will lay a strong foundation for future success.

Website Source: https://essay.utwente.nl/91565/1/Imanbayeva_MA_BMS.pdf

Website Source:

https://assets.websitefiles.com/551e54eb6a58b73c12c54a18/63ce4ec514bd050570e51a30_A5.3%2C%20O1%20CBL_Quality%20criteria%20for%20challenges%20developed.pdf

Strategies for implementing solutions derived from CBL projects

Adopting and implementing CBL strategies for the first time may present challenges for both tutors and students. However, studies indicate that with increased experience, the process becomes more efficient and effective (Fonteijn & Dolmans, 2019). Section 7.1 outlines the steps and considerations for successful implementation, including team building, problem identification, and optimizing the learning context**.**

Step 1. Building Team (Team Characteristic in CBL)

In CBL, creating a well-functioning team is a crucial first step toward successfully addressing a challenge. Team building plays a vital role in fostering collaboration among students, allowing them to devise innovative solutions to complex problems. By implementing a well-structured team-building process, students can effectively harness their unique talents while enhancing overall group dynamics. This approach not only empowers individuals but also cultivates a supportive and productive team environment.

Teams should be composed of individuals with complementary traits and skills that foster collaboration and innovation. The first step in effective team building involves a constructive conversation about the purpose and basic principles of team building. The instructor can initiate this by highlighting the vital role of teamwork in CBL. For instance, the instructor might say, “This process enables a group of individuals to combine their unique skills in order to develop innovative solutions for real-world challenges.” Next, it is beneficial to bring together individuals with diverse skills, interests, and perspectives. Emphasizing this diversity can lead to the emergence of more creative and effective solutions. Additionally, fostering an environment where every team member feels encouraged to share their ideas openly will significantly enhance collaboration, creating a solid foundation of psychological safety within the team.

Website source: https://www.library.hbs.edu/working-knowledge/four-steps-to-build-the-psychological-safety-that-high-performing-teams-need-today

The steps mentioned below should be carefully considered to create a team building in this way:

Step 1.1 Team member characteristic

In the CBL method, team member characteristics are vital in enhancing team dynamics, the problem-solving process, and the overall quality of the solution. Each individual’s traits contribute to a positive synergy within the team, significantly improving the efficiency of the learning experience.

Recognizing and leveraging these characteristics can lead to more effective collaboration and richer outcomes. We can further explore the importance of these attributes under the following headings:

- **Personality:** Traits like extraversion and conscientiousness enhance communication and responsibility within the team, creating a supportive learning environment. Incorporating individuals with leadership qualities into a team can significantly enhance its effectiveness. These students can guide the group through their strong decision-making, coordination, time management, and motivational skills. Their presence can foster team cohesion, ensuring tasks are completed promptly while streamlining the decision-making process. It is also essential for team members to exhibit creative and innovative thinking abilities. Those who can generate alternative solutions and think outside the box contribute immensely to the team's capacity for innovative ideas and problem-solving. Such creativity often leads to groundbreaking solutions that can tackle various challenges. Furthermore, openness to analytical and critical thinking is vital for team success. Team members should be skilled in parts and is able to break problems into manageable parts and develop effective solutions. Strong communication skills play a crucial role in this process. Being able to listen actively, articulate thoughts clearly, present ideas in an organized manner, and communicate effectively in both written and verbal formats enhances collaboration and ensures that solutions are communicated efficiently to stakeholders. High emotional intelligence also plays a key role in team dynamics. By understanding and appreciating different perspectives, team members can resolve conflicts more effectively, fostering harmony and strengthening relationships within the group. In addition, team members should possess practical skills such as research capabilities, technology proficiency, software development, or technical prototyping. These skills empower the team to create effective technical solutions, gather data, and conduct thorough analyses. Lastly, it is beneficial for the team to include individuals with strong time management and organizational skills. This ensures smooth project flow and helps keep tasks on track, ultimately leading to the successful completion of objectives within designated timelines.

- **Abilities:** Skillful students contribute to task efficiency and improve the overall quality of solutions and can enhance group performance. In the CBL process, the skills and strengths of each student in the team play a vital role in enhancing both individual and collaborative efforts. By leveraging these abilities, students can significantly improve their chances of success at every stage of the problem-solving process, from clearly defining the problem to creatively developing and effectively implementing solutions. This collaborative approach fosters a supportive environment where everyone can contribute and grow.

In CBL process, the skills and strengths of each student in a team play a vital role in enhancing both individual and collaborative efforts. By leveraging these abilities, students can significantly improve their chances of success at every stage of the problem-solving process, from clearly defining the problem to creatively developing and effectively implementing solutions. This collaborative approach fosters a supportive environment where everyone can contribute and grow.

To create effective teams in CBL projects, it is essential for students to develop a diverse set of skills. These skills include analytical thinking, creativity, collaboration, effective use of technology, and the ability to find and apply accurate, reliable information. By combining their varied strengths, team members can support and enhance each other's contributions, leading to greater success in both the learning experience and the overall outcomes of the project.

Website source: https://teambuildingnation.com/blog/the-power-of-team-building-how-psychology-shapes-success/

- **Experience:** Previous teamwork experience helps team members work together more easily and avoid conflicts.

In the CBL process, students' experience levels are categorized into three tiers: "Mild," "Moderate," and "Full-Scale." These levels reflect the depth of students' involvement in the problem-solving process and the extent of their impact in the real world. Below, each experience level is discussed, along with its effects on the student's learning process:

Mild CBL Experience: At this level, students participate in the learning process to a limited extent, primarily offering suggestions.

Level of Student Participation:

- Students typically analyze the "big idea" through in-class activities and discussions.
- Solutions to the problem are developed, but they are not prototyped or implemented.
- The engagement remains largely at the theoretical and suggestion level.

Experience Characteristics:

- Passive learning is dominant; students generally only participate during the idea generation phase of the problem-solving process.
- It may not be possible to observe real-world effects.

Example: Preparing a research report or a list of suggestions in response to the question, "What policies should be developed to combat climate change?"

Advantages:

- This level serves as a suitable introduction for students who are new to CBL.
- It helps develop skills in problem definition and solution development.

Moderate CBL Experience: At this level, students become more actively involved in the solution process, often prototyping and testing their proposals.

Level of Student Participation:

- Students develop their solution proposals through individual or group work.
- Solution proposals are tested at the prototype level, and their applicability to the real world is evaluated.
- While there may be a social aspect to the solution, the implementation is not entirely carried out by the students.

Experience Features:

- The learning process is more interactive.
- Students take practical steps to test the feasibility of their solutions, though these steps may be limited in scale.

Example: "Design a mobile application to increase recycling awareness to combat climate change" and develop a prototype for it.

Advantages:

- Students engage in a deeper learning process and enhance their practical skills.
- They experience the processes of creating and evaluating prototypes.

Full-Scale CBL Experience: This level represents the most comprehensive CBL experience, where students are actively engaged in every stage of the problem-solving process and apply their proposed solutions in the real world.

Level of Student Participation:

Students conduct thorough research to address the problem, develop solution proposals, create prototypes, and implement these solutions in real-world scenarios. They evaluate the impact of their solutions on society and make necessary improvements based on feedback. Additionally, students communicate directly with stakeholders to assess the sustainability of their solutions.

Experience Features:

- Active and in-depth learning is emphasized.
- Students cultivate a sense of social responsibility while gaining real-world experience.
- The entire learning process is interactive and hands-on.
- Example: "Organizing a campaign to increase recycling rates in a local community, managing the campaign, and measuring its results."

Advantages:

- Students take full responsibility for both the problem-solving and implementation processes.
- Their motivation for learning increases as they observe the tangible effects of their efforts.
- Leadership, collaboration, and decision-making skills are significantly enhanced.

Table 4. The Comparative Summary Table

CBL Level	Level of Participation	Implementation	Impact	Suitability
Mild	Limited to idea generation	Suggestions are made, no implementation	Theoretical contributions	Ideal for students new to CBL.
Moderate	Active in solution development and prototyping	Solutions are tested, limited implementation	Partial impact	Suitable for students with moderate engagement.
Full-Scale	Active involvement in all processes	Real-world implementation of solutions	High impact	Best for experienced and motivated students.

Source: Imanbayeva et al. (2023)

CBL's experience levels offer a valuable pathway for students to enhance their knowledge and skills. The Mild Level serves as a solid theoretical foundation, perfect for those who are just beginning their journey with CBL. Progressing to the Moderate level, students engage in hands-on experiences that deepen their practical skills. Finally, the Full-Scale level empowers students to make a significant impact by actively addressing societal challenges. By thoughtfully choosing these levels, students can not only foster their personal growth but also make meaningful contributions to their communities.

Website source: https://www.challengebasedlearning.org/wp-content/uploads/2019/02/CBL_Guide2016.pdf

- **Motivation:** Motivated students can enhance the learning of others by sharing feedback and information.

In CBL, students' motivation plays a critical role in the success of the learning process. Ideally, students should possess intrinsic motivation, driven by a genuine curiosity to explore real-world problems and contribute to meaningful solutions. This intrinsic drive helps sustain their engagement through the often complex and iterative phases of identifying, developing, and implementing solutions. Additionally, extrinsic motivation, such as recognition, tangible outcomes, or societal impact, can further enhance their commitment to the project. Effective motivation in CBL also relies on a sense of ownership over the challenge, where students feel empowered to make decisions and see their efforts lead to visible, real-world changes. To maintain high motivation levels, it is essential to align the challenge with the students' interests, values, and aspirations, providing them with a clear sense of purpose. Furthermore, fostering a collaborative and supportive team environment, combined with continuous feedback and achievable milestones, helps reinforce students' confidence and determination to succeed.

Website source: https://www.challengebasedlearning.org/2023/08/22/your-brain-on-cbl/

Step 1.2 Team diversity and size

In CBL, team diversity and size play a significant role in the success of the collaborative process. For this reason, **team diversity and size** are critical factors that significantly influence the effectiveness and outcomes of collaborative learning experience. These elements impact the team's ability to approach problems creatively, divide tasks effectively, and maintain productive dynamics throughout the project. Both factors should be carefully considered to optimize teamwork and outcomes:

- **Heterogeneity:** Diverse teams with members from different backgrounds, skills, and perspectives can generate more creative and innovative solutions. This variety encourages rich discussions and allows for a more comprehensive approach to the challenge.
- **Small Groups:** Small teams are often more agile and easier to coordinate but may face challenges in workload distribution and limited viewpoints. Ideally **3–5 students (max 6)**, small teams are agile, easy to coordinate, and build strong cohesion; however, they risk **uneven workload**, **skill gaps**, **limited viewpoints**, and sensitivity to **one member's absence**. Mitigate these by **rotating clear roles** (facilitator, evidence/data lead, prototyper, stakeholder liaison, presenter/writer) and **cross-training** so no task depends on a single person. Keep the scope sized to capacity, and pair each team with a **"buddy" team** for periodic outside feedback to widen perspectives. Use a **tight cadence** (5-minute stand-ups, time-boxed work blocks, quick consent-based decisions) and require **individual mini-deliverables** (e.g., interview notes, brief, asset) to ensure visibility of contributions. Build **inclusion** with round-robin turns and talk-time tracking so quieter voices are heard. For accountability, add a **mid-point peer review** and maintain simple **contribution logs**—helpful for assessment and for rebalancing workload early.
- **Large Groups:** Larger teams bring a wider range of ideas and skills but may encounter difficulties with communication and coordination, potentially slowing down progress. Larger teams also face notable challenges that can impact the efficiency and quality of collaboration. As group size increases, communication channels multiply, coordination becomes more complex, and the risk of misunderstandings or duplicated efforts grows. Decision-making may slow down as it requires more negotiation and consensus-building, sometimes leading to conflict or delays in meeting milestones. These challenges are especially pronounced in CBL projects where time is limited and tasks are interdependent, such as conducting stakeholder interviews or iterating on prototypes. Research on group dynamics in educational settings (e.g., Johnson & Johnson, 2009; Salas et al., 2015) indicates that while larger groups often generate more diverse perspectives, they also experience a higher "**process loss**"—a decrease in overall productivity caused by increased

effort required for coordination, conflict resolution, and information sharing. Without clear role distribution, structured facilitation, and strong communication protocols, the potential advantages of larger teams may be overshadowed by logistical difficulties.

In addition, team diversity is a valuable asset, and the size of the team plays a significant role in enhancing the effectiveness of the CBL process (Savery, 2019). According to Savery, teams ideally should consist of 4 to 6 members. This size strikes a balance, allowing for diverse viewpoints and equitable workload distribution while fostering effective communication and decision-making. Smaller teams of 3 to 4 members can be incredibly effective for straightforward tasks or challenges with limited scope. These teams are generally easier to coordinate and manage. Conversely, larger teams of 6 to 8 members can tackle more complex projects, bringing together a broader range of skills and perspectives. However, it's essential to ensure that roles and responsibilities are clearly defined to prevent inefficiency.

Step 1.3 Communication, interaction, and team climate

A critical aspect to consider is the distribution of roles within the team. When teams reach the optimal size, assigning clear roles is important for accountability and seamless collaboration. Some valuable roles in CBL teams include:

- Team Leader/Facilitator: These individual guides hold discussions and ensure that the team makes consistent progress.
- Researcher: Focuses on gathering and analyzing relevant data to inform decision-making.
- Creative Thinker/Innovator: Brings forth unique ideas and solutions that foster innovation.
- Technical Expert: Responsible for prototyping and the technical aspects of implementation.
- Evaluator: Monitors the team's progress and assesses outcomes to ensure alignment with goals.

Considering these points, instructors can take proactive steps to balance team size and diversity harmoniously. For instance, while a large, diverse team offers a wealth of ideas, it can also lead to communication challenges and slower decision-making. In contrast, a moderately sized and diverse team can harness a range of perspectives without overwhelming the collaboration process.

To optimize both diversity and size effectively, instructors may want to implement the following constructive strategies:

1. Facilitate team-building activities to foster trust and enhance communication among members.
2. Leverage collaboration tools to streamline workflows, especially in larger teams, making it easier to juggle diverse contributions.
3. Regularly assess team dynamics and be open to redistributing roles when necessary, ensuring that everyone is engaged and contributing to their fullest potential.

By adopting these strategies, instructors can create a more effective and dynamic learning environment that harnesses the strengths of both size and diversity.

Step 1. 4 Coordination

In the CBL process, coordination is essential for the team to work efficiently and achieve its goals. Effective coordination involves establishing a structure that maximizes team members' contributions based on their skills and expertise. Additionally, providing a solid work framework supports this coordination process.

❖ **Work effort and expertise:** The effort and time that team members dedicate to the project are crucial for effective coordination. In the CBL, harmoniously integrating individual contributions is essential; thus, coordination is necessary to monitor each member's input and distribute the workload fairly. For instance, team members should actively participate in

tasks requiring significant effort during specific periods, such as prototyping or data analysis. The expertise of team members is fundamental to successful coordination. Good coordination entails effectively leveraging each team member's knowledge and skills. For example, a team member with technical expertise should lead prototype development, while a member with strong analytical skills should handle data analysis so that tasks can be allocated appropriately.

❖ **Work Structure:** CBL refers to how tasks are organized and distributed among team members. A well-structured approach enhances teamwork efficiency and minimizes confusion that may arise from a lack of coordination. It is essential for all team members to clearly understand their individual tasks and responsibilities. The project should establish target dates and delivery milestones for specific stages, enabling team members to organize their work more effectively. To facilitate information sharing within the team, regular meetings, communication tools, and reporting methods should be employed. Additionally, the work structure should be flexible enough to adapt to unexpected situations or changing project requirements.

Step 2: Identifying Problem/Task Characteristic

A crucial step that sets the foundation for the entire learning process. The problem or task should be authentic, meaning it reflects real-world challenges that are relevant to the students' lives or communities. This relevance fosters engagement and intrinsic motivation, encouraging students to invest effort in finding meaningful solutions. Additionally, the problem must be complex yet manageable, striking a balance between being challenging enough to stimulate critical thinking and feasible within the time frame and resources available.

The task should also be open-ended, allowing for multiple approaches and solutions, which encourage creativity and innovation among students. Furthermore, it is essential for the problem to have a societal or community impact, providing students with the opportunity to create actionable solutions that lead to tangible results. Lastly, the problem should be aligned with the students' skills and expertise level, ensuring that they have a sense of competence while still being pushed slightly out of their comfort zones to facilitate growth. Effective identification of these characteristics ensures that the challenge is not only educational but also transformative, fostering both individual and collective learning.

Step 2.1 Problem Formulation

Problem formulation is a pivotal step that frames the challenge in a way that guides the learning process while encouraging critical thinking and creativity. A well-formulated problem should be clear, concise, and focused, ensuring that students understand the issue without being overwhelmed by ambiguity. At the same time, it must be broad enough to allow for exploration and multiple potential solutions, fostering an open-ended inquiry. The formulation process should start with a "big idea" that addresses a relevant, real-world issue, followed by narrowing it into a specific and actionable challenge question. For example, a broad topic like "sustainability" might be refined into, "How can we reduce food waste in our community?" This approach connects the challenge to students' lives, enhancing motivation and engagement. Additionally, the problem formulation should encourage an interdisciplinary perspective, enabling students to apply diverse knowledge and skills while collaborating effectively. It should also incorporate realistic constraints such as time, resources, and societal factors, ensuring the solutions are both practical and impactful. Effective problem formulation provides a solid foundation for the CBL process, driving meaningful learning and empowering students to develop innovative and applicable solutions.

❖ **Clarity:** Clear and understandable problem. Problem formulation clarity is essential to ensure that students fully comprehend the challenge they are addressing. A clear and

well-defined problem provides a solid foundation for teams to engage in meaningful discussions and explore the issue in depth. To achieve clarity, the problem must be expressed in simple, understandable terms that eliminate ambiguity and confusion. Additionally, it should be interesting and relevant to the students, sparking curiosity and a sense of purpose. When students find the problem engaging, their intrinsic motivation increases, leading to more active participation, creative thinking, and commitment throughout the learning process.

- **Appeal:** It is another critical element in problem formulation, as it determines how the problem resonates with students on a personal or emotional level. A problem with high appeal connects to students' values, interests, or experiences, making it more relatable and meaningful. For example, a challenge related to improving mental health resources for peers may have a strong appeal because it aligns with their lived realities. By combining clarity with appeal, the problem formulation not only provides a clear direction for teams but also inspires them to invest effort and enthusiasm, ultimately driving impactful learning outcomes.

Step 2.1 Task Execution

Task execution is the phase where students actively engage in solving the identified challenge through a structured yet flexible approach. Effective task execution requires a clear division of responsibilities among team members, leveraging their individual strengths and expertise to ensure efficiency and productivity. This phase is highly collaborative, emphasizing open communication, regular progress updates, and mutual support to address obstacles that may arise.

To maintain focus and momentum, task execution should be guided by a detailed plan with specific milestones and deadlines. At the same time, flexibility is crucial, allowing teams to adapt their approach based on feedback, new insights, or unexpected challenges. The process should encourage iterative work, where solutions are developed, tested, and refined based on real-world constraints and results.

Additionally, task execution should be hands-on and experiential, involving activities like prototyping, data collection, and engaging with stakeholders to ensure the solutions are practical and impactful. Reflection and documentation are also integral, as they help students critically assess their progress and learn from their experiences. Overall, effective task execution in CBL combines structure, collaboration, and adaptability, empowering students to translate ideas into actionable and meaningful outcomes.

- **Interdependency:** Interdependent and interconnected tasks can enhance knowledge sharing among students. Interdependency is a critical element that fosters collaboration and ensures the effective functioning of the team. Interdependency means that team members rely on one another's contributions, skills, and efforts to achieve a common goal, creating a sense of shared responsibility and accountability. This dynamic encourages students to work collaboratively, recognizing that the success of the task depends on the collective performance rather than individual achievements.

To establish interdependency, tasks should be designed and assigned in a way that highlights the unique strengths and expertise of each team member while ensuring that their contributions are interconnected. For example, one student might handle research and data analysis, while another focuses on solution prototyping, and a third on stakeholder engagement. Each of these roles should align and integrate into the larger project framework, making it essential for team members to communicate regularly and synchronize their efforts.

Interdependency also cultivates skills such as teamwork, conflict resolution, and mutual support, as students learn to navigate the challenges of group work and leverage diverse perspectives. By fostering a culture of trust and collaboration, interdependency enhances problem-solving, creativity, and the overall effectiveness of the task execution process, ensuring that the team works as a cohesive and dynamic unit.

Step 3. Learning Context

The learning context should be designed to provide students with an authentic, engaging, and supportive environment that mirrors real-world scenarios. It must align with challenges that are meaningful and relevant to students' lives, fostering intrinsic motivation and deeper engagement. The context should encourage collaboration by offering spaces, either physical or virtual, where students can work together effectively, exchange ideas, and develop interpersonal skills. At the same time, it should strike a balance between providing structured guidance and allowing students the freedom to explore, make decisions, and innovate.

A supportive learning context also ensures access to necessary resources, such as tools, research materials, and mentorship, while fostering a safe and inclusive atmosphere where students feel confident to take risks and learn from their mistakes. Additionally, the learning process should integrate reflective opportunities, enabling students to assess their progress, refine their approaches, and deepen their understanding. By creating a learning context that is relevant, dynamic, and nurturing, CBL empowers students to tackle meaningful challenges, develop critical skills, and connect their learning to real-world applications.

- **Learning and Teaching Culture:** A classroom culture that is overly authoritarian, directive, or competitive can inhibit open dialogue, discourage risk-taking, and undermine trust factors that are essential for successful collaboration in CBL. To maximize team performance, students need to perceive the learning environment as autonomy-supportive, inclusive, and psychologically safe, where their contributions are valued and mistakes are treated as opportunities for growth.
- **Tutor characteristic:** The tutor's dual role as both subject-matter expert and facilitator is critical for guiding CBL teams. Strong disciplinary expertise enables the tutor to help students connect theory to authentic problems. At the same time, practical facilitation skills such as active listening, scaffolding inquiry, and conflict management encourage equitable participation and sustained motivation. A tutor who models curiosity and openness fosters deeper engagement and higher-quality team outcomes.
- **Time allocation:** CBL projects require adequate time for exploration, iteration, and reflection. Excessive time pressure or insufficient scheduling can reduce the depth of discussion, limit opportunities for creative prototyping, and ultimately diminish both the quality of learning and the feasibility of solutions. Allocating clear milestones, holding interim feedback sessions, and reserving protected time for group deliberation helps teams sustain meaningful collaboration and achieve well-reasoned results.

Website Source : https://unlimited.hamk.fi/ammatillinen-osaaminen-ja-opetus/building-effective-student-teams-in-problem-based-learning/

Even in courses where individual computers or mobile devices are not available for every student, CBL can still be effectively implemented. In such cases, teamchers are encouraged to allocate additional time within the course schedule to ensure students have access to shared computers during key phases, such as research and presentation preparation. Allowing students to use their personal devices, when possible, can further support and enrich the process. This aligns with the recommendations of Nichols, Cator, and Torres (2016), who emphasize that CBL is adaptable to diverse educational contexts and should not be limited by resource availability.

7.2 Monitoring and evaluating the impact of CBL initiatives

An important task is to improve an evaluation methodology appropriate for the CBL 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

International Case Study: Evaluating the Impact of CBL in Diverse Contexts

An exploratory study across higher education institutions in Mexico, the Netherlands, Ireland, and China examined how CBL is implemented and evaluated in different cultural and institutional environments (Van Den Beemt et al., 2023). The findings demonstrated that CBL enhances student motivation, engagement, autonomy, and problem-solving abilities, thereby confirming its effectiveness as a learner-centered methodology across diverse contexts.

However, the study also highlighted challenges that affect sustainability, including limited time, lack of resources, and the need for pedagogical transformation. Instructors emphasized the importance of institutional support, professional development, and technological infrastructure as critical enablers. Moreover, collaboration with external stakeholders, such as industry and community partners, was identified as a significant factor in ensuring meaningful outcomes.

This international case underscores that evaluating the impact of CBL must include both student outcomes and contextual factors. Institutional culture, available resources, and stakeholder engagement are as important as student learning results when assessing the long-term effectiveness of CBL initiatives.

7.3 Assessment

In CBL methodology, assessment is a crucial component that ensures the process, and the final product are aligned with learning goals and real-world expectations. The evaluation process integrates conventional academic methods and real-world assessment strategies, fostering a comprehensive understanding of student progress. These assessments not only guide decision-making as learners advance toward a solution but also offer meaningful feedback on the depth of their content knowledge and the effectiveness of their efforts.

A robust assessment framework in CBL emphasizes three key areas: **content knowledge and understanding**, **mastery of real-world skills**, and **engagement with the learning process**.

Content Knowledge and Understanding: In CBL, content knowledge is not merely about recalling information but also about applying it to real-world problems. Assessments in this area focus on how well students can integrate theoretical knowledge into practical contexts. This could involve analyzing complex issues, understanding the underlying principles of solutions, and utilizing disciplinary concepts to inform problem-solving. Research by Savery (2006) and Gijbels et al. (2009) supports the idea that assessment of content knowledge should be dynamic and tied to how students use the information to drive their learning process forward.

Mastery of Real-World Skills: The second area emphasizes the development of tangible, real-world skills that students can apply beyond the classroom. CBL encourages students to prototype solutions, collaborate with peers, test ideas, and refine them based on real-world feedback. Assessments in

this domain evaluate not just the technical skills students acquire (e.g., in design or data analysis) but also softer skills such as teamwork, communication, and leadership. According to studies by Johnson & Johnson (2009), these skills are vital in preparing students for success in their professional lives, as they mirror the challenges they will encounter in the workplace.

Engagement with the Learning Process: Finally, student engagement is a key element of CBL assessment. Students are expected to be actively involved in every stage of the project, from problem identification to solution evaluation. Assessing engagement involves looking at the students' motivation, participation in discussions, problem-solving efforts, and reflection on their work. As Gijbels et al. (2009) suggest, high engagement is a predictor of better learning outcomes, as students who are invested in the learning process tend to perform better and retain knowledge more effectively.

By addressing these areas, educators (teachers) ensure that students develop critical thinking, problem-solving, and collaboration skills alongside mastering subject-specific content. Also, this comprehensive approach to assessment aligns with the core principles of CBL, ensuring that students develop not only subject-specific knowledge but also the critical thinking and practical skills necessary to address complex societal challenges. By evaluating students across these three dimensions, CBL ensures a holistic approach to learning that equips students for success in both academic and professional settings.

To effectively assess learning in CBL, two primary strategies are employed: **formative assessment** and **summative assessment**. *Formative assessment* takes place continuously throughout the learning process and acts as a real-time guide for both students and teachers. It helps identify areas of strength and improvement, enabling adjustments to learning strategies. This type of assessment is also ongoing and embedded throughout the CBL experience. Its primary purpose is to provide continuous feedback to students, enabling them to refine their ideas, processes, and solutions as they progress. Formative assessment allows both students and instructors to track development in real-time, making it an essential tool for identifying learning gaps, adjusting strategies, and encouraging reflective practice. It often involves peer feedback, self-assessment, and iterative evaluations of prototypes or project stages. According to Gijbels et al. (2009), formative assessment fosters active engagement and critical thinking by encouraging students to reflect on their work and make necessary adjustments, which is particularly important in project-based environments. Examples of formative assessments include teacher observations, peer reviews, journals, interim work reviews (guided by rubrics), and one-on-one student-teacher conferences.

Summative assessment, on the other hand, evaluates progress at defined checkpoints or after the project. Also, summative assessment occurs at the end of the learning cycle, typically evaluating the final outcomes or solutions developed by students. It measures the overall achievement of learning objectives, such as the quality of the final solution, the depth of content knowledge, and the effectiveness of real-world applications. Summative assessments in CBL may include final reports, presentations, or evaluations of the impact of the solution on the targeted problem. As Savery (2006) notes, this type of assessment is crucial for determining how well students have mastered the key learning outcomes and for providing a comprehensive overview of the project's success. It provides a more formal measure of achievement and may include papers, quizzes, examinations, and portfolios.

Together, formative and summative assessments create a balanced framework that promotes continuous improvement while ensuring that the final outputs meet the intended learning goals. By utilizing both strategies, CBL enhances student learning by providing feedback throughout the process and evaluating the overall effectiveness of the solutions once implemented.

Website Source for CBL Rubric: https://www.challengebasedlearning.org/project/cbl-rubric/

A distinctive feature of CBL is its collaborative nature and integration of online and offline environments, which means that learners receive feedback from a wide variety of sources. These include

teacher feedback, peer interactions, blog responses, text messages, and verbal or video feedback. While this multiplicity of feedback can deepen learning, it can also create confusion if not managed effectively. Therefore, teachers play a critical role in helping students interpret and apply this feedback constructively.

To further support meaningful assessment, educators can utilize learning journals, reflective practices, and professional portfolios as tools for both students and them. For example, modeling the process by maintaining a reflective teaching journal or portfolio can encourage students to adopt similar practices. These tools not only help document progress but also provide a narrative of the learning journey that can be shared with administrators, parents, and other stakeholders.

To optimize the assessment process, educators should also consider how deliverables—such as research papers, multimedia presentations, prototypes, or solutions—align with the broader learning goals. These deliverables not only demonstrate mastery but also serve as artifacts of the CBL process that tell the story of the learners' journey.

Ultimately, while students bear significant responsibility for their learning in CBL, the teacher's role remains indispensable. Regular checkpoints, clear rubrics, and structured reflection sessions ensure that assessment serves as a tool for growth rather than mere evaluation. By actively monitoring each group's progress and leveraging assessment data, educators can offer timely interventions, enhance the learning experience, and ensure that all learners meet the intended outcomes effectively.

Important Note: In CBL, assessment focuses on the learning process rather than the final product (Nichols et al. 2016)

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