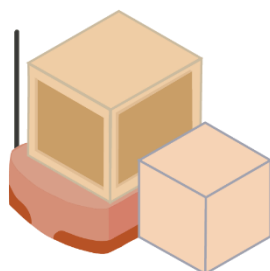




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Teachers Toolkit

Methodological Guidelines for Challenge Based Learning

Project number: 2022-1-ES01-KA220-HED-000089767

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2. INTRODUCTION TO CHALLENGE BASED LEARNING

Challenge Based Learning is a powerful educational framework pioneered by Apple, Inc. and adopted by universities, schools, and institutions worldwide. This framework promotes collaborative learning among education stakeholders, including students, teachers, administrators, and community members. By primarily focusing on learners, it aims to cultivate a multifaceted mindset for addressing both local and global challenges while acquiring knowledge in subjects such as maths, science, social studies, language arts, medicine, technology, engineering, computer science, and the arts.

[Why?] This methodology derives from a context in which exchange of knowledge and information happens through technology and the internet. Today, students can instantly access information, take charge of their own learning through informal methods, and independently evolve from mere consumerism of content to learning autonomy. Consequently, traditional teaching approaches are becoming less effective in engaging and motivating them. Current educational practices often focus on content-centric assignments that meet standards but lack real-world context and opportunities for active involvement. These assignments fail to capture students' interest, resulting in uninspired work and a gradual decline in engagement.

[How?] To address this need, challenge based learning emulates real world working environments where problem solving and teamwork are at front of project success. Students are required to come up with solutions to challenging issues. Challenge based learning builds on the foundation of experiential learning by getting students to solve the problems in the actual world rather than merely get them to finish a critical thinking exercise. Such environment, results in increasing levels of motivation in learning and ownership for the experiences' success. Moreover, such scenario fosters the use of technology as a tool for research, communication, organisation, creation, and presentation of information.

[structure] The following guide is for educators of the STEM sector implementing Challenge Based Collaborative Learning into their courses. The guide is structured in three sections:

1. An overview of the framework, and its principles, assessing into the opportunities and implications of integrating the methodology.
2. An in-depth step-by-step framework on how to apply Challenge-Based Learning.
3. Examples, tips, and best practices to support the process of implementation.





2.1 OVERVIEW

Challenge Based Learning starts with a significant concept and progresses through the following stages: the central question; the challenge itself; guiding questions, activities, and resources; identifying and expressing the solution; putting the solution into action; evaluation; and sharing the solution with the broader audience. Reflection and constructive assessment play a vital role at each stage, reinforcing learning and preparing students for subsequent steps.

Challenge-Based Learning Framework



Source: <https://www.challengebasedlearning.org>

While teacher involvement is essential throughout the Challenge Based Learning process, its role evolves as students advance through the stages. Initially, when introducing Challenge Based Learning and setting up the challenge, teachers are making decisions, conveying information, imparting skills, and clarifying expectations for their students.

During the middle stages, students take the lead in planning and researching their projects, with teachers primarily serving as a project manager and mentor. Teachers' role involves guiding them through challenges and ensuring they stay on course. In the later stages, students are deeply engrossed in their projects, while teachers verify their mastery of the necessary knowledge and skills through appropriate assessments. Eventually, teachers transition into the role of a product manager, supporting students as they implement, evaluate, and share their solutions and findings.

2.2 CHARACTERISTICS

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INTERMODULARITY. Challenges are based on the development of professional competences and learning outcomes. This way of working reflects better the reality they will find out at work. Opportunity for learning: by exploring a topic from various perspectives and across multiple disciplines, and applying them to life scenarios, it enables students to naturally cultivate 21st-century skills: human oriented problem solving, ethical analysis of technological developments, adaptive storytelling. These skills don't merely become an additional task for teachers to manage but arise organically from the Challenge experience.

Implications for the assessment: collaboration between teachers from different disciplines is strongly advised to enhance and effectively manage the learning experience. When exploring new ideas, review institutional requirements and establish a shared vocabulary among all stakeholders (students, collaborating teachers, and administrative assessment). A mutual understanding of language is essential for making informed decisions.

SELF MANAGED CYCLE TEACHING TEAMS. The way you promote teamwork also in teachers. Opportunity for learning: the widespread availability of information provides a chance to dismantle traditional hierarchical structures in learning environments. Through challenged oriented students continue their learning journey by taking responsibility for defining the path of the project, aligning with teachers' set standards, and securing resources.

Implications for the assessment: allowing time for critical and creative thinking should be considered for consequent successful engagement. For this matter, offering chances for profound reflection by deliberately pacing at intervals the learning process is a matter to be considered when developing the methodological framework of the activity. Initially or in specific situations, reflection boundaries may be limited, but the objective is always to progress towards greater freedom and responsibility for the learner.

EVALUATE TO EVOLVE IN COMPETENCE DEVELOPMENT. The evaluation is integrated as a key element in the students' own learning process, providing frequent feedback on their evolution in the degree of acquisition of the provided professional competences.

Opportunity for learning: when students have control over the process, it increases the level of ownership. As such, significant connections are established between content and learners' lives. The more enthusiastic learners are about the content, the more profound the learning experience.

Implications for the assessment: it is important that the path towards finding the solutions that students make, is equally valued to the solution they find. To achieve this, students should be encouraged to document their experiences using text, video, audio, and images. These artifacts serve for continuous reflection, informative assessment, demonstrating learning, building portfolios, and narrating their Challenge journey. Throughout the journey, learners consistently reflect on both the content and the process. Deep learning often occurs when considering the process, reflecting on one's learning, and analyzing the ongoing connections between content and concepts.





ADAPTATION OF LEARNING SPACES. Flexible, open and interconnected rooms.

Opportunity for learning: it offers a real-world experience for all learners to think creatively, test new ideas, experiment, encounter setbacks, receive feedback, and try a new way. Every phase of the framework provides chances for iteration.

Implications for the assessment: Challenge Based Learning necessitates the use of real-world tools, requiring both teachers and students to have constant access to technology tools and community feedback. This includes the utilisation of multimedia creation tools, the Internet, and online management tools. Moreover, educators should engage students with community partners by setting them up in feedback meetings with possible stakeholders or setting deadlines for updates on the project.

3. IMPLEMENTATION OF THE CHALLENGE BASED LEARNING

3.1 WORKING IN TEAMS

With this methodology students learn about a subject by working in groups to find a solution to an open-ended problem. Students have the protagonist role and they assume the responsibility for their own learning. Before starting with the learning, we are going to divide our students into different groups. These are temporary groups, with little or no time spent on assigning people to groups, getting to know each other, or assigning roles. They last one session or less and it is used to ensure cognitive processing and engagement in learning.

To create the groups, we present these techniques that you can use in your classrooms, for example:

- ✓ The Nine Belbin Team Roles technique.
<https://www.belbin.com.au/free-resources>
- ✓ Test as a function of cognitive knowledge
<https://www.supportrealteachers.org/techniques-for-forming-groups.html>
- ✓ Balance between different types of skills.
<https://koruro.com/tecnicas-para-formar-grupos> (only available in Spanish)

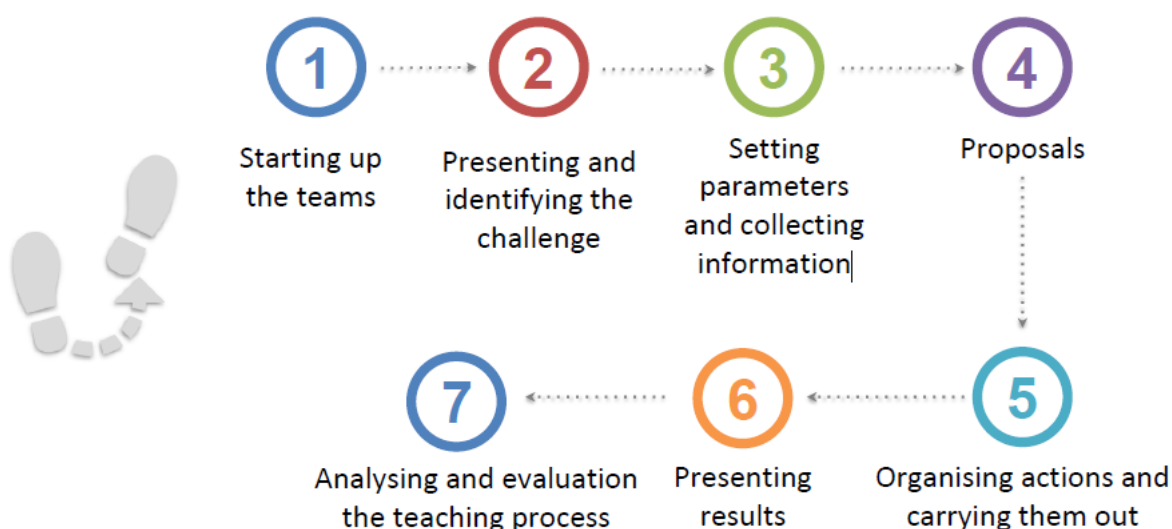
Once the groups are already created, we can start to draw up the group's worksheet. We can also allocate responsibilities, once the functions of each member have been understood. Throughout the learning we will work on group identity; positive mutual dependence; in-person communication and individual responsibilities.

Challenge-based learning encourages students to build problem-solving abilities and acquire concepts rather than just memorising information by using complicated, real-world challenges as the subject matter in the classroom.





STEPS



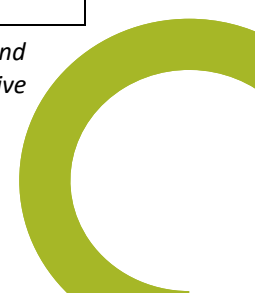
Source: <https://tknika.eus/en/cont/proyectos/ethazi-3/>

3.2 CHALLENGE BASED LEARNING PROCESS

The Challenge Based Learning Framework is structured into five interconnected phases: engage, investigate, identify, act, reflect. Each phase incorporates activities designed to prepare learners for the subsequent stage. Throughout the entire process, there is a continuous effort to document, reflect upon, and share insights.

0	Create the teams	1. Create and reinforce the collaborative environment 2. Get to know the students and their profiles 3. Establish agreement on operating rules 4. Activate the team and prepare it for action
1	Presenting the Challenge	1. Present the tasks to the students in an attractive way. 2. Give them a picture of what you are about to start. 3. Explain the new scenario to them.
2	Identifying the aims	1. Understanding the problem and what needs to be done 2. Identify previous knowledge 3. Motivate students and turn problem solving into a challenge for them.
3	Setting parameters	1. Create questions o What do I have to learn? o Which are the learning outcomes? o What information do I need? 2. Split the challenge into areas of expertise 3. Create research
4	Collecting/ organising information	1. Answer the previous questions 2. Raise new questions based on these answers

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5	Create proposals	1. Each student has to bring at least one solution to the problem (DIVERGENCE) 2. Working on creativity 3. The more solution ideas the better
6	Present proposals	4. Presentation and defense of the student's solution 5. Learning from others 6. Working on communication
7	Select a proposal	7. The group of students has to choose one of all the solutions (CONVERGENCE) 8. Decision-making: individual and group. 9. Searching for a common solution through teamwork
8	Organising actions	1. Structure how they will take the proposal forward. 2. Use of planning tools 3. Timing, sequencing, responsibilities, risk agreement.
9	Carrying them out	1. Carry out what they have identified, enhancing specific skills and abilities 2. Develop what they have learned in the process 3. Follow up on what has been done by correcting deviations.
10	Goals of presentation	1. Present the tasks to the students in an attractive way 2. Give them a picture of what you are about to start 3. Explain the new scenario to them
11	Analysing and evaluation the teaching process	1. Refining the teaching process 2. To offer tools to see and improve the level they have in the different competences through feedback 3. Become aware of how far they have come, where they want to go, and what commitments they will make 4. Making compromises

3.3 ENGAGE: FROM BIG IDEA TO THE CHALLENGE

Goal: Understand the multidisciplinary of global challenges and focus on elaborating tangible research questions.

1	Presenting the Challenge	1. Present the tasks to the students in an attractive way. 2. Give them a picture of what you are about to start. 3. Explain the new scenario to them.
2	Identifying the aims	1. Understanding the problem and what needs to be done 2. Identify previous knowledge 3. Motivate students and turn problem solving into a challenge for them.

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Explanation: During the Engagement Phase, learners transition from a broad big idea to a specific and actionable challenge using the essential questioning process:

- Big idea: Data → Essential question: how can we effectively use data to make the world better?
- Big idea: science → Essential question: How can we increase interest in, and commitment to science and math?
- Big idea: creativity → Essential question: Why is creativity important for developing robots?

While beginning with a Big Idea and fostering engagement and ownership through identifying an intriguing challenge is recommended, it's not a strict requirement. In some scenarios, it might be more practical to start with a challenge without focusing on the big idea. A helpful source for further global challenges is through the news. Here, the challenge transforms the essential question into a call to action by tasking participants with devising a personal solution to a global issue.

The choice of where to initiate the process depends on objectives, time constraints, scope of the project, learners' age, and familiarity with Challenge Based Learning. However, the challenge should remain difficult to multiply build responsibility and permit multiple possibilities for solution.

Teachers' responsibility:

- Making decisions for the student's comfort: arrange regular checkpoints with students to confirm they're progressing as planned and utilising feedback to enhance their work.
- Imparting on research skills: teachers might consider reviewing Internet research skills with students. This could include teaching them how to identify keywords for their information searches and how to recognize various types of reputable resources.
- Clarify expectation: teachers must help students feel at ease within their groups, offer guidelines on task division and provide them with tools to contribute meaningfully to the team's success.

3.4 INVESTIGATE: SETTING THE PARAMETERS TO FIND AN EFFECTIVE SOLUTION

Goal: identifying rigorous, content- and concept-based research question through contextualised learning





3	Setting parameters	1. Create questions - What do I have to learn? - Which are the learning outcomes? - What information do I need? 2. Split the challenge into areas of expertise 3. Create research
4	Collecting/ organising information	1. Answer the previous questions 2. Raise new questions based on these answers

During this stage, the focus should be set on refining specific questions that will help the student find precise answers to the challenge. Seeking truth involves examining the challenge deeply and from various perspectives, rather than from a narrow viewpoint based on preexisting beliefs and ideas. Following on previous examples, questions should vary from personal questions to contextual ones:

- Big idea: Data → Essential question: how can we effectively use data to make the world better?
 - What makes good data?
 - How do algorithms impact societies?
 - Who collect the data in my community?
- Big idea: science → Essential question: How can we increase interest in, and commitment to science and math?
 - Why do students lose interest in science?
 - Why is science difficult for many students?
 - What scientific programmes are reachable to my community?
- Big idea: creativity → Essential question: Why is creativity important for developing robots?
 - Is creativity only present in art?
 - Can robots be creative?
 - What is creativity?

The research phase concludes when previously presented questions are well answered:

If yes = proceed! If no = research question is re-calculated, or research continues.

Teachers' responsibility:

- Ensuring students' stay on course: standardise the research process to align with previously set curriculum goals. For this aim, teachers may previously prepare a set of resources, set interviews with local stakeholders, or pre-state some of the research questions.
- Guiding resources and research activities.

3.5 IDENTIFY: PROPOSE A SOLUTION

Goal: Students develop grounded solutions and receive feedback

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5	Create proposals	1. Each student has to bring at least one solution to the problem (DIVERGENCE) 2. Working on creativity 3. The more solution ideas the better
6	Present proposals	4. Presentation and defense of the student's solution 5. Learning from others 6. Working on communication
7	Select a proposal	7. The group of students has to choose one of all the solutions (CONVERGENCE) 8. Decision-making: individual and group. 9. Searching for a common solution through teamwork

After thoroughly researching the guiding questions, students have a strong foundation to start identifying various potential solutions. They should choose one solution to develop through prototyping, experimentation, or other methods. Subsequently, they should thoroughly research, document, and refine that solution, followed by outlining steps for its implementation. While exploring the challenge may lead to multiple solutions, each group should focus on developing and implementing a single solution.

Teacher's responsibility:

- Assess findings: students should be encouraged to be creative in devising and executing their solutions, and to document their activities as according to curriculum standards.

3.6 ACT: IMPLEMENTATION AND EVALUATION

Goal: Students implement solutions in real settings, receive feedback, and learn from practice.

8	Organising actions	1. Structure how they will take the proposal forward. 2. Use of planning tools 3. Timing, sequencing, responsibilities, risk agreement.
9	Carrying them out	1. Carry out what they have identified, enhancing specific skills and abilities 2. Develop what they have learned in the process 3. Follow up on what has been done by correcting deviations.

Once students have identified their solutions, they will put them into action, measure the outcomes, reflect on successes and challenges, and assess their progress in addressing the challenge. Upon completing the implementation, students showcase their work to the broader community.

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Teacher's responsibility:

- Project management: make sure that all investigative purposes are policy compliant and well documented. For this aim, monitor students' tasks and make sure to obtain necessary certification, permission, or releases for the successful output of the project.

3.7 REFLECT: PRESENT FINDINGS AND REFLECT ON THE JOURNEY

Goal: reflect on the experience and process gained knowledge

10	Goals of presentation	1. Present the tasks to the students in an attractive way 2. Give them a picture of what you are about to start 3. Explain the new scenario to them
11	Analysing and evaluation the teaching process	1. Refining the teaching process 2. To offer tools to see and improve the level they have in the different competences through feedback 3. Become aware of how far they have come, where they want to go, and what commitments they will make 4. Making compromises

Students are urged to maintain individual written, audio, or video journals throughout the process. As a concluding activity, they can receive a set of prompts for final reflections on what they've learned about the topic and the process.

As a form of commitment to the activity, results on the projects can be shared with the local community via school online platforms, local newspapers, or community organisations.

4. CONCLUSION

In conclusion, Challenge Based Learning (CBL) offers a dynamic framework that fosters both collaborative problem-solving and critical thinking skills among learners. Through its structured process, the ROMOTICS participants will be able to engage in real-world challenges, driving them to explore, propose solutions, and reflect on their experiences. By working in teams and following the CBL process—engaging with big ideas, investigating parameters, identifying solutions, acting on implementation, and reflecting on outcomes—students not only address complex issues but also develop a deeper understanding of the subject matter and their own capabilities. This holistic approach to learning equips individuals with the skills and mindset necessary to tackle challenges beyond the classroom, preparing them for success in an ever-evolving world, while in the same time exploiting the ROMOTICS learning materials and challenges to the fullest.

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