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ANFEI
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Formación de ingenieros para la innovación

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Challenge-based learning as a tool for acquiring *skills* on the path to transforming society

Dr. Jorge Membrillo-Hernández

jmembrillo@tec.mx

https://tec.mx/en/soi-stem

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Before	Now

Why Education has not changed as fast as the Technology has?

COVID19 triggered a new way of teaching, first Sudden major change in Education in decades.

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EDUCATION ⟷ SOCIETY

STEM ADVANCES → SOCIAL SOLUTIONS

WAY OF TEACHING ← SOCIAL SITUATIONS

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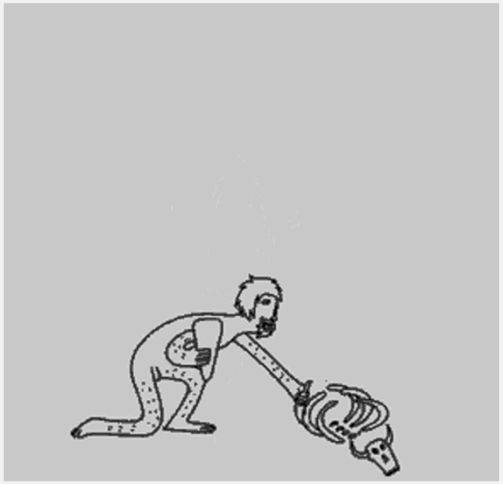
Skills to overcome challenges



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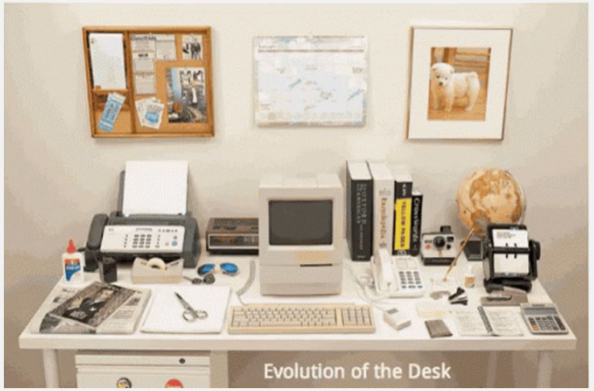

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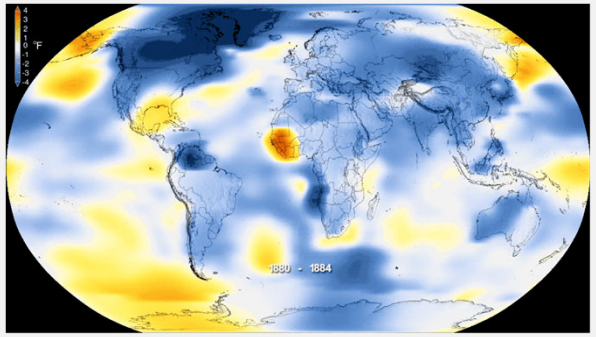

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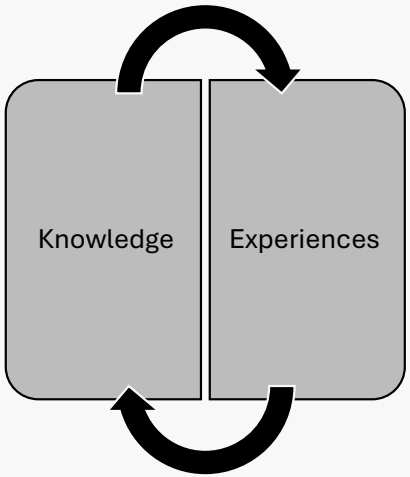
Experiential learning theory

(Kolb & Kolb, 2017)



*New **knowledge** is built, and new **competencies** are developed to apply what has already been learned to a **new situation**.*

Competence (*competere*, means "to respond") links:

- Knowledge
- Concepts
- Abilities
- Attitudes
- Values
- Strategies
- **Skills**

To respond to the demands of the environment and society.

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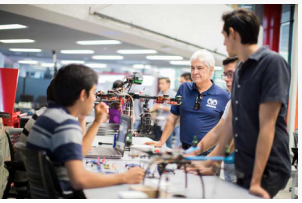
Implications of the shift towards the new model based on challenges

from	to
Curriculum based on subjects and contents	Curriculum based on competency development through challenges
Subjects as the basic element for curricular design	Challenges as the basic element for curricular design
Evaluation of knowledge in each subject	Evaluation of competencies through challenges
Sequence of courses	Modularization of contents and flexibility of use
Professors with multiple roles	Role separation based on the context
Decision of major from Day 1	*Pathways: Explore, Decide, Specialize*



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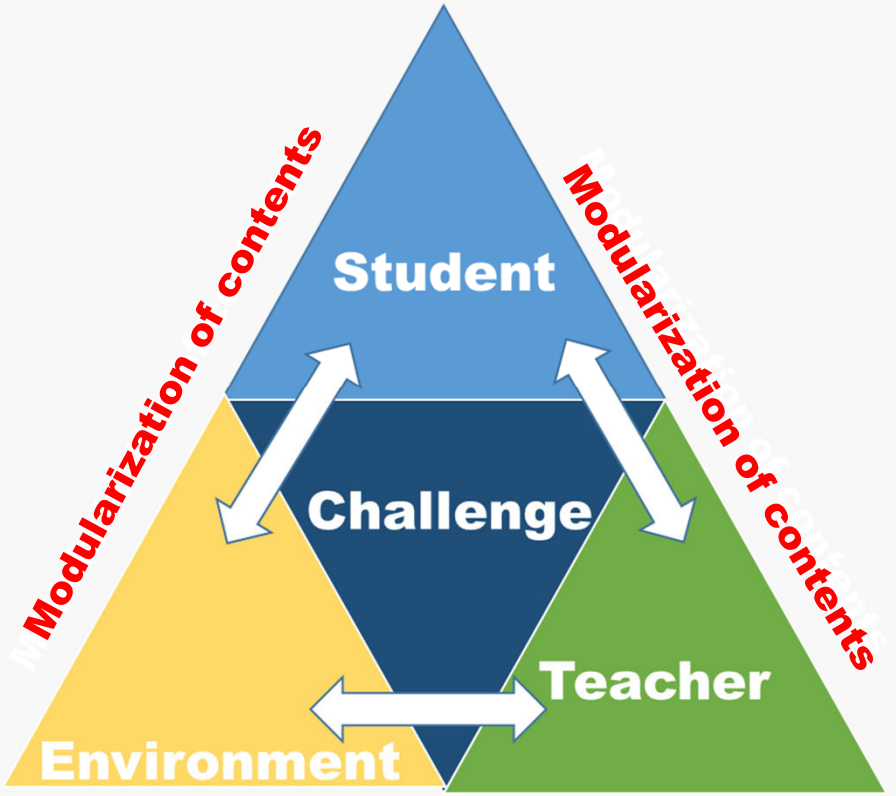
Challenge-based learning

- Immersive challenge-based content
- Real-life societal challenges of the future
- Sustainable Development Goals
- Necessary skills and competences
- Technological infrastructure
- Redefinition of the role of teachers and students
- Life-long learning
- Training partners
- The school as part of the community
- Stakeholders' common understanding

How to solve a Challenge?



Modularization of contents

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Comparison chart of Project, Problem, and Challenge Based Learning.

Technique	Problem-based learning	Project-based learning	Challenge-based learning
Learning object	Designed problems	Specific task	Real-world problems
Characteristics	Often fictional, not real solutions are needed	Predefined problematic, requires a solution	Open, problematic, real solution needed
Expected outcome	To solve the problem at hand.	To carry out the assigned project.	To develop a more profound knowledge of the subjects.
Expected product	None, focus to learn	A presentation or implementation of the solution	The best solution is to find a concrete action.
Student's role	Work with the problem	Work with the assigned project	Analyze, design, develop and execute
Teacher´s roles	Facilitator, guide, adviser	Facilitator, manager	Designer, coach, co-researcher
Assessment	Ability to reason and apply their knowledge	Product	Tackle the challenge in a way stakeholders measure

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CBL emulates the experience of the modern workplace, leveraging the interest of students in a practical meaning for their education while developing key competencies (Santos et al., 2015; Malmqvist et al., 2015).

In this way, CBL fits the requirements of generation Z (Caratozzolo et al., 2021) and industry 4.0 (Caratozzolo & Membrillo-Hernández, 2020) and becomes the new way of doing research in education.

In CBL, specific skills are developed.

- Tolerance to frustration
- Collaborative work
- Resilience development
- Collaborative work
- Decision making
- Leadership

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Flexibility

in how, when and where the teaching-learning process is done

Challenging,

engaging classroom experiences for students

Tec 21

Inspiring faculty

innovative and professors, leaders in their fields and with experience in the practice of their profession

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Challenge Based Learning with Boehringer Ingelheim

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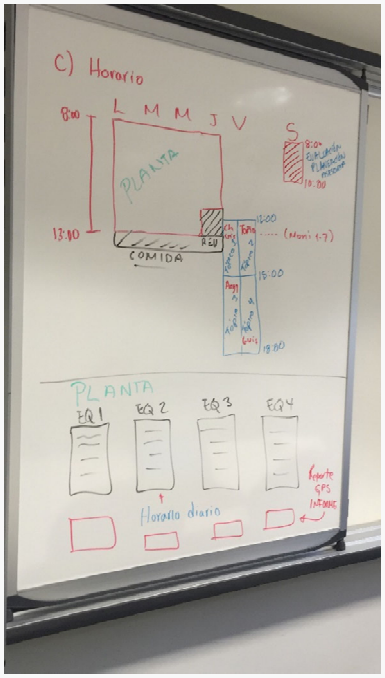
Teacher training for module design



Boehringer Ingelheim

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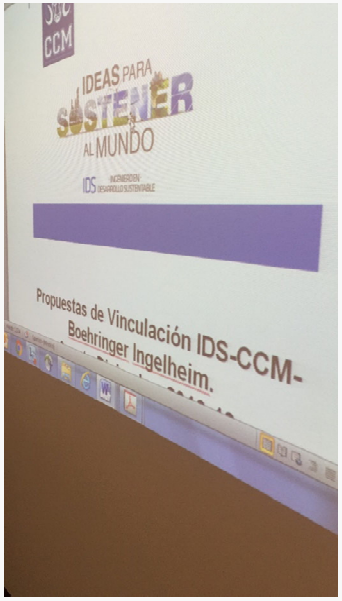
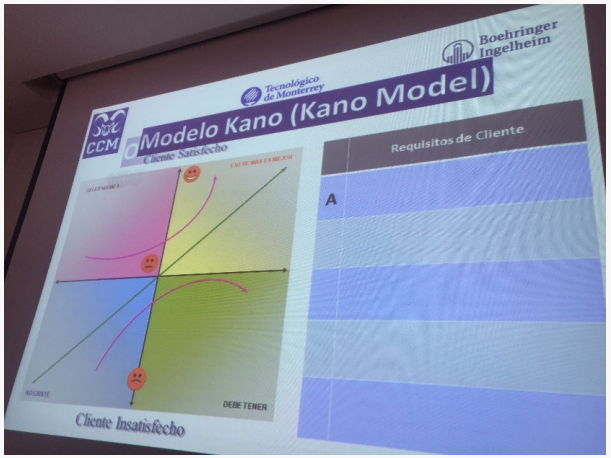
CBL Training at the Boehringer Ingelheim Premises





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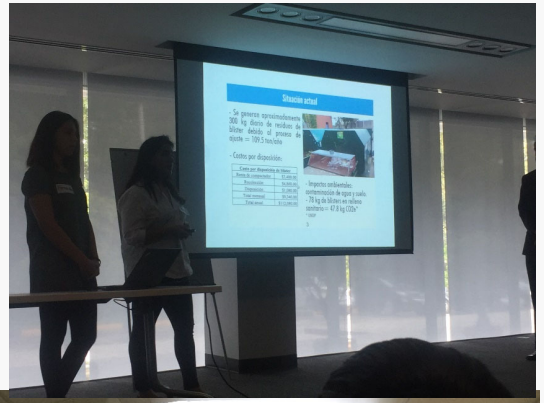
EVALUATION



García-García and Membrillo-Hernández, J. (2020). Challenge -Based Learning (CBL) in engineering: Which evaluation instruments are best suited to evaluate CBL experiences? IEE Global Engineering Education Conference, EDUCON 2020-April, 9125364:8885-893. doi:10.1109/EDUCON45650.2020.9125364

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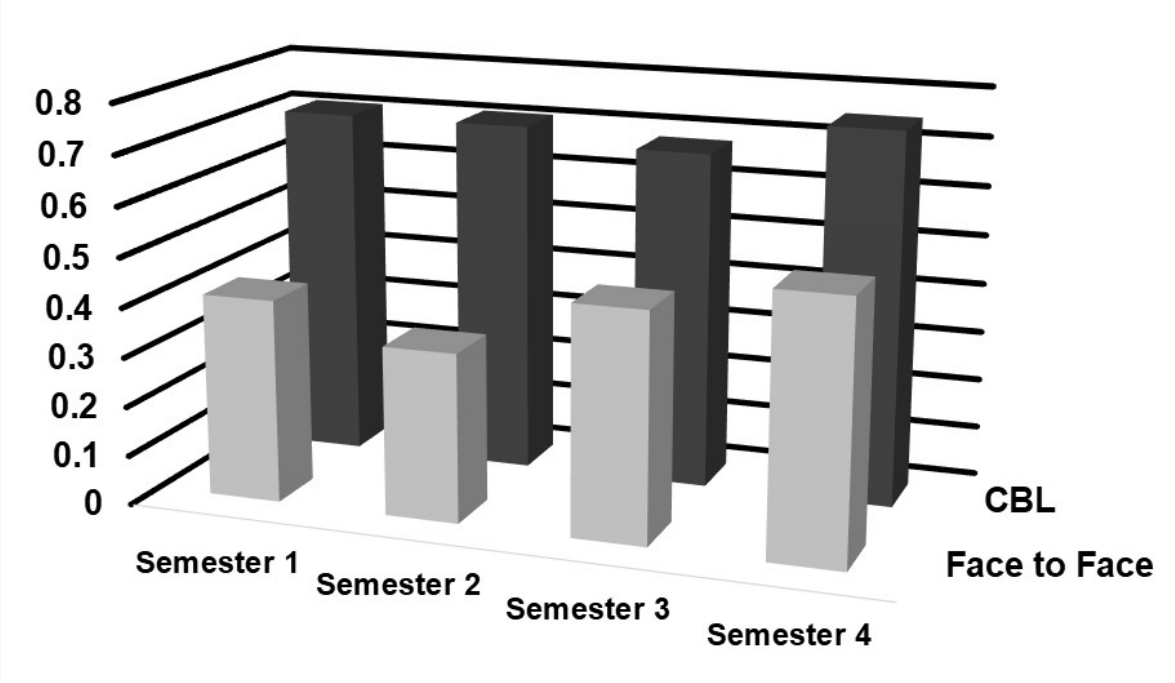
CBL vs Face to face courses



The learning gain analyses of the CBL experiences for Mechatronics and Mechanical Engineers students. The light grey bars show the results with classroom classes using traditional teaching strategies. The dark bars show the learning gain average of the parallel CBL experiences.

Some conclusions, so far….

In CBL, students work with teachers and experts in their communities on the challenge.

A challenge is an activity, task, or situation that represents an incentive and an obstacle to overcome and that requires the application of diverse, inter and multidisciplinary knowledge to be solved.

The challenge itself triggers the generation of new knowledge and the necessary tools or resources (Membrillo-Hernández et al., 2019).

One of the main elements of the challenges is uncertainty.

The element of uncertainty refers to the fact that we would add that we also need adaptive learners who can function well when optimal conditions do not exist when situations are unpredictable.

Task demands change, when the problems are messy and ill-formed, and the solutions depend on inventiveness, improvisation, discussion, and social negotiation

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Table 1. Engineering employability skills required by employers, adopted from Kaewunruen [55].

U.K. [56]	Singapore [57]	Japan [57]
- New and specific technical skills - Computer literacy and IT skills - Multi-skilling and greater -flexibility - The ability to deal with change - An ability to continue learning, re-skilling - Communication skill - Team working and getting on with others, including being able to work in self-managed teams - problem-solving and diagnosis - "Whole system" thinking - Organisation and management	- Workplace literacy and numeracy - IT and Technology - Problem solving - Initiative and enterprise - Communication and Relationship - Lifelong learning - Globalisation - Self-management - Workplace-related life skills - Health and workplace safety	- Communication skills - Problem solving - Goal-setting skill - Personal presentation skills - Visioning skills - IT and computer - Leadership - Self-assessment skills

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