PROJECT-BASED LEARNING

European Federation of Chemical Engineering

DESCRIPTION

Project-based learning (PBL) is a student-centered teaching method that involves a dynamic classroom approach, in order students to acquire a deeper knowledge about a subject through active exploration of relevant challenges and problems. The students learn about a subject by working, for an extended period of time, to investigate and respond to complex questions and problems. PBL integrates knowing and doing. Students learn knowledge and elements of the core curriculum but also apply what they know to solve authentic problems and produce results. Sure, Professors have been assigning projects to students for years, but PBL is something different. Doing a project, at the end (or alongside) of a teaching unit, is an add-on to the traditional instruction while in PBL instruction is integrated into the project (the project is the unit)
Learning goals for PBL are somewhat different than traditional engineering science courses that emphasize lecture presentations; homework problems, often from end-of-chapter textbook problems; and exams that emphasize problems somewhat similar to homework problems. With PBL the content is baked inside of a long-term project, that the students need to address in a creative way. The project itself must contain and frame curriculum and instruction.

KEYWORDS

project-based, definitions, concepts, examples, many reasonable possibilities

WHY IS IT INTERESTING ?

Facilitates Student Development: Adoption of approaches to guide, facilitate, and support students as they work on the project**.** Students are encouraged to be self-directed

HOW TO DO IT ?

Instructional approach:
A faculty member begins a unit in the course by presenting a project to students before presenting content (e.g., definitions, concepts, examples, etc.).
Student teams focus on the project during the unit, but are evaluated with respect to the learning goals.
Student teams address the project by ultimately presenting one of many reasonable possibilities, based on feedback from instructors and experts

1. Present a project to students

2. Try by hand or by computer simulations, feasible alternative solutions to the problem. Do the sequences for the refined estimates converge?

3. Present the best feasible solution, in a report and/or class

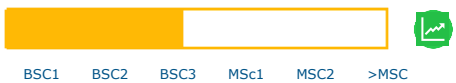
WHAT'S SO GOOD ABOUT PROBLEM-BASED LEARNING?

The PBL model may be considered as consisting of the following seven characteristics, which are certainly its advantages over traditional teaching methods.

- Focuses the student on a big open-ended quest, challenge or problem to research and respond to and/or solve.
- Brings what students should academically know, understand and be able to do into the equation.
- Is inquiry-based
- Uses skills such as critical thinking, communication, collaboration and creativity, among others
- Builds student choice into the process
- Provides opportunity for feedback and revision of the plan and the project
- Requires students to present their problems, research process, methods and results, in the form of a report and/or video or any other multimedia tool

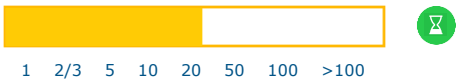
Instead of short-term memorization strategies PBL provides an opportunity for students to engage deeply with the target curriculum content, bringing about a focus on long-term retention
Professors coach more and instruct less, embrace interdisciplinary learning instead of a single subject and are more comfortable with uncertainty and discovery during the learning process. They facilitate and assess deeper understanding rather than stand and deliver factual information.
Of course, like any approach, PBL is only beneficial when applied successfully!

Suitable for learners of level

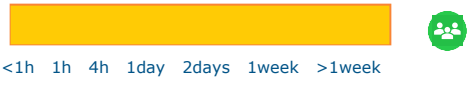


Investment time before session for tutor

Suitable for managing large groups



Duration of the act



PROJECT BASED LEARNING

EFCE
WP on Education

EXAMPLES AT ENGINEERING

Project-based Approach to Teaching Power Electronics

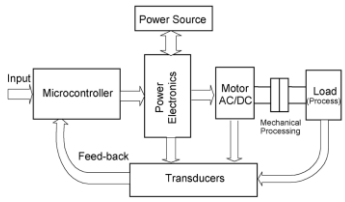


Fig. 1. Block diagram of the power electronics drive system.

Chu, R. H., Lu, D. D., Sathiakumar, S. (2008). Project-based lab teaching for power electronics and drives. *IEEE Transactions on Education, 51*(1), 108-113. doi:10.1109/TE.2007.906607

Given:
- Motor

Student teams submit:
- Load, e.g., washing machine
- H-Drive
- Sensing circuits
- Program for microcontroller

Course
~7-week project in 13-week course

Designing Engineering Science Courses Using Project-based Learning, Jeffrey E. Froyd, The Ohio State University, Lecture Course presented at Texas A&M University at Qatar, 2019

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MISTAKES TO AVOID ?

The need for facilitation and guidance is stressed because using project-based learning (or its relatives) without guiding, facilitating, and supporting students has been repeatedly shown to lead to inferior results, compared to instructional approaches that emphasize lecture, homework problems, and traditional engineering science exams.
The instructor must formulate very carefully the path which corresponds to the syllabus or curriculum, when planning the project and answer questions such as, how should the teams be formed, including size, how does one promote individual accountability, how the project was selected, and many more.

EXAMPLES OF USE

Chemical engineering, mechanical engineering

Facilitation Example: Purging a Methane Tank

Project: A 100-liter tank of methane will be purged with N2. How much N2 (by volume) will be required so that the final percentage of methane will be 1%?

Starfield, A. M., Smith, K. A., & Beloch, A. L. (1990). *How to Model It: Problem Solving for the Computer Age*. Burgess International Group

Solution

- ✓ **First Sub-task:** Generate a quick, by-hand procedure for computing a rough upper bound for the amount of N_2.
- ✓ **Second Sub-task:** Generate a quick, by-hand procedure for computing a rough lower bound for the amount of N_2.
- ✓ **Third Sub-task:** Generate a two-step procedure for computing a rough upper bound for the amount of N_2 that builds on the concept for generating the first upper bound.
- ✓ **Fourth Sub-task:** Generate a two-step procedure for computing a rough lower bound for the amount of N_2 that builds on the concept for generating the first lower bound.
- ✓ **Fifth Sub-task:** Generate a iterative procedure for refining the upper bound for the amount of N_2 that builds on the concepts for generating the first two upper bounds.
- ✓ **Sixth Sub-task:** Generate a iterative procedure for refining the lower bound for the amount of N_2 that builds on the concepts for generating the first two lower bounds.

The professors' role in PBL is that of a facilitator. They do not relinquish control of the classroom or student learning, but rather develop atmosphere of shared responsibility. In the above steps, the instructor must structure the proposed question/issue so as to direct the students learning toward content-based materials. He must regulate student success with intermittent, transitional goals (like the ones above) to ensure student projects remain focused and students have a deep understanding of the concepts being investigated. The students are held accountable to these goals through ongoing feedback and assessments, designed to ensure the students stay within the scope of the driving question (how much N2 will be required etc., above example) and the core standards the project is trying to unpack.

Nicholas Markatos
n.markatos@ntua.gr

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