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Introduction

In the context of an Educative Innovation Project (EIP) to be developed in the academic courses 2019-20 and 2020-21 and entitled "Collaborative learning of Biochemistry based on projects and case and problem solving" and two other previous EIPs, we have designed and used problem-based learning (PBL) cases to help our students to study metabolism and its regulation.

In the present communication, we show and discuss the results obtained with the application of an extended PBL approach focused on the four metabolic cycles described by the Nobel prize winner Sir Hans Krebs under a learning contract.

Objectives

- To improve the teaching-learning process applied to the study of metabolism by using a Design-Based Research methodology (DBR) and a Problem-Based Learning approach (PBL).
- To change certain attitudes of students, decreasing their competitiveness and increasing their cooperativity by stimulating their engagement with procedures of co-operative study in a class less hierarchical and more horizontal, with the professor in the role of a facilitator/guide in a flipped classroom.

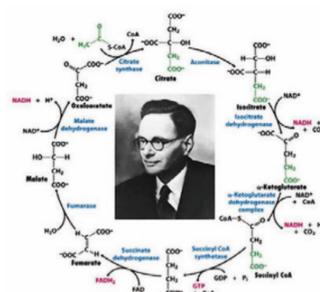
The case

It covers systematically the main contents related with the four metabolic cycles described by Sir Hans Krebs

- Historical issues regarding the scientific studies by Sir Hans Krebs (6 tasks)
- On the structure and properties of some molecules of the Krebs cycles and on the topology of these cycles (10 tasks)
- The four Krebs cycles, their regulation and their metabolic integration (21 tasks)
- Biochemical foundations of clinical cases (9 tasks)

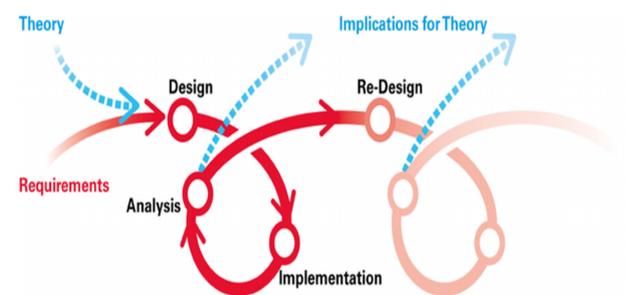
The guided tasks have been designed to stimulate the interaction among the members of the different teams/groups of students, their cooperative behavior during learning and their critical thinking. Some of them encourage the reading of scientific papers and the use of biological databases and online resources of great utility.

The tools



Hans Krebs inserted into his most famous metabolic cycle

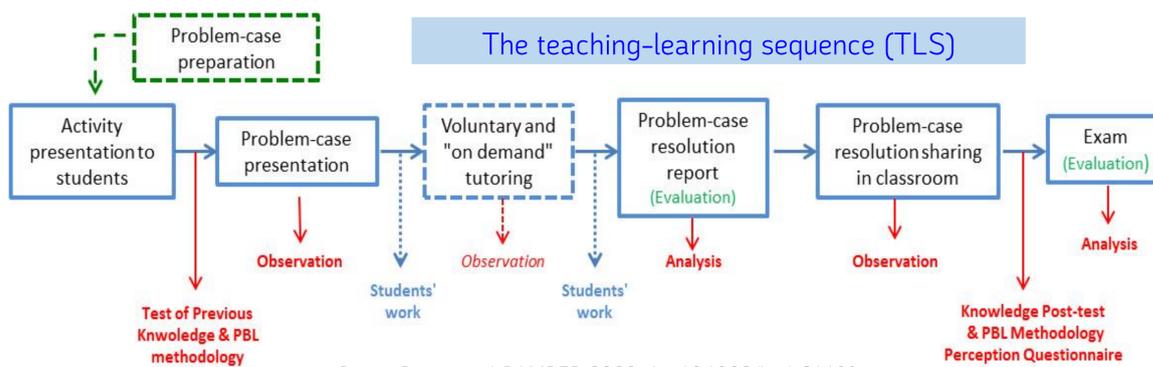
The educational research methodology: Design-Based Research



Picture source: Fraefel, U. (2014). DOI: 10.13140/RG.2.1.1979.5925

The implementation

The teaching-learning sequence (TLS)

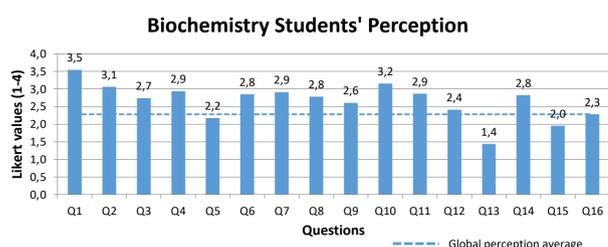


García-Ponce et al. BAMBED 2020, doi: 10.1002/bmb.21499

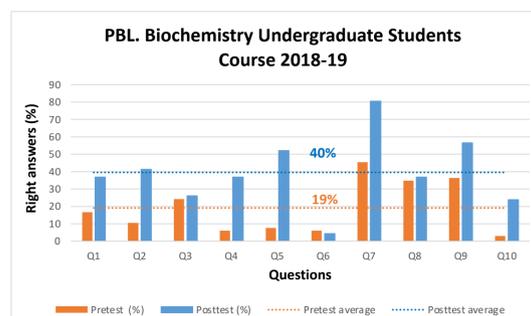
The context

- The study was implemented in 2nd semester of the academic course 2018-19.
- Volunteer participants signed a Learning Contract:
 - ✓ 13 *Metabolic Regulation (Biology Degree)* students split in 4 groups.
 - ✓ 47 *Regulation of Metabolism (Biochemistry Degree)* students split in 11 groups.
- Each group freely decided how to organize the work and how to share the tasks. Tutorial sessions were only provided on student demand basis.
- Groups had two months to prepare a final report mentioning the specific work done by each student.

Results and discussion



(*) 1 to 4 Likert scale: 1-the least positive student perception, 4-the most positive student perception.



- Most of the students (both enrolled and not enrolled to this activity) declared have not heard of and have never used the PBL approach prior to this course.
- Pre and post multi-choice test showed a relevant specific knowledge improvement on the Krebs' cycles case.
- PBL methodology had a real impact not only in the overall knowledge of Krebs' metabolic cyclic pathways but also on the study of the course on metabolic regulation as a whole for most of the enrolled students in both groups of the Biochemistry and Biology Degrees.
- On the other hand, there was a general student consensus that they improve their learning experience by using this type of TLS, despite a major effort and dedication to solve the case.

Acknowledgments

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