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A PBL CASE ON GLYCOGEN AS AN EVALUABLE TASK FOR STUDENTS STUDYING METABOLISM

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Abstract

We are currently involved in an Educative Innovation Project (PIE17-145, funded by the University of Malaga) aimed to improve the teaching practice of Metabolism to undergraduate students. We are designing and developing new metabolism cases of problem-based learning (PBL) applied to different groups of Biochemistry and Biology undergraduate students. In the academic course 2017-18, we implemented a first trial for a PBL case on glycogen and its metabolism that was offered as an optional evaluable task for students of two courses devoted to metabolic regulation, both corresponding to the second year of the Degrees in Biology and Biochemistry.
Metabolism, its regulation and its integration is one of the most complex study subjects for Biochemistry students. In fact, its learning is perceived as a demanding and difficult task by undergraduate science students, and only few of them achieve an integrated and deep learning of the subject. In END 2018, we presented a communication describing how PBL can be used as a motivating didactic strategy for the study of fundamental topics in biochemistry. In the present communication to END 2019, we will show the impact of a specific PBL case on the performance and final scores of the students enrolled in the afore-mentioned courses.

Keywords: *Problem-based learning, metabolism, biochemistry, higher education, science education.*

1. Introduction

In END2018, we presented two communications on PBL and learning contract as two useful tools for the study of metabolism (García-Ponce et al, 2018; Martínez-Poveda et al, 2018). At the University of Málaga (Spain), metabolism is a topic cover by mandatory courses in the Degrees in Biology (*Bioquímica II*, devoted to the study of *Metabolic Biochemistry*), Biochemistry (*Regulation of Metabolism*) and Chemistry (a course entitled *Biochemistry* that is fully devoted to the study of metabolism). Some specific features of metabolism, such as being a complex dynamic network, its extremely high levels of plasticity, its ability to adapt to both internal and external changes through metabolic reprogramming and its multiple levels of regulation and integration, contribute to make metabolism a specially complex and difficult subject for students of biosciences (Vella, 1990; Vullo, 2014).

In the present communication, we show and discuss the results obtained with the application of an extended PBL approach for the study of glycogen metabolism under a learning contract.

2. Objective

Our current Educative Innovation Project (PIE17-145, funded by the University of Málaga) has as its final objective to improve the teaching-learning process applied to the study of metabolism by using a design-based research methodology (Collins et al, 2004) and a problem-based learning approach (PBL) (Barrows, 1986; Gallagher et al, 1995; Dolmans et al, 2016). As already mentioned in our previous END communication (García-Ponce et al, 2018), another important target of this project is 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.

3. Design

Figure 1. Flow chart of the present study.

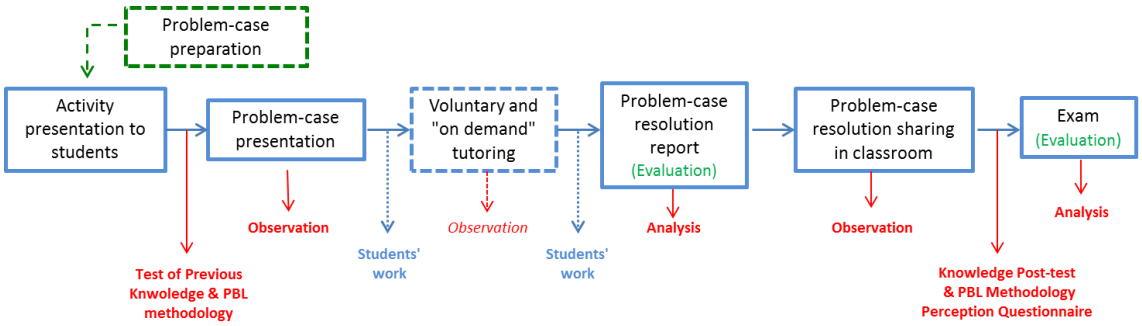

Figure 1 shows the flow chart of this study. The whole extended PBL case for the study of glycogen metabolism and its regulation was designed during the first semester of the first academic year of application of the project PIE17-145. This PBL case included 57 guided tasks organized around five topics: 1) On the structure and properties of glycogen (13 tasks). 2) Historical issues regarding the scientific study of glycogen metabolism and its regulation (5 tasks). 3) On glycogen metabolism and its regulation (24 tasks). 4) Glycogenosis. Biochemical foundations of clinical cases (10 tasks). And 5) Integration of glycogen metabolism (5 tasks). These guided tasks were designed to stimulate the interaction among the members of the different teams/groups of students, their cooperative behavior during learning and their critical thinking. Furthermore, some tasks were designed to encourage the reading of scientific papers and the use of biological databases and online resources of great utility.

The study was implemented in the second semester of the academic course 2017-18. We presented the activity and enrolled volunteer students of both *Metabolic Regulation* and *Regulation of Metabolism* courses to a system of continuous evaluation under a learning contract. In *Metabolic Regulation*, 20 volunteer students who signed the learning contract were split in 5 groups. In *Regulation of Metabolism*, 32 students signed the learning contract and were split in 8 groups. To monitor the learning process, before glycogen case presentation to the students and after the submission of their final reports, they answered anonymously the questions of a test to analyze the impact of the PBL work on their acquisition of knowledge regarding glycogen, its metabolism, regulation and integration.

All the groups received the instructions and rules to solve the "case" and a written document with all this information, along with the 57 tasks of the case. Each group freely decided how to organize the work and how to share the tasks. Groups had two months to prepare a final report with the description of the response provided to each task and a public declaration of engagement, with mention of the specific work carried out by each member of the group in the resolution of the overall case. Throughout the whole procedure groups were allowed to demand tutorial sessions and guidance from their professors.

Before the final examinations of the subjects, enrolled students had a final meeting in which, under the supervision of the instructors, the different groups discussed their answers to the different tasks included in the PBL. In the same session, students anonymously filled a post course mixed questionnaire, elaborated by using the 1 to 4 Likert scale for most of the questions, complemented with some other open answered ones. This questionnaire was designed to evaluate students' perception of this PBL methodology. Finally, the impact of this methodology on the performance of students in the final examinations was evaluated.

4. Results and discussion

Most of the enrolled students (74% of the students in the Biology Degree and 87% of the students of the Biochemistry Degree) declared that had no previous knowledge of the PBL methodology and very few had used previously this methodology (14% of the students in the Biology Degree and 13% of the students of the Biochemistry Degree). Regarding the perception and the satisfaction of students with the PBL methodology, students of both courses considered this methodology useful (scores 3,6 and 2,8 in a Likert scale for Biochemistry and Biology students respectively), believed that they had learned more (75% of both Biochemistry and Biology students), but almost 100% of them declared that they had to work more and harder than for the preparation of other kind of tasks in the same or in other subjects. Overall, 83% of Biochemistry students and 75% of Biology students enrolled in this study declared to be "very satisfied" or "satisfied" with their experience.

Regarding the percentage of correct answers provided by the enrolled biochemistry students for each of the 10 multi-option questions in both the pre-test and the post-test on the topic, in all the 10 questions there was an increase in the percentage of correct answers in the post-test as compared with the pre-test. Altogether, correct answers increased from 31% to 54%.

This PBL had a real impact not only in the overall knowledge of glycogen metabolism 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. In fact, the percentages of students attending and passing the final examinations of both the *Metabolic Biochemistry* and *Metabolic Regulation* courses were higher among enrolled students to the PBL under learning contract. Specifically, in *Metabolic Biochemistry* (Biology Degreed) course, a 63% of the enrolled students passed the final exam, to be compared with only a 37% of students passing the final exam among those not enrolled in the study. In the *Regulation of Metabolism* (Biochemistry Degree) course, the figures were 79% and 50% for students attending the final exam previously enrolled in the PBL activity or not, respectively.

5. Conclusion

The use of the PBL case designed to study glycogen and its metabolism within the framework of a collaborative learning in a flipped classroom has contributed to improve the experience of our students learning metabolism and its regulation. Furthermore, they have learned that cooperation is a better strategy to study than competition.

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