PROJECT-BASED LEARNING USING SCIENTIFIC POSTER AS A TOOL FOR LEARNING AND ACQUISITION OF SKILLS IN PHYSICS SUBJECTS OF ENGINEERING BACHELOR'S DEGREES.

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ABSTRACT

This article shows the experience of working on project-based learning using scientific posters, on the study of the mass geometry of matter, with students of various Physics subjects of Degrees in Engineering of the School of Design Engineering of the Polytechnic University of Valencia. The development of this work has been carried out with a dual purpose: on the one hand, to improve the teaching-learning process of mass geometry; and, on the other hand, to improve the acquisition of skills by students. This matter, which is studied in the Physics subjects of the first year of the degree, forms part of the basis of the studies of resistance of materials and theory of mechanisms of subsequent courses. The inclusion of two sessions of laboratory practices, as an extension of the work carried out in the theory and classroom practice sessions, has allowed us to study more deeply the theoretical concepts of mass geometry and their application to a real project, improving the learning by the students. In addition, the presentation of the project through the scientific poster has facilitated the acquisition of cross-curricular competencies such as application and practical thinking, teamwork, effective communication, and critical thinking.

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1 INTRODUCTION

1.1 Context

This project was born in the subject of Physics-10270 of the bachelor's degree in Industrial Design Engineering and Product Development of the School of Design Engineering of the Polytechnic University of Valencia, taking into account that one of the professional opportunities of this bachelor's degree is the industry of the furniture. Later it is extended to the bachelor's degrees in Electrical Engineering and Mechanical Engineering, of the same School, being implemented in the subjects of Basic Physics and Physics Complements, respectively.

In the laboratory practices of these subjects is where the theoretical knowledge is applied to the experimental practice, carrying out tasks like those of laboratory research on physical phenomena studied in the classroom.

The initial decision to carry out this project was due more to a spirit of innovation and improvement than to a problem or difficulty in teaching Physics-10270. Although, despite the good academic results of the students, the experience in recent years courses showed us a slight decrease in the grades obtained in the laboratory practices with respect to the global grades of the Physics subject.

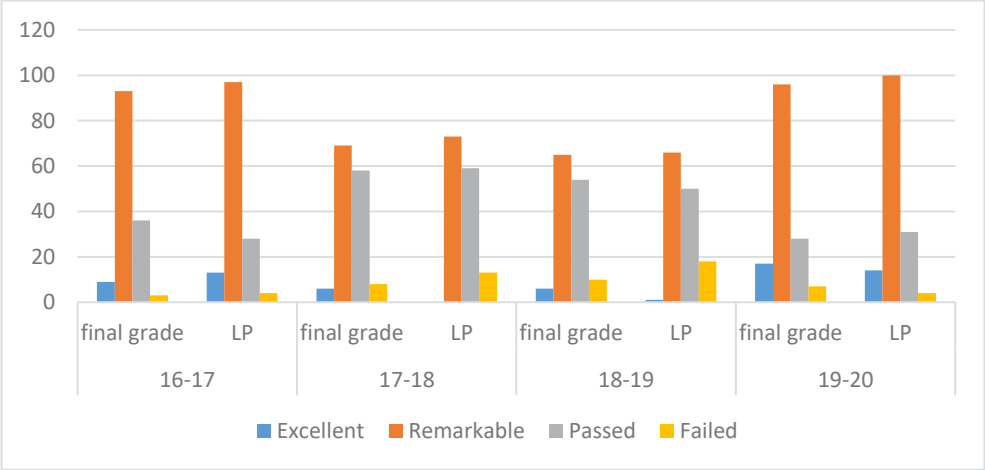

Fig. 1. Number of students and grades obtained in the final grade of the subject Physics 10270 and the average grade of the laboratory practices LP.

Even so, it is inevitable to think that, sometimes, the teaching of Physics, and the rest of the basic sciences, can be tedious; therefore, the inclusion of some methodological strategy can motivate students, and even "entertain" them [1].

1.2 Project-Based Learning (PBL) and Scientific Poster

The commitment to the PBL methodology is based on the conviction that the development of a project in engineering studies, even at a basic level, can be a great incentive for first-year students, as it facilitates the connection between training they receive and their future performance in the profession, in addition to the development of self-learning and creative thinking [2]. In fact, among the benefits of this method, it stands out that: it increases autonomous learning, prepares students for jobs, increases motivation, strengthens self-confidence, establishes connection

between learning at school and reality, offers collaboration opportunities to build knowledge, increases social and communication skills, increases problem-solving skills... If we add to this the benefits of collaborative work in terms of increased interaction and critical thinking skills in the negotiated solutions, PBL seems to be a good strategy for improving the quality of learning [3].

For the transmission of the results of the project, the scientific poster format is chosen because it is expected that the students, who work as a team in the laboratory practices, will be able to build knowledge through the projects worked on, and to present them orally. Therefore, it is established as a teaching and evaluation tool within the course.

According to the Dictionary of the Spanish Language, a poster is a "banner that is fixed on the wall, without advertising purpose, or having lost that character". But we also understand the poster as a multimodal communicative genre, with text, graphics, color, speech, and even gestures, used to convey ideas. It is an alternative to the oral presentation, but with the same purpose [4].

Normally, the presentations of the tasks carried out in the laboratory practices are presented through written reports as a scientific article. In these works, we have verified that, very often, more than a true collaborative work, what is produced is rather the sum of pages created individually, despite the mechanisms and strategies that we carry out to try to avoid it. With the creation of a poster, we want to minimize this problem in some way, as well as the frustration or demotivation it generates.

In addition, we think that the presentation in poster format can be more stimulating, since the way of presenting the posters puts the communicator and the audience on the same level, facilitates the exchange of ideas and the comparison of results, and offers a panoramic vision of the different topics and contents presented. The poster is intended to see the other mode of presentation that takes place in academic and scientific conferences, with a more relaxed atmosphere, which promotes interaction between students in the meeting place.

2 METHODOLOGY

2.1 Objectives and Learning Outcomes

The main objective of this action is to initiate first-year students in the development of projects and their presentation through posters, so that they see the relationship between learning a basic training topic, such as mass geometry, and the future performance of the profession. The specific objectives of the action, related to the teaching methodology, are:

- Increase student motivation, through the development of a project, at a basic level, that gives meaning to the acquisition of knowledge.
- Improve the ability to apply the contents to practice, broadening the vision of the students' professional future.

- Promote the acquisition of cross-curricular competencies such as effective communication and critical thinking, through the delivery of the project in poster format and its exhibition.
- Quantify the degree of acquisition of knowledge by students.
- Quantify the degree of satisfaction of students and teachers regarding the effectiveness of the PBL methodology in the learning process.

Regarding the learning outcomes, it is expected that the students, upon completion of the project, will be able to:

- Detail the starting conditions for the design of a piece of furniture: materials, densities, shapes, etc.
- Analyse furniture elements by modelling the whole by decomposition into simple geometric figures.
- Calculate the basic parameters of mass geometry of furniture elements.
- Check the coherence of the results with respect to the selected reference system and axis.
- Prepare a report on the behaviour of a piece of furniture using the poster format for its presentation, paying attention to the correct use of scientific-technical language.

2.2 Work development

The work teams are made up of 5-6 students. The project is developed in two phases: first, a partial delivery is made, whose evaluation is used as feedback for the optimization of the work; and in the second phase, the final delivery is made, in which the complete development of the project is formalized, in poster format.

The development of the project is indicated in the following steps, briefly explained, considering that some of them are worked on at the same time, despite the exposed order:

Sketch (1.1): Each team will select an element of furniture to design, from those listed in the project script (chair, table, bench, shelf, staff, canopy, etc.), and will make a sketch of the design of the selected element.

Modelling and decomposition of the element (1.2): The team will model the furniture element in such a way that the simplicity requirement is met, to apply the calculation hypotheses. They will decompose it, into all the parts that are considered necessary, to analyse the element as a system of simple geometric figures.

Table of materials (1.3): The team will select the manufacturing materials of the different parts of the element, considering that it must consist of at least two different materials in its manufacture.

Delivery of the first phase (1.4): Each team will include the information from the previous sections in the script prepared by the teaching staff for delivery. Teachers will correct this delivery before starting the next phase of the project, so that students have the necessary feedback.

Choice of the reference system for calculating the centre of mass (2.1): Each team must analyse its element to select the reference system with respect to which its centre of mass will be calculated.

Choice of the axis with respect to which the moment of inertia will be calculated (2.2): Each team must analyse its element to select the axis with respect to which it will calculate its moment of inertia. This choice will be supervised by the teaching staff and their approval will be required to continue with the subsequent calculation.

Calculation of the centre of mass of the element (2.3): The team must apply the calculation equation for the centre of mass of material point systems.

Calculation of the moment of inertia of the element (2.4): The team must apply the calculation equation of moments of inertia of material point systems.

Preparation of the poster (2.5): All the elements described above in both phases of the project must integrate the poster that the work teams will present. The basic instructions for making a poster will be followed [4], leaving the structure arranged in title, authors, degree, introduction with hypothesis and objective, methodology and development, results, and conclusions.

Presentation of the poster (2.6): The day of presentation will be defined, in the course programming, as a congress. Teachers will oversee printing the posters and leaving them presented on the panels. The teams will explain their projects in the corresponding session.

Fig. 2. Exhibitions of the posters of the Mass Geometry Projects.
Course 20-21 on the left and course 21-22 on the right.

For the evaluation of the achievement of the objectives, the following were designed:

- Teaching materials for the acquisition of knowledge and development of the project.
- Two rubrics for the evaluation of the two phases of the project (first delivery and poster), in which the cross-curricular competence CT02 – Application and practical thinking was also assessed.
- The self-assessment questionnaires for the evaluation of the cross-curricular competence CT06 – Teamwork.

- The evaluation rubric of the cross-curricular competence CT08 – Effective oral communication, used by students and teachers in the exhibition of the posters.
- Questionnaires for student satisfaction surveys.

3 RESULTS

The two aspects that teachers most value at the end of each course are academic results and student satisfaction. Regarding the first aspect, a comparison of the average of the results obtained in laboratory practices 5 and 6 is shown, before including the mass geometry project, and the results obtained in these practices, after the change by the project, compared to the final lab grade (except the current course, which has not yet been completed). As can be seen, the change of the old practices 5 and 6 by the project has led to an improvement in the grades obtained.

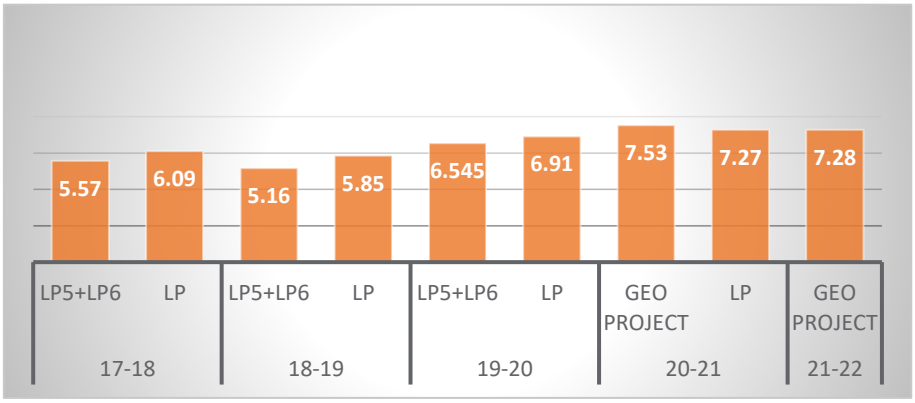

Fig. 3. Grades obtained in 5 and 6 laboratory practices, average grade of the GEO Project, and average grade of the laboratory practices LP of the subject Physics 10270.

Regarding the second aspect, it has been possible to observe a significant percentage of students satisfied with the work carried out, and a slight increase in the motivation of the students with respect to the work developed in the conventional laboratory practices, clouded by the sanitary restrictions that have not allowed much interaction in the development of work.

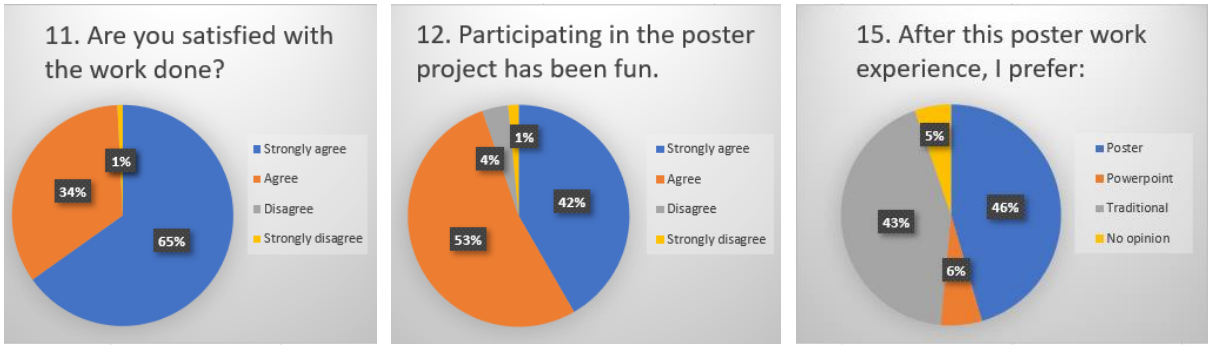

Fig. 4. Answers to some of the questions asked in the satisfaction questionnaire.

In view of the results of the questionnaire, it can be concluded that the application of the PBL methodology using Scientific Poster for improving the teaching-learning process of students of various Physics subjects of bachelor's degrees in Engineering of the School of Design Engineering has been successful. As a closure of this work, some representative posters of the students of Physics-10270 subject are shown.

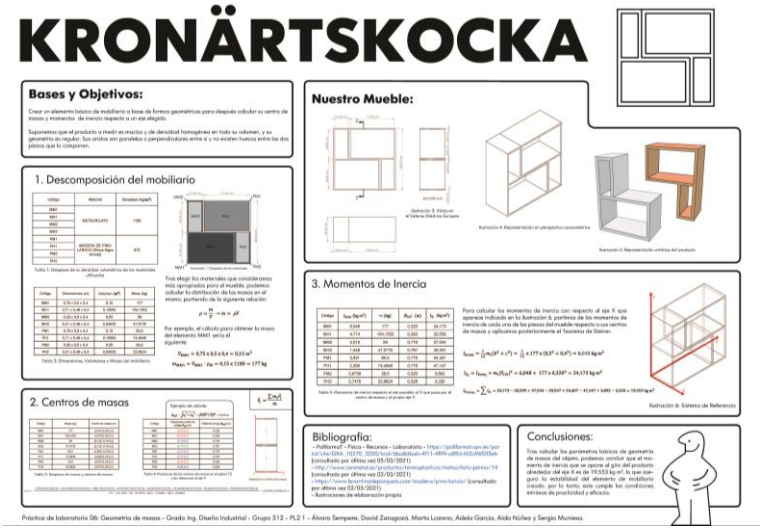

Fig. 5. Poster made by Á.Sempere, D.Zaragozá, M.Lozano, A.García, A.Núñez, S.Muniesa.

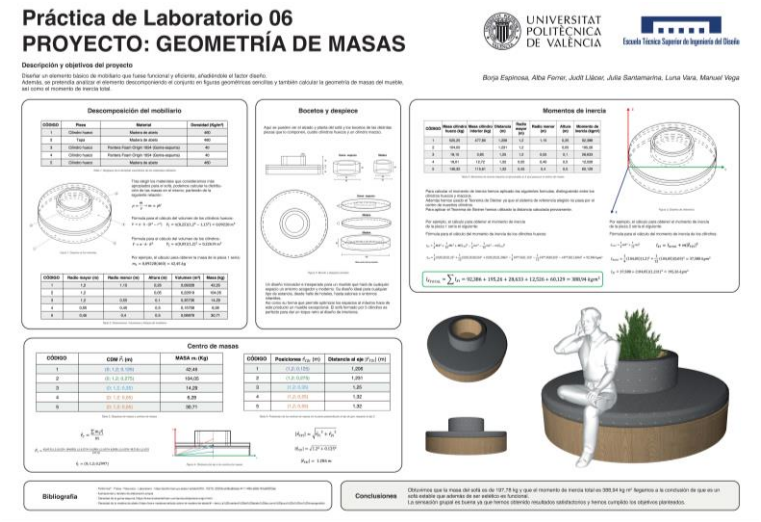

Fig. 6. Poster made by B.Espinosa, A.Ferrer, J.Llácer, J.Santamarina, L.Vara, M.Vega.

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