V Congreso en Docencia en Educación Superior Codes y I Congreso Latinoamericano y del Caribe de Innovación en Investigación en Educación Superior LatinsoTl La Serena, Chile. 8,9 y 10 de noviembre del 2023

DOI: https://doi.org/10.15443/codes1960

Using the phases of the Solt approach in a Physics remote Laboratory Innovation

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Abstract. The systematization of the innovation process developed in the subject of Experimental Physics, in Engineering careers, is presented. This innovation process responds specifically to the need to massify physics laboratory experiences for first-year engineering students with a low cost of resources. It contemplates the application of three moments of experimentation with synchronous and asynchronous digital support. Various cognitive activities are implemented, including: Plenary discussion of experiences in the production of knowledge, video analysis, and experiment development. These activities make it possible to strengthen the students' ability to understand the phases of the physical phenomena modeling cycle. Through the Solt approach, it was possible to systematize the initial design in light of the implementation carried out in 2020. First-year students from three sections of Experimental Physics of the Universidad Andrés Bello, in Chile, were considered as a sample for this study. The strengths and aspects of improvement necessary in the implementation of a remote laboratory model considering experiential learning are described.

Keywords: Laboratory experience, distance learning, physics, pedagogical innovation.

1 Introduction

Teaching innovation in higher education is a dialectical practice, involving heterogeneous subjects, a complexity inherent to cognitive processes (Olivo-Franco, J. and Rosales, J., 2022). It functions in the dynamic interaction between different actors that come together in the constructive management of learning significance (Cebeiro, 2019); teachers, students and activities provide opportunities for innovation, action and learning; they can be promoted and intentional from the curriculum (Correa et al., 2019). This work systematizes from Solt's innovative approach, routine practices of the teaching process, from a remote physics laboratory for engineering careers. It describes challenges that underlie collaborative activities to achieve disciplinary learning, as a continuous process based on the management of student experience, the construction of

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data, and the evaluation of behavior in the face of understanding and modeling phenomena (Casillas, C., 2019).

2 Theorical Framework

The SOLT approach strengthens innovation and communication in teaching processes; through the development of a pedagogy through recursive and increasing cycles of design, application and systematization; from the taxonomy of Jerez, et. al (2017) for small-scale innovations. In this innovation, it is approached from experimental physics, recognizing as key practices those of the physics community and the scientific method.

It is based on the construction of meaning from experimentation; the key routines emerge and recognize practices typical of physical experimentation such as variable delimitation, numbering, data graphing and construction of valid experiments. It shows how phenomena are apprehended in the laboratory, the key concepts of physical activity and how they are expressed in known routines. The physical experimentation is foreseen in a complex way, it allows us to understand the behavior of the variables of interest; verifying explanations that generally encourage questioning (Rodríguez and Quiroz, 2016).

The Blum model (Ferri, 2006) is followed, a model that contemplates the deconstruction phases of a real model; the description of the phenomenon characterizing the variables and their estimated relationships. It allows its numbering and graphing; the mathematical results and their interpretation in terms of the phenomenon, make up the real results and, from this, the modification and/or precision of the real model built.

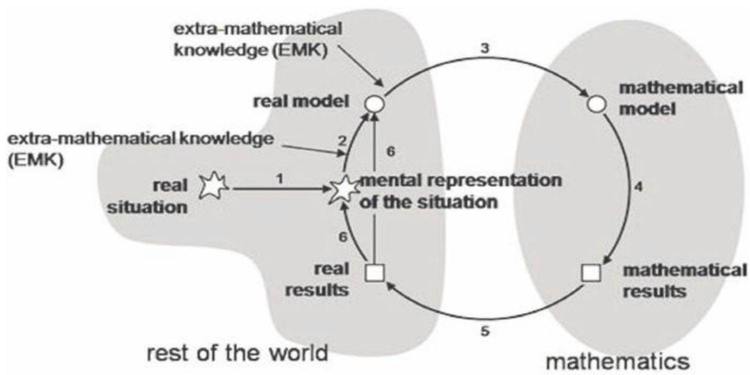

Fig. 1. Modelling cycle from Blum/Leiss. tomado de (Ferry, 2006)

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3 Method

The didactic innovation of the remote physics laboratory was carried out through the Solt approach (Jerez et al., 2017); from the stages: 1-Analysis, leads to the elaboration of reflective questions about the practice, bibliographic review and establishment of a preliminary model. 2-Development, plans to elaborate the design, application, evaluation and adjustment of the pilot experience, generating virtuous recursive cycles, to improve the application. 3-Explanation, relieves the analysis, systematization and communication of the experience; and impact evaluation.

The research was implemented at the Andrés Bello University, in Santiago de Chile; in the Experimental Physics subject, from the second semester of 2020, in the common Engineering plan. The study population consisted of 540 students, classified into 12 sections of 45 members for each course of the subject and the sample was 135 students corresponding to three sections.

4 Results and discussion

In view of the nature of this research, the categories are described below according to the methodology used:

4.1 Analyze

The key practices of experimental physics: a) Quantification of variables of the phenomenon, implies the speculative description, from the previous knowledge of the students to make assumptions, recognize errors and adjust said assumptions. b) Quantification of the measurement error implies the construction of criteria to identify useful data, without resorting to the use of digital tools to see the result; c) Enumeration of the behavior of the variables of interest, recognizing behavior trends; d) Establishment of reference systems in modeling processes. That they are concatenated in different activities that made up the virtual laboratory during the school semester.

In the experimental activities, the role of digital tools in collaborative learning work is observed; from the use of networks and chats to view, produce and analyze videos. It enables a change of scenery for the exercise of key practices, incorporating the use of digital collaborative spaces for video recordings and tracker software in hybrid activities of physics experimentation.

4.2 Develop

It was implemented in four learning moments: (a) Fermi estimates, including a theoretical introduction; (b) Work of reading and analysis of guide or learning support; c) Collaborative work of synchronous validation of results through Blackboard Collaborate video conference; (d) Plenary discussion of experiences. The results of the implementation allowed: Maintain the number of activities, modifying the duration times. Modify the initial focus of the formative evaluation to summative, considering the perception of the student and the rigor of the tasks.

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5 Conclusions

The phases of the Solt approach allowed to systematize the implementation of the teaching process and the experimental activities at a distance, which included different tools; such as, the elaboration of reflexive questions about the practice and the bibliographic review, the quantification of the error by means of Fermi's estimations, from learning based on experience, such as the case of filling a bottle with water. The analysis, systematization and communication of the experience is relieved through discursive practices through the use of chat within the field of learning. Likewise, the role of the key practices of the activity of scientific experimentation is recognized; and the construction of innovative learning experiences in scenarios other than the traditional physics laboratory. The key practices allow maintaining the didactic intention in the teaching of physics, enabling activities in workspaces with few resources and at low cost. The experimentation allows us to recognize elements that are at the base of the activity in the classroom, and those that emerge as keys in the implementation of the improvement of the didactic design.

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