THE EXPLANATIONS OF PHYSICS TEACHERS IN CLASSES WITH REMOTE LABORATORIES

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This paper presents a qualitative descriptive study on the explanations of three university physics' teachers in kinematics classes with remote labs. Real experimental activities can be carried out remotely using these devices. Methodology included non-participant observation, audio recordings and transcriptions of classes that implemented a remote lab. The transcriptions of classes were analysed using Content Analysis and pre-constructed dimensions and categories. The results showed that teachers used guided strategies, recognized the ease of use of remote laboratories and their versatility to teach concepts and procedures, and understood them as a replacement for the hands-on labs. This work constitutes a contribution to the study of remote experimentation in science education, introducing the particular perspective of the teacher as an important user of this type of device because they determine the mode of remote labs inclusion in the educational proposals.

Keywords: Remote experimentation, Physics education, University

INTRODUCTION

Consolidation of the proposals for hybrid or digital education in science imposes the necessity to rethink experimental activities (Area & Adell, 2021). These are essential elements for the construction of scientific knowledge and can be held up by interactive simulations, virtual labs and remote labs (Gamage et al., 2020).

Remote labs are technological tools, made up of software and hardware, that allow teachers and students to carry out experimental activities at distance because users have access to real lab equipment and can control it by a virtual interface (García-Zubía, 2021). Therefore, students can increase the number of hours of practice, what it is especially important in heterogeneous and massive university courses. Moreover, this kind of devices enable empirical data collection and make possible working with measurement uncertainties.

The use of remote labs promotes learning of either sensorimotor and intellectual procedural contents (Post et al., 2020) and could resolve traditional issues in Physics' teaching in higher education, like conceptual understanding of Uniformly Accelerated Rectilinear Motion (Kofman et al., 2011).

Teachers have specific knowledge about science disciplines and its teaching with technology (Li et al., 2022). These entail particular conditions and environments in order to learn science. In consequence, the impact of teaching innovative strategies might be study considering teachers as key actors in the educative process.

The aim of this work is to study teaching practices in Physics higher education with remote labs. The principal objective is to describe and characterize some aspects of teachers' explanations when they use remote labs to teach Kinematics.

METHODOLOGY

A qualitative descriptive study was performed in a Physics freshman course of Universidad de Buenos Aires in 2022. Methodology included non-participant observation, audio recordings and transcriptions of classes where a remote lab was used in order to carry out experimental practices in Kinematics. Participants were three volunteers' teachers (T1-T2-T3). Personal data of the participants was coded and the academic schedule was not affected by this study.

The transcriptions of classes were analysed using Bardin's Content Analysis and investigator triangulation. It was used pre-constructed dimensions and categories previously produced by Author (2021) for the characterization of science teaching with remote labs (Table 1).

Teachers' statements were translated by us in order to be discussed here.

Table 1. Pre-constructed dimensions and categories for the study of teaching with remote labs.

Dimension	*Description*	*Categories*
Didactic	It refers to teachers' actions and strategies when they use remote labs.	**Mimetic strategy:** when activities of observation, imitation and rehearsal are proposed until an expected result is obtained. **Guiding strategy:** when teaching is based on a series of directives in order to obtain an expected result. **Exploratory strategy:** when learning by trial and error is promoted
Use	It refers to teachers' experience in the use of remote labs. In particular, the ease/difficulty in device handling.	**Intuitive type:** When the use of the remote labs is simple, friendly and without difficulties. **Time-limited type:** When the use of the remote labs is made difficult by the fixed-time of the devices. **Visually-limited type:** When the graphical resources of the remote labs bring difficulties in their use.
Curricular	It refers to science content which could be taught with a particular remote lab.	**Conceptual content:** Ideas, models and theories. **Procedures:** Sensorimotor and intellectual processes associated with experimental activities.
Contextual	It refers to the main reason that leads teachers to include remote labs in their particular context.	**Substitution:** Remote labs are used instead of hands-on labs when the use of these last ones is not available. **Complement:** Teachers use remote labs to complement hands-on labs.

RESULTS

First, considering the didactic dimension, differences were found among teachers. T2 and T3 showed a guiding strategy. They presented clear instructions in order to optimize the time needed to complete the experimental activity and identify relevant aspects of this. For example: "Following the instructions given step by step is very important (...) so you can carry out the experimental activity in time and prepare the laboratory report" (T3). This type of strategy is related to the traditional approach of recipe-type experimental protocols. On the other hand, T1 used an exploratory strategy, encouraging students to try different resources of the remote lab. For example: "Enter into the remote lab, take your time and see how it works. You can do it every time that you need" (T1). In this way, the possibility offered by this type of technologies to repeat and modify the experimental practices in science promotes students' autonomy.

Second, considering the dimension of use, the three teachers showed an intuitive type. They highlighted the user-friendliness and the transparency of the interface of the remote lab. For example: "You will realize what each button is for without any problems" (T1). Only one teacher (T3) remarked on the limited time of use of the remote lab: "Remember that the session of this remote lab expires in twenty minutes". These results mark the good perception of usability of this remote lab, which could facilitate its inclusion in Kinematics teaching in higher education.

Third, considering the curricular dimension, teachers mentioned either conceptual content and procedures during their classes with the remote lab. For example: "This remote lab is great to understand what a Uniformly Accelerated Rectilinear Motion is. This was very difficult to do it before" (T2); and: "Now, we are using this remote lab to measure and make a Cartesian graph" (T3). These results showed the potential of remote labs to promote learning of both types of curricular content in Physics.

Finally, the three teachers considered remote labs as substitutes for hands-on labs when it's impossible to carry out traditional experimental practices due to the conditions of their context. For example: "This is an excellent alternative that allow us carrying out experimental activities despite not being able to go to a real lab" (T3). This perspective does not recognize the role of the remote labs as a particular and valuable resource in science education.

CONCLUSION

This research emphasizes the central role of the teachers in the design of teaching. Teachers' explanations are considered a key factor to detect advantages and limitations about the use of remote labs to science teaching. This is relevant to open the possibility of setting up sustainable proposals in science education that include new technologies.

However, this work reveals the persistence of traditional laboratory practices, even if teachers use new technologies. In this sense, guiding strategies could limit remote labs possibilities, avoiding students to repeat experimental practices and regulate their own learning. Moreover, considering remote labs as substitutes of hands-on labs could prevent the inclusion of these kinds of devices in innovative educational projects.

Results show here are encouraging in respect of the teachers' perception of the ease of use of the remote lab and its versatility to work on both conceptual content and procedures.

In conclusion, this work constitutes a contribution to the study of remote experimentation in science education, introducing the particular perspective of the teacher as an important user of this type of device because they determine the mode of remote labs inclusion in the educational proposals.

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