

## **The Experimental Activities during the COVID-19 pandemic. The teachers' perspective**

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### **Abstract**

An exploratory and descriptive research with a quantitative approach was carried out in order to describe the situation of the experimental activities during the COVID-19 pandemic. It considered the teachers' point of view. 450 Physics, Chemistry and Biology teachers of Secondary level, University and Teacher Education, voluntarily participated in an online survey in June of 2021. The outcomes of three questions about frequency, relevance and type of experimental activities in emergency remote teaching settings are discussed here. Although the teachers stated the high relevance of these activities, the frequency of them in their classes was around 23%. The predominant types were the home-made (53%) and the video or stream (51%). These results show the extreme necessity to develop new theoretical and methodological models to support the experimental activities in educative settings mediated by technologies.

### **Introduction**

The COVID-19 pandemic forced the deployment of several Emergency Remote Teaching (ERT) devices to guarantee educational continuity (Hodges et al, 2020). Most of the tested approaches involved digital developments and then, teachers and education managers found obstacles related to the access and use of technologies (Pardo Kuklinski and Cobo, 2020).

The subjects corresponding to the natural sciences field faced the challenge of sustaining experimental activities (EA) in the digital environments. These activities are central to the construction of the scientific knowledge (Franco Moreno et al, 2017). They can be understood as the set of didactically planned actions with the aim of generating the conditions to promote

the learning of concepts, procedures and attitudes which are typical of the experimental work (Lorenzo, 2020).

The teaching proposals with EA that were hold during the ERT were multiple and diverse. Many of these proposals were documented, collected and reported in academic papers (Erduran, 2020). Although these works make a valuable contribution, it is necessary to advance in new research that allows to analyse and systematize the strategies used during the health crisis in Latin America.

This work presents a first exploratory and descriptive study that aims to investigate the purpose and nature of the EA that were carried out by teachers of Physics, Chemistry and Biology in the Secondary level, University and Teacher Education during the COVID-19 pandemic.

### Methodology

The study is a first quantitative research of an exploratory and descriptive nature. A 36 items questionnaire and the research variables are related to categories defined at the beginning of the study. Three items were analysed and discussed in this work.

#### A. Participants

The participants were 450 Natural Science teachers (Table 1) of different countries: 264 from Argentina, 159 from Uruguay, 7 from Costa Rica and 20 from other countries. Their participation was voluntary, their personal data was coded, and the responses were treated confidentially.

*Table 1. Participants of the research*

Discipline	Physics (P)	Chemistry (C)	Biology (B)	Total
Secondary Level (SL)	40	107	86	233
University (U)	36	56	32	124
Teacher Education (TE)	18	28	47	93
Total	94	191	165	450

#### B. Data collection

An online *GForms* questionnaire was used to collect the data in June 2021. It was structured in 2 sections. The first one collects the data about the participant teacher's profile (subject, tenure, educational level, country, among others). The second one asks about the situation of EA that were carried out during the pandemic. According to 'a priori' theoretical categories, three dimensions were studied: 1) Frequency, 2) Relevance, 3) Type of EA. Multiple choice questions were used for the first and second one, while non-exclusive checkboxes were used for the third one.

#### C. Research variables and levels

V1. Frequency (F): Activities frequency in classes. How many times EA were performed during the pandemic. Qualitative ordinal variable. Levels: Never, Few times, Many times, Always.

V2. Relevance (R). The relevance assigned to the EA from the teachers' point of view. Qualitative ordinal variable. Levels: No relevant, low relevance, some relevance, high relevance.

V3. Type (T). What type of EA were implemented. It was linked to the EA carried out by the teachers. Qualitative nominal variable.

As independent variables were considered: Educational Level (SL, U, TE), and Subject (P, C, B) where the teachers enact their activities.

#### D. Data Analysis

The variables analysis needed the calculation of absolute and relative frequencies. In order to compare the results of ordinal variables (F, R) considering the educational levels (SL, U, TE) and science subjects (P, C, B), Kruskal-Wallis non-parametric test was applied. Spearman correlation coefficient was used to evaluate the correlation between the ordinal variables (F, R).

The Chi-square test was used to evaluate the association among nominal variable (T) and the independent ones (Educational Level and Subject). A 5% level of significance was established for the statistical inference tests. The statistical package SPSS version 22 was used.

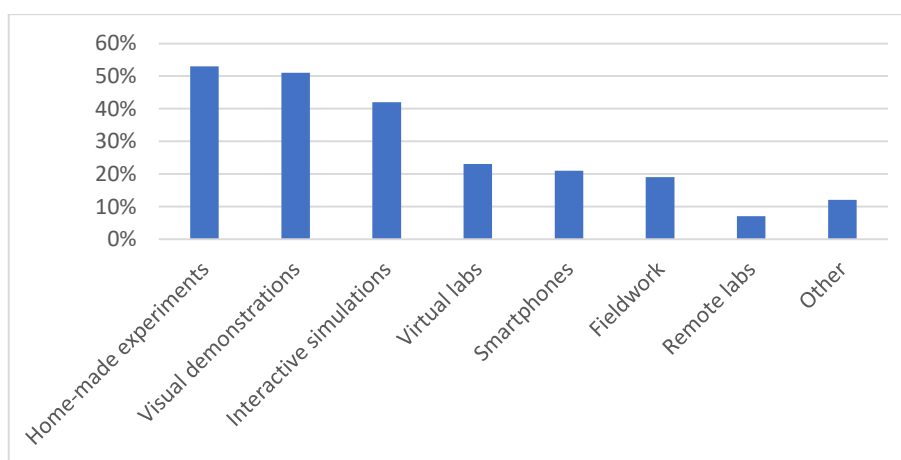
### Results

First, the dimensions: “Frequency” and “Relevance” were analysed. Although most of the teachers (68%) assigned a high relevance to the EAs, their answers showed that only 23% proposed them many times or always in their classes during the pandemic. The results showed a positive (Spearman coefficient = 0.34) and significant ( $p < 0.001$ ) correlation between frequency and relevance allocated to experimental activities.

When the behavior of ordinary variables was studied, it was found that the relevance ( $p = 0.648$ ) and the frequency ( $p = 0.236$ ) assigned to AE do not show significant differences according to educational levels (SL, U, TE). In turn, in relation to the subject, it was only found that Physics teachers carry out EA more frequently than Biology ( $p < 0.0001$ ) and Chemistry ( $p = 0.006$ ).

Secondly, the study of the type of EA proposed during the pandemic showed that most of the teachers have used home-made simple experiments (53%), visual demonstrations by streaming or recorded videos (51%) and interactive simulations (42%), virtual labs (23%), smartphones (21%), fieldwork (19%), remote labs (7%) and home labs kits (5%) (Graph 1).

Graph 1: Type of EA proposed during pandemic



Finally, the comparison between the type of EA developed and the educational level and the science subjects showed that the simulations were predominant in Teachers Education than the other educational levels ( $p = 0.043$ ). In the same way, Physics and Chemistry teachers preferred simulations in contrast to Biology ones ( $p = 0.002$ ). Related with the preferences about the types of EA in each educational level, teaching in the field resulted prevailing in Secondary School ( $p = 0.048$ ); and, home-made simple experiments were less used at University ( $p < 0.001$ ).

## Discussion and Conclusions

The fact that the participant teachers have carried out experimental activities infrequently or never during the pandemic may be reflecting the difficulties they had to face when they could design these kind of activities within the digital emergency remote teaching context. Moreover, this idea gains strength when one considers that most of the teachers assign a high or medium-high relevance to these activities. This shows the preponderant place that experimental activities have in the traditional practice of science teaching. Consequently, the development of theoretical and methodological models that promotes the design of experimental activities in b-learning and e-learning is urgent.

Although remote experimental activities predominated over face-to-face ones during the pandemic, the teachers' responses provided some evidence about their constrains. In those cases, real equipment which are very important to work with measuring and experimental error, like remote labs or home labs kits, were not used in the remote experimental activities. Over half of 450 teachers who participated in this study answered that during the covid-19 pandemic they did demonstrations in school labs or remotely, by using video conferencing systems. In these cases, students just had to observe what the teachers were doing. This deserves a special mention because it suggests that traditional educational practices could strongly persist despite the conditions during the pandemic.

The differences found between the type of experimental activities carried out at the different educational levels and the different disciplines put in evidence that the participant teachers share a general vision about the role of the experimental activities in teaching. Particularly, the increased use of simulators in Physics and Chemistry may be accounting for the availability of these resources. In addition, the low level of home-made simple experiments in the university could indicate the lack of knowledge of the power of this particular type of activities by the university professors.

In conclusion, the role of experimental activities in remote teaching is clearly exposed from the outcomes of this work. In order to improve STEM teaching, in-service teachers training is necessary to design, plainly and carry out new proposals in order to endorse experimental activities using digital resources.

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