# Comparing the efficacy of real and virtual experiences about electrification on primary school pupils

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**Abstract**. We compare two learning sequences for 9-10 years old pupils about electrostatic phenomena including the same activities in two different orders: (a) in the Real-Virtual (R-V) sequence, hands-on experiences about balloon electrostatic attraction and repulsion come first and virtual simulations follow; (b) in the Virtual-Real (V-R) one, the order is reversed. We analyze the learning progression on 101 pupils involved in the two sequences, focusing on how they explain the observed phenomena. Our preliminary results indicate that pupils' explanations at the end of each sequence are very similar.

## 1 Real or virtual experiences? A matter of interest in the teaching of electrostatics

Computer-based simulations play a relevant role in science classrooms thanks to their interactive and multimodal character and to the ease with which students can visualize complex, time-consuming or dangerous phenomena [1]. Various studies have highlighted the educational value of virtual tools in terms of students conceptual understanding and skills development [2], but important difficulties for students understanding have been also identified [3].

Which criteria should a teacher follow to decide when it is appropriate to use a simulation instead of a real experience? This real-virtual comparison has been a matter of interest in science education research: the results emphasize that virtual experiences cannot entirely substitute physical experiences and that the learning effects mostly depend on the specific design of the activities [4]. This issue is particularly relevant in the teaching of electrostatic concepts, since the scientific explanation of electrostatic phenomena requires the combination of physical interactions (repulsion or attraction between materials) with abstract entities (positive and negative charges). The PhET platform addresses this issue with a simulation devoted to help students in understanding attraction and repulsion phenomena in terms of charged particles [5].

## 2 Research objective, methodological approach and sample

A formative intervention on electrostatic phenomena for 9-10 years old pupils was proposed to 101 students of six Italian primary schools in order to answer the following research question: how is pupils' understanding of electrostatics affected by the order in which Real or Virtual experiences are presented? To this aim, we projected two sequences of 4 inquiry based learning activities (each one including both prediction and interpretation of the observed phenomenon). The Real-Virtual (R-V) sequence begins with two hands-on experiences about balloon electrostatic attraction and repulsion; then pupils experience the PhET simulation that represents the same phenomena (two virtual activities) [5]. The sequence Virtual -Real (V-R) includes the same four activities, but in the reverse order. A pre-knowledge of the proposed activities was the existence of positive and negative charges as constituents of atoms.

We analyzed the learning progression of the pupils involved in the two sequences (59 R-V and 42 V-R), focusing on how they use the concept of electrical charge to explain the observed electrostatic phenomena. Table 1 summarizes the categories of our qualitative analysis in terms of levels of explanation, obtained through an iterative process [6].

**Table 1.** Categories for the analysis as levels of explanation according to:

| |
|---|
| **0. No explanation or alternative explanations:** No electrical interaction mentioned |
| **1. Electricity** as an attractive/repulsive propriety of bodies, but charges are not mentioned. |
| **2. One body has charges,** so this produces attraction/repulsion despite the other object is not charged. |
| **3. Two bodies have charges.** If the charges of the two bodies have the same sign, repulsion is produced. If they have different sign, attraction is produced. |
| **4. Two bodies have charges that are transferred by rubbing.** Explanation of level 3, the difference of charges occurs rubbing two objects, since charges are transferred from a body to another. |
| **5. Bodies have non-equal number of positive and negative charges**. Electric charges are everywhere, so being charged implies having more positive than negative charges, or viceversa. This occurs rubbing two objects, because charges are transferred from one body to another. |

## 3 Results and conclusions

Figure 1 summarizes the distribution of pupils in the 6 levels with respect to the 8 moments (prediction and interpretation for each one of the 4 activities) in each sequence: the final distributions (at the end of both sequences) are very similar, suggesting that the R/V order does not considerably affect pupils learning. Instead, different patterns are seen in the intermediate moments, which will be discussed in detail during the conference.

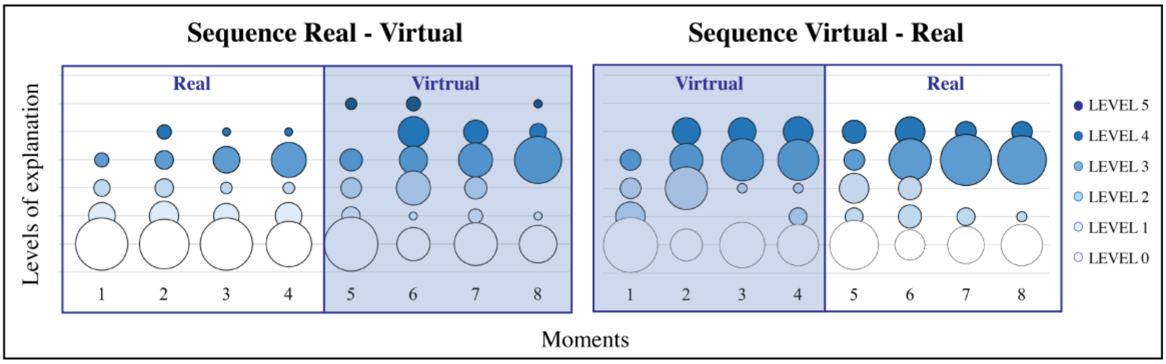


**Figure 1**. Distribution of pupils into the 6 levels of explanation with respect to the 8 moments of the R-V and V-R sequences. Moment 1 and 2 refer to prediction and interpretation of the first activity and so on.

## References


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