Combining Theory and Practice to Solve a Common Problem: A Simple Circuit for Indoor Plants Watering

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Presentation type: single oral presentation or workshop, in which the attendees can build the circuit themselves.
Topic: Physics teaching and learning at Primary and Secondary Education

Background

Italian secondary schools are differentiated according to different curricula. Depending on the main theme of the curriculum, there are variations on the sets of subjects that are taught and the amount of time spent on each subject (*e.g.* "scientific" high schools have 99 hours per year dedicated to Physics [1], high schools for social studies have only 66 hours [2]). Teaching Physics in non-science oriented schools might be challenging for several reasons (*e.g.* lack of time and students tend to be less motivated toward STEM subjects). The general aim of our activities, in such high schools, is to develop teaching paths that could emphasize the different aspects of Physics: theory, problem-solving, applications, practice and socio-cultural impacts.
This project is focused on the problem-solving and practical sides. We propose to solve a problem that can occur in the students' daily lives: determine when an indoor plant needs watering.

Concept

We present here a teaching path that applies the concepts of Ohm's and Kirchhoff's laws to a real-life situation. The problem we want to solve is to detect when an indoor plant needs watering. This is a common enough situation that anybody might have faced.
The soil electrical resistance has a rough correlation with the soil wetness. A wet soil exhibits less resistance than a dry one. For the intent of measuring the wetness, we can simply apply Ohm's and Kirchhoff's laws and compare the soil resistance with a reference value. The circuit that we designed is extremely simple, so students can build it during one regular class period (60 min). The soil is treated as a variable resistor in series with two regular resistors. The reference value is obtained using a potentiometer. The two branches of the circuit are connected in parallel. This approach can emphasize the understanding of the cited laws and of the difference between series and parallel circuits.

Implementation

The introductory lessons are structured as a combination of lectures, in-class demonstrations, and group discussions. Before the hands-on activity, the theoretical bases are presented to the students. Web applets are employed as teaching aids. The functioning of real components is demonstrated in class, as well. These aids are used to leave a mark on the students' memories [3]. After the theoretical introduction, the functional parts of the circuit are presented as specific exercises. Finally, all the parts are put together theoretically defining the complete circuit.

The laboratory activity follows. In the circuit building lesson, students are split into groups of up to four members (Fig. 1). Plants, electronics components and supports are provided to each group. The instructor traces the circuit step-by-step, supporting the students during the developing of the activity. The final circuit (Fig. 2) lights up a LED if the plant needs watering. After the circuit construction, the theoretical explanation is reviewed in light of the practical experience.

Figure 1. Students building the circuit

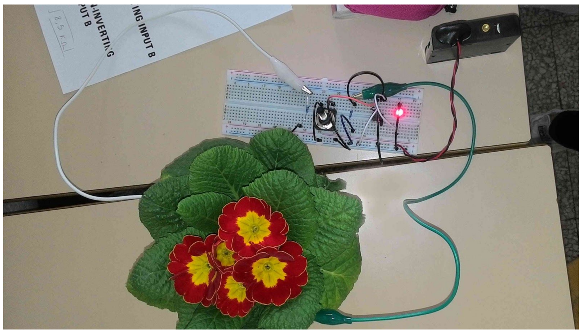

Figure 2. Working circuit

Conclusions

In our real-life application of the project, the students were supported by three people: the class teacher, an external expert in electronics and another teacher that acted as an in-class peer reviewer. Having had a concrete problem, and a goal ahead, motivated the more practically-oriented students to comprehend the real meaning of the theory. The questions that the students raised during the laboratory activity highlighted how the previous lessons were understood. Moreover, the exercises that followed showed that the students really understood the difference between series and parallel circuits.

The students' reaction was very positive; they both showed enthusiasm and interest. At first they felt intimidated by the task, but the instructors' guidance allowed them to build functioning circuits. As an anecdotal evidence, we report that, at the end of the hour, one of the students uttered "has the class already ended!?"

References

[1] Allegato F al Decreto del Presidente della Repubblica 89 del 15 marzo 2010

[2] Allegato G al Decreto del Presidente della Repubblica 89 del 15 marzo 2010

[3] S. Hemmer, S. Moretto and O. Pantano, *"Integrating Simulations and Hands-On Activities in Physics"*, Selected Papers from the 20th International Conference on Multimedia in Physics Teaching and Learning (2016) 93-99. ISBN: 978-2-914771-95-5