Interactions between Schools and Universities: The Example of Lab2go in Calabria

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Abstract: Recent research emphasizes the need for a more sustained interaction of schools with universities and research institutions. For example, informal after-school programs integrated into the school curriculum can provide opportunities for meaningful interaction with researchers in active learning settings. At the physics department of University of Calabria it has been launched in 2016 a program aimed at recovering disused, and in several cases ancient, instrumentation in laboratories of some schools in the region of Calabria. In 2022, our local project merged into Lab2go, a national project of the National Institute of Nuclear Physics (INFN) (Lab2go; https://web.infn.it/lab2go/) and of University of Rome "La Sapienza" devoted to the enrichment of the laboratory activities of the schools. Lab2go involves a steadily increasing number of schools and has expanded to include chemistry, robotics and other subjects. This contribution discusses some didactic activities developed within Lab2go. The activities of lab2go are integrated and form part of the (formal) school curriculum as work based experiences, which have become mandatory during the last three years of secondary schools . Thus, this project is an example of how specific policy interventions can lead to the kind of long-term structured collaboration between schools and research institutions needed to favor the shift of focus in science education.

Keywords: Physics Education, History of Physics, Third mission, Public engagement

Citation: Prete, G., Chiappetta, F., Riccardi, P., Tucci, R., Bruzzese, A., & Meringolo, C. (2023). Interactions between Schools and Universities: The Example of Lab2go in Calabria. In M. Shelley, V. Akerson, & M. Unal (Eds.), *Proceedings of IConSES 2023-- International Conference on Social and Education Sciences* (pp. 548-555), Las Vegas, NV, USA. ISTES Organization.

Introduction

The term "public engagement" indicates the myriad of initiatives that have been developed aiming at creating points of contact between scientific research and the public. Most of these initiatives, like seminars, science festivals etc… are one-day event, which remain isolated and sporadic, and are not able to fill the gap between science and the public. Recent research emphasize the need for a more sustained interaction of the public with universities and research centers, while at the same time requiring a larger participation of research scientists in education and public outreach (Mack et al., 2020; Dudo et al., 2014).

To favor a large participation of researchers, our efforts at the physics department of University of Calabria have gone in these last years in the direction of adopting a participatory approach, which includes forms of two-way communication, that allow outreach to evolve towards forms of public engagement that provide both researchers and the public with opportunities for mutual learning (Chiappetta et al., 2020; Leshner, 2003). Moreover, the interaction with schools have been developed with great attention to provide students and teachers with the opportunity of a longer and more meaningful interaction with a research environment (Riccardi & Goletti, 2017; Riccardi, 2023a), also by taking advantage of recent reforms that have been introduced in these last years in Italian secondary education systems (Riccardi, 2023a).

This contribution discusses recent activities conducted by researcher scientists of the Physics department of the University of Calabria within Lab2go (https://web.infn.it/lab2go/), a national project of the INFN (National Institute for Nuclear Physics) aimed at recovering and restoring instruments of school laboratories. Our local project started in 2016, as elsewhere discussed (Riccardi, 2023a; Riccardi, 2023b). The activity is conceived as work-based learning experiences for the school pupils of about 30 hours, i.e. more sustained than the usual one-day laboratory or seminar activity, which can be concentrated in short periods of about a couple of weeks or diluted over longer periods.

This longer interaction is made possible by the recent reform introduced in 2015 in Italian secondary education system. This policy intervention mandates these experiences for all Italian students in the last three years of the secondary education cycle (PCTO – piano per le competenze trasversali e l'orientamento - plan for transversal skills and guidance – formerly known as school work alternation) (Riccardi, 2023a). Work-based learning entails non-formal experiences integrated within the curricular (formal) program and performed in collaboration

with an enterprise or an organization, like for example a physics department in a university, for which it is included within its third mission programs. In this sense, these didactic paths are part of our local outreach project within the PNLS (Piano Nazionale Lauree Scientifiche – National Plan for Scientific Degrees) (Riccardi & Goletti, 2017), which is an initiative of the minister of university and research aiming at creating contact between university and schools operating in the same local context.

Similar local projects were independently launched in other universities. The local initiative of "La Sapienza" University of Rome developed a nation-wide collaboration within the National Institute of Nuclear Physics (INFN) (Lab2go - https://web.infn.it/lab2go/). Our project joined Lab2go in 2022. In the following we will discuss some of the activities conducted in these last couple of years in our local project within Lab2go.

Goals of the Initiative

Activities in the laboratory constitute fundamental part of the teaching of physics, not merely to illustrate the concepts studied theoretically, but primarily to educate the ability to the systematic observation of natural phenomena as they occur, which is one of the main skills in the process of scientific research. An effective teaching of physics, as well as all of other scientific disciplines, therefore requires a sustained practice in the laboratory by the students. The laboratory is the place where students could learn to use the scientific method, practicing it in a collaborative environment, capable of stimulating their engagement from both cognitive and emotional point of views; it is the place where teachers can discuss, plan and implement educational paths and strategies, according to an active learning methodology, based on scientific investigation and where the learners are situated at the center of the teaching activity (Mack et al., 2020). Therefore, science laboratories should be one of the most important places in the life of a school community. Actually this is not so, particularly in Italy, where it is common experience that the laboratory is one of the least attended places in the school.

Generally, the physics laboratory in schools appears as a well-equipped space, where students and teachers could find plenty of scientific instruments purchased by the schools over the year. As a result, many schools have rich collections of instruments acquired over decades. Furthermore, in the oldest schools one can find experimental apparatuses of appreciable historical value, and in some of them the instruments are cataloged and showcased in real museums (Leone & Rinaudo, 2020; Gallitto et al., 2021). There is also no shortage of the most recent and technologically advanced equipment, generally purchased according to the input provided by those teachers, that are aware of the help that new technologies can give to teaching.

The problem of the vitality of school laboratories, therefore, does not appear to be related either to the limited instrumental equipment or to the technological updating of the instrumentation. Furthermore, new technologies, especially those related to multimedia, the internet and digital technologies, have been around for several decades now. We argue here, that the main problem, therefore, is not which technology is used, but the defamiliarization with the practice of the laboratory. The ultimate goal of the project is the revitalization of the school laboratories as spaces of both didactic activities and socialization. In fact, the laboratory teaching in

schools is also promoted through the production with the recovered instrumentation of materials and events open to the school community and/or to a wider public. The recovered equipment has been used also for other activities, such as exhibitions and public events (see Fig. 1), which represented an interesting and intense moment of socialization between the participants. Thus, Lab2go aims at restoring the centrality of the laboratory in the every-day life of the school community, working as a mean to recover the ability to experience the laboratory as a place of educational planning and socialization.

Figure 1. The stand of the school Liceo Scientifico "E. Fermi" during the EU researchers' night at University of Calabria on September 29th 2023

The Activities of Lab2go in Calabria

Some of the activities conducted within lab2go have already been discussed elsewhere (Riccardi et al., 2022; Riccardi, 2023b). Briefly, physicists from the University of Calabria are helping some schools in the region to recover disused instruments in their storerooms and put it back into operation. Currently the project currently involves about a hundred students in four schools of the region: the Licei "E. Fermi" in Cosenza, "G. Berto" in Vibo Valentia, " A. Volta" in Reggio Calabria and "F. Bruno" in Corigliano Calabro.

Generally, the instruments are found in good shape and working, so that they can be used immediately by the students. Those instruments that are not working are brought to the physics department where they can be repaired, if possible. Many old instruments usually do not fulfill the requirements to recent safety regulations. In that case they are used only for exhibits but not operated in the presence of students or the public. The selected instruments are entrusted to the students that learn how to use them and perform experiments, under the guidance of their teachers and the university staff.

An important thing that is required to the study is to take pictures and movies so that the instruments can be catalogued for the benefits of future users. Example of the recovered instruments are reported in Fig. 2 and Fig. 3. Figure 2 shows also the description of the instruments produced by the students participating in for cataloguing and showcasing the instrument.

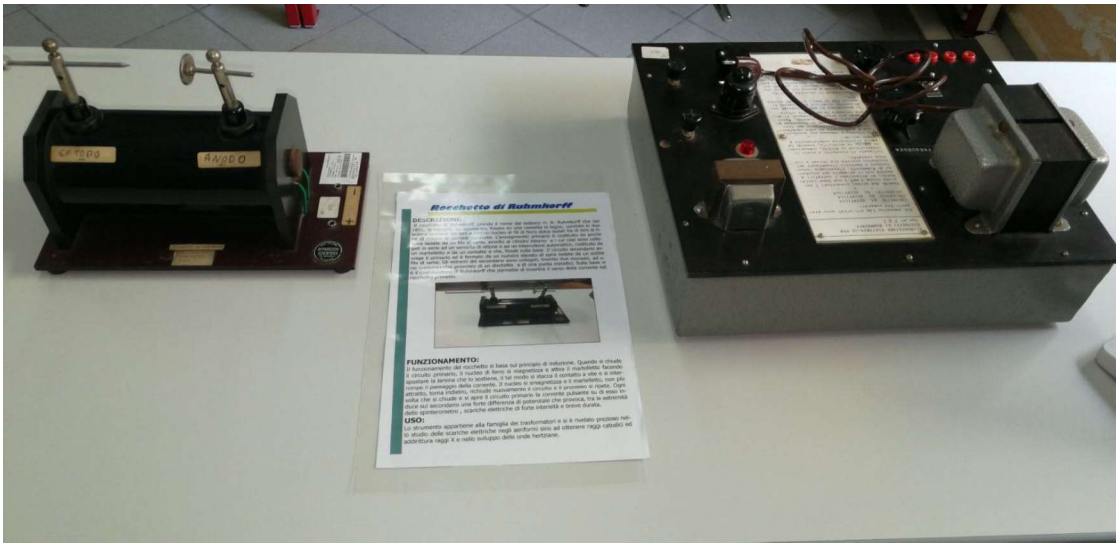

Figure 2. A Ruhmkorff coil and its power supply from Liceo Scientifico “G. Berto” in Vibo Valentia

Figure 3. A Tesla coil lighting a Neon lamp at the Liceo “G. Berto”

The activity proved to be perfectly functional also with respect to the innovations that have occurred in recent years in the teaching of physics in Italian schools. These innovations concern the introduction of elements of quantum mechanics into the curriculum. It has been realized the need to broaden students' knowledge by

including in school curricula those experimental observations and the consequent conceptual developments, which led to the so-called crisis of classical physics.

These innovations immediately pose a problem regarding the training of teachers, the majority of whom do not have degrees in physics and have never studied these topics during their degree courses. In fact, from the requests we often receive from teachers, we can sense their difficulty in adequately carrying out the part of the curriculum concerning the twentieth-century physics. This difficulty is often associated with the difficulties of students in understanding the profound changes that these theories have brought to our vision of the world. On the other side, we found in schools many instruments and set-ups that are suited to study modern physics, like those shown in Fig. 4 and Fig. 5. These are apparatus for the diffraction of electrons, discharge and spectral tubes for the study of atomic and molecular spectra, Thomson experiments and cathode ray tubes of various types and ages, Wood lamps for the study of radiation-matter interaction, superconducting materials. Not to mention all the devices that we are unable to show, from Franck-Hertz to Millikan, Michelson, etc. etc… Therefore, recovering the instruments a project like Lab2go can help schools in overcoming the difficulties generated by the updating of the school curriculum, providing help to both teachers and students.

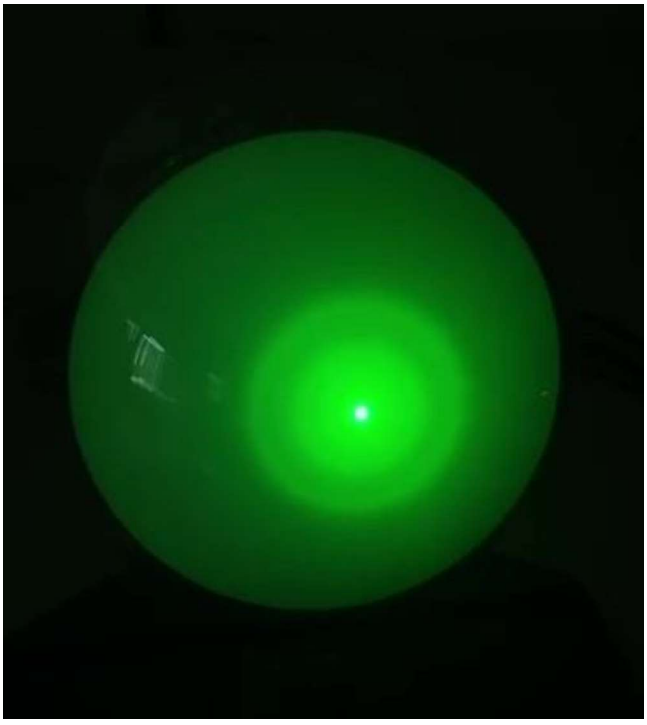

Figure 4. Electron diffraction at the Liceo “E. Fermi”

As mentioned, the issue does not only concern the old instrumentation of the laboratories. Over time, schools have continued to acquire material, and in laboratories today you can find robotics kits, hydrogen engines, kits for the physical-chemical detection of various types of environmental pollution, meteorological stations and various types of photovoltaic cells and panels. This equipment is purchased by schools with the aim of

introducing students to topics of absolute importance and urgency, not only from a scientific point of view but also and above all from a social, economic and human relations point of view, such as energy efficiency, new technologies, climate change, smart and sustainable growth. To this picture, we must add the infinite possibilities that digital technologies and the internet offer today for effective laboratory teaching of physics, ranging from the use of the smartphone to Arduino and computer simulations of phenomena and experiments.

Our action, initially aimed at the oldest instrumentation, often deviates from this path to also use the most recent instrumentation, which is in any case rarely used. Indeed, Lab2go has been recently expanded at the national level to include chemistry, robotics and other subjects.

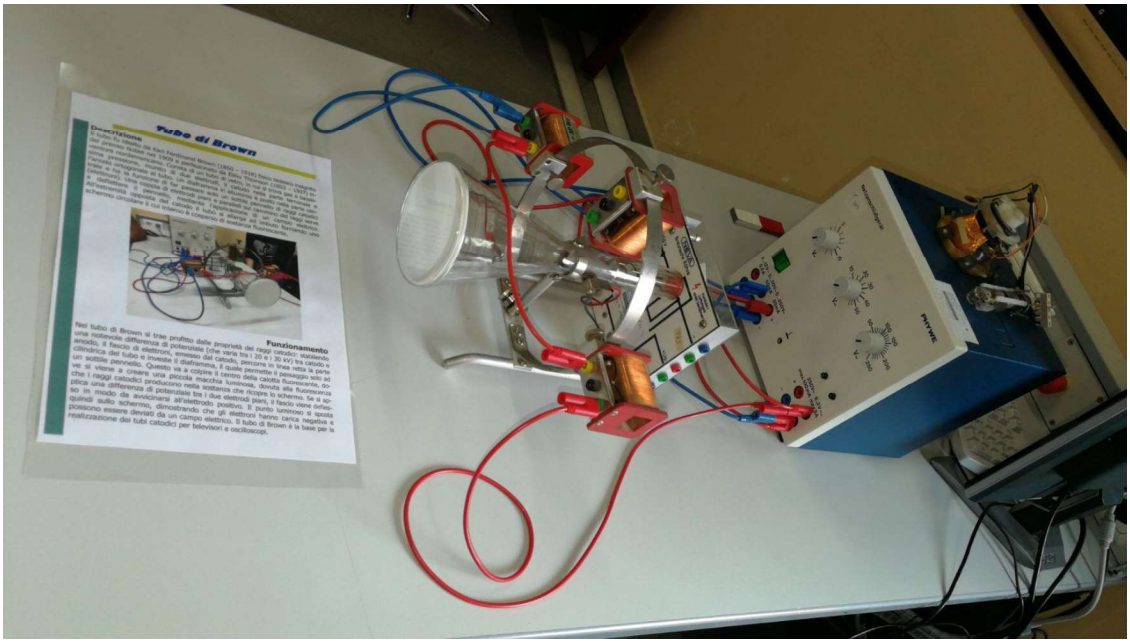

Figure 5: A Braun tube for studying the deflection of electrons into electric and magnetic fields from Liceo "G. Berto"

Conclusion

With the aim of making the laboratory a lived-in place again, teachers need help and not to be left alone. This help can be found in universities, research institutions and centers through projects like Lab2go, that can help schools to recover the equipment and plan teaching and laboratory activities, according to participatory methodologies, with great attention not only to the contents of the activity but also and above all to the interaction between participants. The project represents also a strong moment of socialization through the participation of the students to public events. Projects like Lab2go, that contribute to strengthening the interaction between schools and universities, can be favored by specific policy intervention and we advocate support for efforts in this direction.

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