

# PROMOTING THE PHYSICS LABORATORY WITH LAB2GO

G. Organtini<sup>1,2</sup>, F. Ameli<sup>1</sup>, G. Cavoto<sup>1,2</sup>, E. Di Marco<sup>1</sup>, F. Piacentini<sup>2</sup>, S. Morganti<sup>1</sup>, E. Pasqualucci<sup>1</sup>, A. Polimeni<sup>2</sup>, M. Rescigno<sup>1</sup>, F. Safai Tehrani<sup>1</sup>, G. Salmé<sup>1</sup>, P. Vicini<sup>1</sup>, R. Faccini<sup>1,2</sup>

<sup>1</sup>*INFN-Sez. di Roma (ITALY)*

<sup>2</sup>*Sapienza Università di Roma & INFN-Sez. di Roma (ITALY)*

## Abstract

Laboratory activities are the essence of natural sciences and a key tool to convey the taste for experiments and physics, in particular for the new generations.

Italian secondary schools are mostly equipped with some kind of physics laboratory, but it is often under-used because of lack of experience or knowledge, as well as degradation of the instrumentation. Also, when the instrumentation is working well, only a fraction of the physics teachers in a school utilizes it, due, in particular, to the fact that they are often graduated in mathematics with little or null experience in laboratories.

Having this in mind, we promoted an activity aiming at building a deeper knowledge of the instruments available in such laboratories and the experiments that can be realized with them. In the first year of this project (named LAB2GO) we achieved to have the instrumentation in the laboratories of 19 schools catalogued and documented, in Italian, in a Wiki page.

The goal of the second year of the project is to extend the knowledge acquired in the first year from the teachers that collaborated with us, to as many as possible teachers of the same school.

In the third phase, we plan to set up a mechanism such that a teacher that would like to show the class an experiment that requires instruments not present in his/her school, can identify in which other school the required tools are via a geo-localizing tool and loan them or bring the class to the laboratory of the other school. The geo-localized map is already implemented, so this phase will mostly require administrative work.

All this is being realized by the students in the context of a training program. Part of the work can be done at school or at home, but has to be certified by the third party.

The core of the work of this first year of project has been carried out by students with the support of tutors from Sapienza Università di Roma and INFN. The enthusiasm of all participants (students, teachers, tutors and headmasters) brought to brilliant results and encourages us to bring the project forward and hopefully extend it to the largest possible set of schools. The model can also be extended to other disciplines.

Keywords: Physics laboratory, sharing, documenting.

## 1 OBJECTIVES

The dissemination of some scientific culture is a key aspect in the growth of a Country and it must be fostered at all grades of the educational system. Furthermore, the number of students that choose scientific faculties at universities and their quality strongly depends on the capability of the high school to form the scientific reasoning.

A key tool for the formation of individuals with sensitivity to science is the availability of laboratories, well documented and regularly utilized.

A fraction of the Italian schools is not equipped with a laboratory, while most of them have a laboratory, which however is only partially equipped and used by a small fraction of the teachers.

The LAB2GO project, promoted by Sapienza Università di Roma and INFN, addresses this issue focusing on physics laboratories. Its specific objectives are therefore:

1. requalification of the physics laboratories by cataloguing the instrumentation present and repairing the damaged components.
2. documentation of the instruments and of the experiments that can be performed with them and sharing of the same
3. training of all the teachers of the high school to the use of the laboratories
4. sharing of the physics laboratory instrumentation within a network of schools

To realize this project, high school students were in the context of the so called “Alternanza Scuola-Lavoro” (ASL), a training program that the latest Italian reformation (the “Buona Scuola”) has made compulsory to all kinds of high schools. Within this program, students must take at least 200 hours of work in three years, coordinated by an external entity (a University, a public or private company, etc.). Part of the work can be done at school or at home, but has to be certified by the third party. This choice added objectives related to the education of the students themselves:

1. make the students familiar with the laboratory practice and experiments
2. let the students be active part in the requalification of their own school
3. familiarize the students with cataloguing and documentation, and, in particular, introduce them to the development of collaborative tools like Wiki pages, Google sheets and Google Maps.

## 2 STRUCTURE OF THE PROJECT

The project, named LAB2GO, consists of three phases: in a **first phase** 19 schools were selected to provide an inventory of the devices found in their laboratory. The inventory is done by about 15 students per school coordinated by one or more teachers with the help of a student or post-doc of the Department of Physics of Sapienza University.

The details of the instruments found in the laboratory are inserted into shared Google Sheets that is intended as a record for the future. Also, in this phase the instrumentation out of order was sent to Sapienza and repaired by the technical personnel, if possible.

Starting from the catalogue, the students entered the documentation (described in detail in the next section) with the information relative to the instruments found in the labs and the corresponding experiences.

The information is supposed to be terse, directed to allowing to use the instruments and perform the experiences, and is supposed not to superimpose with the host of information already available on Internet. In particular, the use of links of existing web sites, both in terms of physics explanations and examples of movies, emulators, etc., was encouraged. It has to be noted that also linking material from the Internet requires discerning, for instance, on the accuracy and clarity of the content, or on the quality of the product.

The documentation work is performed partly at home or at school and partly in the laboratories of Sapienza, under the supervision of researchers.

The **second phase** of the project is devoted to the diffusion of the use of the physics laboratories to teachers that were not involved as tutors of the students in the first phase. The aim is to make the use of the laboratories more uniform across the classes in a school. To achieve this, we envision groups of students in ASL to assist their tutors of the first phase of the project in a training course for the rest of the physics teachers. This course will comprise a theoretical part, where the documentation is described and a practical part where the students realize the experiences for other classes in the school.

In the **third phase** we expect to setup the administrative machinery to allow the loan of instruments among schools. A Google Map, which is a product of the project described below, would then allow a teacher of a school lacking the instrumentation for a given experience to find the most convenient school that has it and borrow it or bring a class to visit the laboratory of the other school.

### **3 STRUCTURE OF THE DOCUMENTATION**

The tools required to host the documentation were developed by the INFN personnel to maximize the collaborative approach. Available commercial programs were exploited to minimize the IT development efforts. In particular Google Sites was setup to share the documentation while Google Maps was configured with the goal of stimulating the sharing of experiments among schools, as it will be detailed in the third phase.

To develop the structure of the Wiki, the concept of “instrument” and of “experience” were introduced. “Instrument” is the physical object that is required, alone or in conjunction with others, to setup a demonstration or a measurement, called “experience”. The relationship between schools, instruments and experiences is many-to-many: several schools have the same kind of instrument and each school has several instruments; several instruments are needed to setup an experience and several experiences can be achieved with the same instrument. The Wiki pages were accordingly of three types (school, instrument or experience), distinguished by a different visual template.

The schema describing the relationship between the pages that was adopted to minimize the risk of duplication, and thus potential inconsistency, is shown in Fig. 1. The solid arrows correspond to direct links between Wiki pages, while the dotted arrows are implemented by means of the Google Map.

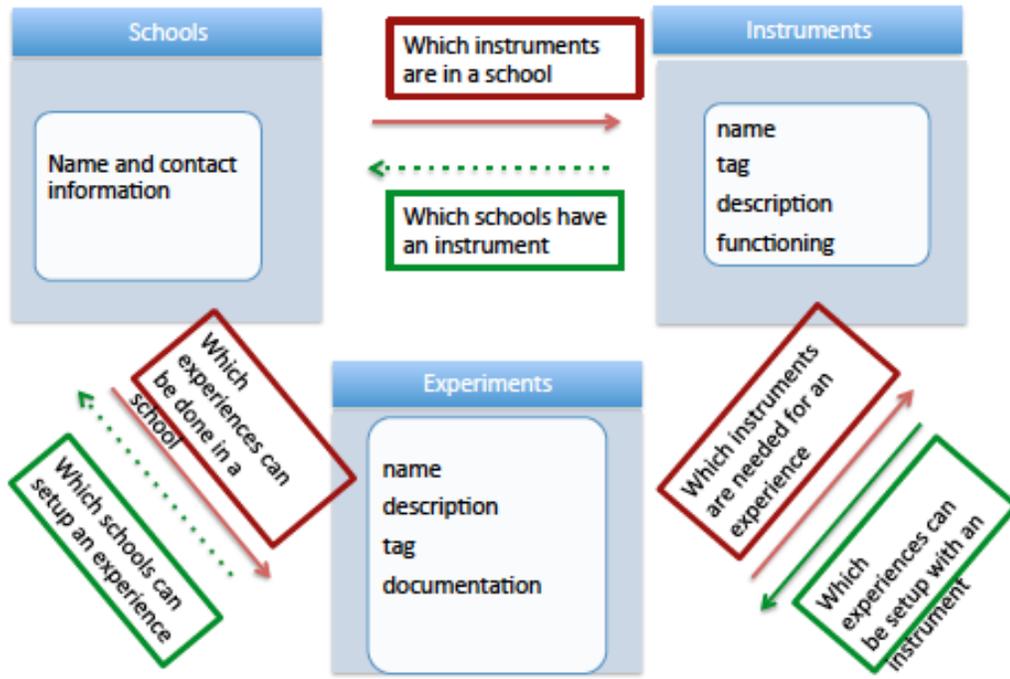


Figure1: Logical Structure of the documentation

In particular, the school pages contain links to the Wiki pages describing the existing instruments and the possible experiences, while the instrument and experience pages are cross-linked (see Fig. 2).

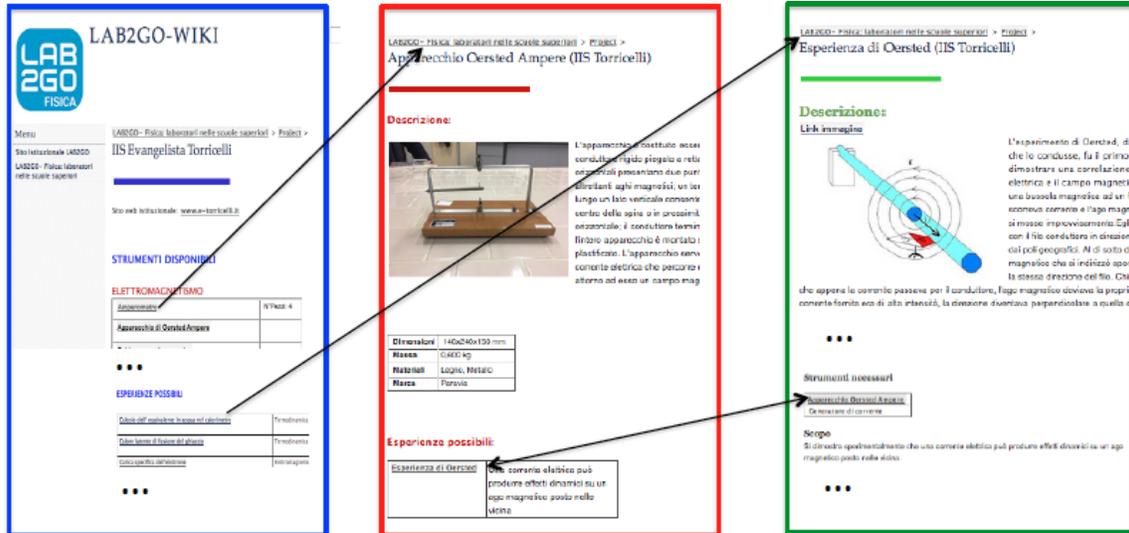


Figure 2 Example of school (left blue pane), instrument (central red pane), and experience page (right green pane). The arrows indicate the relationships enforced by direct links as described in the text.

The information of which schools possess a given instrumentation and can setup a given experience is instead delegated to a custom Google Map (see Fig. 3), where there is a location for each school and each of them is tagged with the tags assigned to all the instrumentations and experiences linked from the Wiki page of the school.

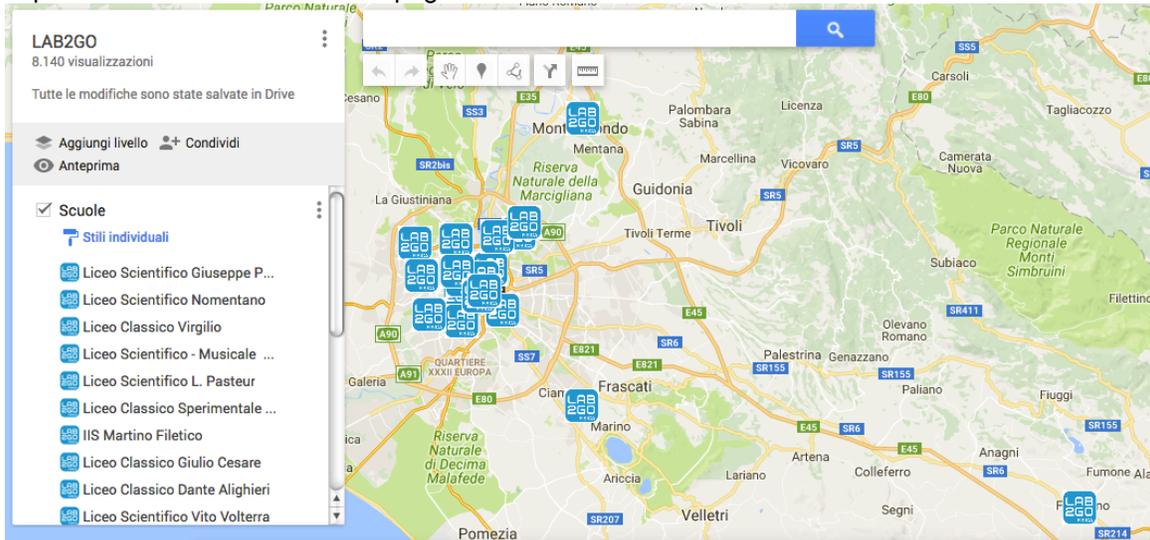


Figure 3 Google Maps with the localization of the schools taking part to the project so far. The search for a given instrument or experience would restrict the visualized entries to the school which have such instrument or can setup such experience.

A key point we had to resolve is the interplay between the schools. The goal is that the general information on a given instrument or experience is collected in only one page even if more than one school has it. We therefore setup a booking mechanism: the first school that catalogued a given instrument or experience created the page in the Wiki. All the other schools, seeing that the page was already created, linked their entry to the existing page and went over to other topics. Once the school that “booked” the page has a draft ready, the other schools are entitled to integrate it.

Separate mention needs to be given to the material that instead is specific to the school, such as the constructive and operating details of a specific device. This information needs to be directly linked from the school page, aside of the name of the instrument or experience it refers to (second column in the school pane of Fig. 2).

## 4 RESULTS AND OUTLOOK

The project is still in the first phase with 19 schools, but it already seems quite successful: the laboratory practice has been increased in the involved schools, students are more passionate with physics and they are learning new technologies such that databases and the usage of online tools.

As far as the documentation is concerned, both the Wiki and the Google Map can be visited from the home page of the project ([www.roma1.infn.it/LAB2GO](http://www.roma1.infn.it/LAB2GO)). More than 300 instruments and 200 experiences have been entered in the Wiki.

The level of depth and clarity of the pages is not yet uniform and therefore we have setup a review of the contents of the Wiki.

The real point of strength of this project is the collaborative approach: since the documentation is shared among all the schools, the effort to produce it is easier to sustain. Also it allows to have in the same project schools working at significantly different paces and in completely different conditions: we have schools with an already well equipped laboratory that are concentrating on the documentation and schools where there was no knowledge left among the teachers on what was in the laboratory. The latest schools can concentrate in the cataloguing and mutuating some of the documentation from the others. A good level of competition between schools has been observed, leading to an increase of the quality of the pages after a first public round.

In any case, with the support of the schools system, Sapienza University and INFN, we are going to promote a second year for this project.

It is also to be noted that this approach can be extended to other infrastructures in the schools, such as other laboratories or libraries.