

## A Spin-off from Physics Education Research

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**Abstract:** The need for an effective communication between scientific research and society is widely known to the broadest scientific community, and the sad times we are living in make it even clearer. At the same time, the need of establishing long-term structural connections between the worlds of research and that of education and scientific communication can open the way to new market opportunities. This led us to develop a cooperative society, academic spinoff of university of Calabria, named “Missione al Cubo” (mission cubed), evocative of both the “third mission” and the “cubes”, the buildings of University of Calabria. The cooperative aims at operating in the market sectors at the interface between research and society. In this interface region, the spinoff will interact on one side with universities and research centers developing educational, cultural and entertainment activities directly derived from their scientific research conducted. On the other side of the interface, the cooperative will distribute the products and services generated by the interaction with research environments in a large market, consisting of schools of all levels, local administrations, museums, science communication centers. We believe that there is a large market space for a whole series of products and services conceived to create a solid and lasting interface between scientific research and the public, at both the local and global level. This market space can offer interesting opportunities of self-entrepreneurship for young physicists with strong communication skills and rich research experience.

**Keywords:** Physics Education Research, Spin-off, Science Education, Public engagement with science

### Introduction

The participation of researchers from universities and research institutions in Education and Public Outreach activities is increasingly recognized as necessary, in order to establish an effective communication between scientific research and society, which could result in a correct information of the public about scientific issues of urgent societal relevance and in improving the way scientific research is conducted [1-4]. However, mutual mistrust, misconception, fake news are currently major issues that represent obstacles in the dialogue between science and society [1-5]. At the Physics department of university of Calabria, the need to increase the participation by researchers in education and public outreach activities has been pursued through a series of specific research lines on Physics education and public engagement [6-10].

These activities have been developed within the institutional framework of the Piano Nazionale Lauree Scientifiche (PNLS -National Plan for Scientific Degrees) in the two areas of Physics and Materials Science [6,7], an initiative of the Italian ministry of education and research (MIUR) that aims at creating connections between secondary schools and universities operating in the same local context. Within the PNLS, we have developed many initiatives, as for example didactic experimentations with schools, often integrated with work based learning experiences, which in Italy are compulsory for all the students in the last three years of the secondary cycle. These experimentations comprised didactic extracurricular (informal) activities integrated with school (formal) education, as well as citizen science projects [11] on monitoring natural radioactivity. We have also collaborated with local administrations and private enterprises in performing public events and exhibit [10] and, finally, between October 2019 and February 2020, we have managed the program with Schools of the Planetarium “G.B. Amico” of the town of Cosenza [8].

At the same time, the encounter between the demand and the offer of interaction with research environments can develop new market spaces. This led us to develop a cooperative society [11], that received the status of academic spinoff by university of Calabria and is named “Missione al Cubo” (mission cubed), evocative of both the “third mission” and the “cubes”, the buildings of University of Calabria. The cooperative aims at operating in the market sectors that are determined at the interface between research and society. In the following we examine the opportunities for new business activities spinning off from universities and research institutions and operating in the market sectors developed at the interfaces between science and society.

### **Physics Education Research at the Physics department**

In the last few years, Physics education and outreach activities towards schools have been developed at our Physics department through informal programs, developed in collaboration among the physics department of University of Calabria, schools, and informal education providers, such as museums, science centers, planetaria etc... and integrated with schools' programs and schedule. These programs have given the opportunity to bridging scientific research and science education and communication. The mechanism of integration of non-formal programs developed and supervised by our scientific institution is aided by flexibility in schedules and programs of formal schooling. For example, in Italy schools are allowed to include after-school programs, up to 15% of the regular school time. This made possible a structural and long-term collaboration among schools, universities' departments and other informal education providers in the development of after-school programs, aiming at establishing innovations and at introducing new topics, like the "School of Physics and Materials Science Technologies" that is currently under development in some schools in Italy [6], aiming at introducing topics of nanotechnology and materials science. Extracurricular programs can provide a wide variety of activities and generally operate during the hours immediately after the school day, but also include activities on weekends or during the summer. They have the great advantage that they can be freely chosen and can have open curricula, which can align with the learner's interests in a participatory and collaborative settings [6]. Moreover, specific policy interventions, such as the informal work-based experiences that are an integral part of

school curricula in many education systems worldwide like, for instance, the Italian “PCTO” ( “Piano per le Competenze Trasversali e l'Orientamento” - PCTO - plan for soft skills and guidance, formerly known as school-work alternation) can allow for a larger integration of formal and informal education that can enable stronger connection with universities and research environment[9,10]. In fact, in Italy during the last three years of the secondary education cycle, students must mandatorily perform a total of 90 h of informal work-based learning experiences, i.e. in a real workplace [13]. Therefore, this requires a collaboration of the school with an organization or an enterprise, like for example a physics department in a university. This mechanism of integration between educational structures can allow a greater connection with school curricula and allowed us to develop new forms of education. For example, many schools have collections of disused and in some cases ancient scientific instruments in their physics laboratory, as well as in university laboratories many instruments are frequently replaced. Restoring this equipment can represent a meaningful work-based experience for students and can be a useful activity for creating partnerships between the school and the university [10].



Figure 1. Some Moments of an Exhibit of School Instruments at the Cloyster of “San Domenico” in Cosenza, during the 104° Congress of the Italian Physical Society (SIF) [10]

Therefore, these activities and programs allow and support opportunities for more sustained and deeper interactions than most of the current ones between research scientists and the public, especially in schools. In this way, actual research topics can be transferred into both formal schools and informal contexts, which schools and museums usually have difficulty implementing [8]. At the same time, museums and science centers can establish an enduring interaction with students, teachers and the general public that goes beyond the usual one-day visit. Moreover, through the integration of citizen science and inquiry-based after-school programs with formal school activities, the approach can enhance the diffusion of active learning techniques, which are still poorly applied [14]. These interactions can be further strengthened by institutional collaborations of universities and research institutions with science communication centers and schools. For example, the inclusion of PhD students from our physics department into the staff of a planetarium favored the involvement of young researchers [8], simultaneously providing them with the opportunity for the specific training needed to improve communication abilities, which is still largely inadequate within the current graduate programs in higher education. Outreach activities are still poorly practiced by young researchers [15], though there is evidence of the success of these programs when they are actively involved [7, 8, 16]. Participation also enhances the education of scientists and helps them to develop skills and capacities useful for both academic and non-academic careers.

### **A Spin-off Company**

In particular, in the project developed at the Planetario “G.B. Amico” in the town of Cosenza [8], the activities with schools of the planetarium during the first year of activity have been managed by young researchers of the physics department of university of Calabria, under the supervision of senior researchers.



Figure 2. A Lesson in the Planetarium of Cosenza

This initiative showed that there exists a wide market space for a whole series of product and services conceived to create a lasting and solid interface between the university and the public. Therefore, to facilitate a large involvement of young researchers in public engagement activities and to cope with these opportunities and challenges, we decided to establish a spin-off company [12]. The cooperative society, which received the status of academic spin-off from university of Calabria, has been named “Missione al Cubo” (mission cubed), recalling both the “third mission” and the “cubes”, the buildings of the university of Calabria (pictured).



Figure 3. The Cubes of the University of Calabria

The cooperative aims at operating in the market sectors that are determined at the interface between research and society. Operating in an interface region, the spinoff will interact on one side with universities and research centers developing educational, cultural and entertainment activities directly derived from the research conducted by individual researchers, research groups and departments, which can provide an almost infinite resource of cutting- edge science content on which to base the activities. In turn, the interaction with the spinoff can allow universities and research institutions to expand, through the market, their public engagement activities, reaching sectors of the public currently not reached by the institutional activities and favoring a large participation of researchers. Just to make an example, our physics department interact with 25 schools, reaching about 1000 pupils each year, while the number of schools in our region is more than 2300 with about 300.000 students.

Therefore, on the other side of the interface, the cooperative will distribute the products and services generated by the interaction with research environments in a large market, consisting of schools of all levels, local administrations, museums, science communication centers. Most of the products and services have been developed in these last years in the outreach programs of our physics department [6-10], which have been conducted with the involvement of many young researchers, graduate students and post-docs. The products include laboratory activities and extracurricular science programs for schools, development of multimedia and digital teaching materials, services for distance learning, advisory service for schools and science centers, preparation and management of science museums and exhibitions, multimedia material and fulldome shows for

planetariums. There are also products, such as summer camps and teachers' professional development activities, aimed at the public and a market of individual users. Furthermore, the evolution of public engagement as an academic research line will favor the development of new products that will expand the activities and the market space also in other fields beyond physics. Around the cooperative society it will therefore be possible to build a network for education and public outreach integrated with the school and museum system of the territory. This network develops first in the region of Calabria, whose expanding tourism market offers interesting opportunities for the business idea, but the services and products can also be exported to a wider market, both at the national and European level.

The team is made up of 14 people, mainly young PhDs and PhD students of the physics department, who therefore have a substantial background in scientific research and can bring to the public topics of actual scientific relevance, which are subject to active research at the University of Calabria. We believe that the real strength of the entrepreneurial idea is its derivation from an important scientific and research structure such as the University of Calabria, which can provide a wealth of skills and professional experiences to give the public, mainly pupils, the opportunity to approach correctly scientific research, interacting directly with people who know and practice it. Furthermore, participation in public engagement activities, which have been carried out in recent years by our physics department with a large involvement of young researchers, ensures that the team has acquired all the necessary communication skills and abilities. The choice of the cooperative form derives from these experiences. The mutualistic and democratic purposes of the cooperative society are in fact those that are best suited to an entrepreneurial activity based on collaboration between doctoral students. The cooperative form is also compatible with the scientific duties of PhD students, which can be complemented by the activity within the cooperative, according to an operating method long tested in our outreach activities. In addition, this form allows an easy exit and entry mechanism for members in the years to come, following both the evolution of the market and the formation path of the participants in the initiative. This will favor an easy turn-over, in a company made up mostly of PhD students.

In conclusion, we believe that there is now a large market space for a whole series of products and services conceived to create a solid and lasting interface between scientific research and the public, at both the local and global level. This market space can offer interesting opportunities of self-entrepreneurship for young physicists with strong communication skills and rich research experience.

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