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https://doi.org/10.1038/s41567-023-01941-8

How to restore trust in science through education

P. Riccardi

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The authority of science within society is contested by antiscientific movements. To restore trust, science education should involve students in the social processes of knowledge production.

Over four centuries, society has granted institutional authority to science because of its contributions to technological innovation and economic development. Recently, however, antiscientific movements have questioned this authority, promoting misconceptions and ill-founded debates that undermine society's ability to address global challenges.

The success of science derives from its social nature. In science, knowledge is established when consensus is reached within the community about objective facts upon which there is no disagreement. For example, saying that competent agencies have approved a vaccine means that an agreement about its reliability has been reached within the scientific community. The social process of building scientific consensus is still the most reliable and authoritative way to produce knowledge of natural phenomena. Therefore, it would be more appropriate to talk about trust in scientific research, rather than in science or scientists. Though admittedly semantic, this distinction emphasizes that the problem of restoring trust is not simply that of promoting the value of scientific discoveries and technological innovation but, rather, that of increasing the awareness among the public of how science works. This is particularly important for those issues for which consensus has not yet been reached and are still subject to (legitimate) debates.

For this long-term goal, it appears crucial that the teaching of science — and in particular physics, one of the most widely taught experimental sciences — develops a clear focus on the methodologies of scientific knowledge production.

The role of science education

Currently, science education focuses mostly on content knowledge, which is needed, for example, for the formation of the scientific workforce. However, most students will not become science experts and science classes in school will likely not suffice to enable them to understand an issue in scientific terms. Therefore, science lessons should also focus on how science works and how it operates within society[1] to help students identify reliable sources of information and make informed decisions.

For this purpose, history and philosophy of science should have an important role in science education. Although the educational value of the history of physics in physics education has been recognized[2], it is still rarely included in school curricula. The history of physics can be a useful tool for dealing with students' conceptual difficulties and for promoting cognitive and emotional engagement[2]. Moreover, the use of old instruments from museums, schools, and university laboratories[3] can encourage the interaction of schools with universities and research institutions.

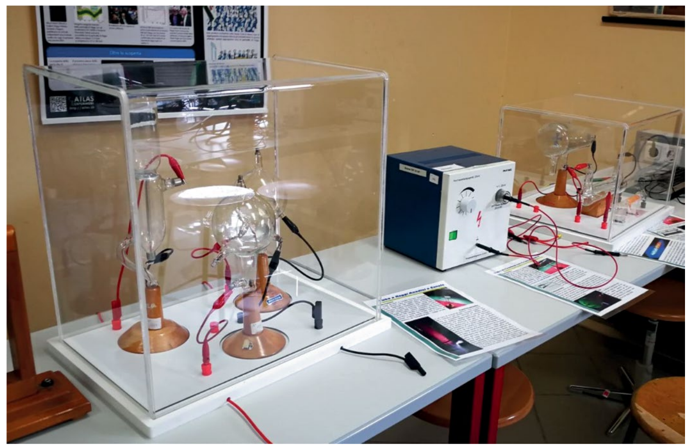

Fig. 1 | Recovered laboratory instruments. Disused laboratory instruments were recovered through the scheme Lab2go at the Liceo "G. Berto" in Vibo Valentia, Calabria, Italy. School pupils showcased the instruments at science festivals.

Active learning techniques are another effective way of teaching science, but they too are seldom used[4]. They consist of collaborative activities that stimulate distributed reasoning processes[5] similar to those in research groups, where incorrect assumptions, personal opinions, and biases are gradually eliminated through peer-to-peer interactions in the collective endeavour to reach consensus. These learning techniques therefore emphasize the social nature of building scientific knowledge[5].

The interaction with research environments

Informal after-school programmes[6–8] integrated in the school curriculum can provide opportunities for meaningful interaction with researchers in active learning settings. This connection between schools and research institutions is usually based on short-term activities[6–8] but specific policy interventions have recently allowed for more sustained experiences.

In Italy, a secondary education reform introduced in 2015 mandates a period of work-based learning[3,9] of about 30 hours per year in the last three years (students of age 16–19) of Liceo (http://www.indire.it/en/progetto/school-work-alternation/). This programme is creating interesting points of contact with universities and research institutions.

For example, in 2016 our department at the University of Calabria launched a scheme to recover disused instrumentation in school physics laboratories[3,9] (Fig. 1). Similar local projects were independently launched in other universities, which eventually led to the development of a nation-wide collaboration with the National Institute of Nuclear Physics (INFN) (Lab2go; https://web.infn.it/lab2go/). It involves a steadily increasing number of schools and has expanded to include chemistry, robotics and other subjects. 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[8,10] needed to favour the shift to active learning in science education.

Another way to promote active learning is through citizen science projects, which involve students and teachers in real research activities[11]. Citizen science is best known for involving adult volunteers and including the public into the process of knowledge production[11]. However, an increasing number of studies argue that this kind of exposure to research has interesting educational benefits for school pupils[12]. Unlike projects for adult volunteers, educational citizen science projects[12] must ensure that both research and educational goals are taken into consideration. Citizen science in schools is seen as a way to expose pupils to all stages of scientific inquiry and to consolidate teachers' and students' knowledge of scientific methodologies[12].

For example, RadioLab is an educational project of the INFN that involves environmental monitoring of natural radioactivity (https://web.infn.it/RadioLAB/). The project exposes students to a real research activity on a topic that is part of the school curriculum and is conducted in collaboration with professional researchers. Although the main aim of the project is educational, the involvement of students allows the territorial mapping to be expanded in a way that would not be achievable for a single research group. The project also aims to improve diversity and inclusion in science, for example through surveys that identify issues connected to gender inequity in science education and inform specific actions to tackle them. This example of citizen science for high-school students, therefore, fits the vision of public engagement with science as an open and bidirectional dialogue. It benefits both scientists and the public by promoting scientific literacy as well as improving the way scientific research is conducted[13].

Challenges

Involving school pupils in real research activities is challenging. Educational citizen science activities need to be carefully calibrated and focused, so that the level is appropriate to the age and knowledge of the pupils, to avoid feelings of frustration and inadequacy.

The proposed shift of focus in science education requires a mindset change and there will likely be some resistance. Teachers would have to switch from traditional teaching methods to collaborative settings that stimulate peer-to-peer interactions among students, researchers and teachers. Researchers should also revise their approach to outreach and public communication. Many scientists still follow one-way communication models and prefer to act individually[14,15]. As a consequence, outreach programmes with schools, seminars, public talks and debates, science fairs or festivals, and so on, though enthusiastically performed and highly appreciated by the public, are generally short-term, isolated events, which do not succeed in closing the gaps between scientific research and the public.

Public engagement and outreach should transition from one-way communication that is based on the assumption that the public lack understanding toward the above-mentioned forms of bidirectional dialogue between scientists and the public[13] that takes into account the public's perspectives and addresses their concerns about scientific issues. This is particularly true for open societal issues that are likely to generate antiscientific discourse.

Conclusions

Research in science education and in the history of science already provides a wide variety of methods that expose school students and teachers to scientific research and include them in research environments. These methods that are still poorly applied can become more widespread through appropriate policy intervention. In this way, students will experience how science deals with incorrect common beliefs and intuitions and individual or ideological biases by removing them through its social process of knowledge building. If the public knows how science works, they are more likely to support it as a means for producing reliable descriptions of the world around us.

P. Riccardi
Dipartimento di Fisica, Università della Calabria and INFN – gruppo collegato di Cosenza, Cosenza, Italy.
e-mail: pierfrancesco.riccardi@unical.it

Published online: 1 February 2023

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Competing interests

The author declares no competing interests.