

## How to Teach High-School Students “How Science Really Works?”

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One of the largest problems in Poland (as well as in the large part of the developed world) is that people do not understand how science works. Based on what they learned at school, they think that science is an aggregation of facts that you need to learn by heart. Based on media coverage of the science topics, they think it is a collection of curiosities about the two-headed-snakes. Based on the way in which science is shown in movies and TV series, they envision science as a magic performed in a white coat with usage of colorful fluids and magic spells such as “transformative hermeneutics of quantum gravity”. As a result, our societies include a large number of people who “do not believe” in evolution, think that vaccinations are causing autism and that anthropogenic global warming is a myth.

This is not very surprising, given that most people never had a chance to perform a real scientific experiment. Most of people, if they are lucky, are able to see some science demonstrations in the classrooms. They are of course very useful, but it is quite clear for everyone that (if everything goes well) the demonstration can end up in one, pre-defined way. The “real” scientific experiment, as a part of the scientific process, is when the outcome is unknown until the end of the entire process.

In order to teach high-school students “How Science Really Works” we have developed a project lasting one year (grant from Foundation for Polish Science 26/UD/SKILLS/2015):

- 1) At first students learned about scientific method, science history and performed a simple scientific experiment.
- 2) Later, students developed an experiment that was answering a real, unanswered scientific problem (the problem was given by the Leading Scientist). The aim of the project was to determine influence of albedo and emissivity of rock particles laying on a surface of a glacier on the rate of cryoconite holes formation. The results of this experiment can be used to better determine the rate of melting terrestrial glaciers and Martian North Polar Residual Cap.
- 3) Students were responsible for physically preparing scientific equipment (within a given budget).
- 4) Students prepared detailed procedures which were used during the experiment. The experiment was performed by the Austrian Space Forum analog astronauts during the Mars Analog Mission AMADEE-15 between 2nd and 14th of August 2015 at the Kaunertal Glacier in Austria.
- 5) During and after the mission students analyzed data collected during the experiment.
- 6) Students presented their findings during the regional science fair (Dolnoslaski Festiwal Nauki).

Despite the fact the quality of the data produced during the experiment was not satisfactory, the project was a success in terms of explaining students “How Science Really Works” (e.g., how much depends on the properly designed and executed procedures).