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Secondary school students' perception related to Responsible Research and Innovation

Responsible Reseach and Innovation

According to Rapotem Directorate-General for Research and Innovation European Commission is determined to create a connection between the scientific community and European citizens (*Responsible Research and Innovation. Europe's ability to respond to societal challenges*, 2012). Responsible research and innovation can be understood through the effective cooperation between scientists, citizens, policy makers, business, third sector organizations, society during the process of research and innovation in order to meet the expectations and needs of society.

Quoting a report on Responsible Research and Innovation (Sutcliffe, 2011) RRI is about trying to get better at anticipating problems, taking into account wider social, ethical and environmental issues and being able to create flexible and adaptive systems to deal with these unintended consequences. This is sometimes called "Anticipatory Governance".

Hilary Sutcliffe defines 6 kye of RRI (http://www.rri-tools.eu/about-rri#in-short) (Fig. 1):

- **Engagement:** *all societal actors work together during the whole process in order to align its outcomes to the values,*
- **Gender equality:** *promoting gender balanced teams, ensuring gender balance in decision-making bodies, unlocking the full potential of society,*
- **Science education:** *creative science education to foster the future needs of society,*
- **Ethics:** *focuses on research integrity: the ethical acceptability of scientific and technological development,*
- **Open access:** *free and online access to the results of research,*
- **Governance:** *the responsibility of policy makers to develop harmonious models for Responisible Research and Innovation* (Maciejowska, Apotheker, 2014).

Fig. 1. RRI Key Components (http://rri-tools.cienciaviva.pt/about/)

Project IRRESISTIBLE[1]

The aim of the international project IRRESISTIBLE was the involvement of Young People in Responsible Research and Innovation and enhancing the knowledge of Nanotechnology. Implementation of this project took place among others on the team learning (community of Learners): scientists, teachers and students. During the annual work in 2015/2016 students under the guidance of their teachers discussed topics of Nanotechnology and nanomaterials, performed a series of experiments, taking into account the principles of IBSE. In addition, students participated in meetings with scientists, classes at the Museum, where they learned how to prepare an interactive exhibition (Kluza, 2016). The effect of it was preparing several exhibits for the school exhibition and two exhibits on the main exhibition. One of the exhibits was called Career Scientist (Fig. 2) and has been prepared based on the realization of the Principles RRI. During the classes students used the materials prepared by the International Consortium (Fig. 3).
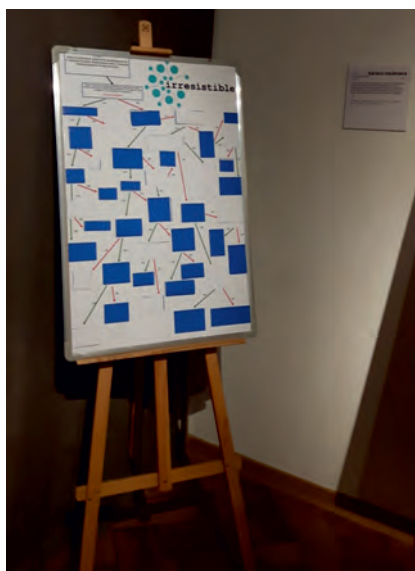
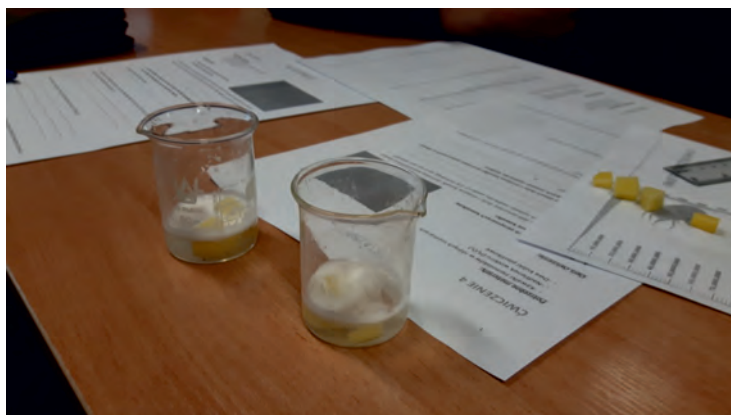**Fig. 2.** The exhibit prepared by students: Career Scientist

Fig. 3. The materials from the classes of project IRRESISTIBLE

Research of perception related to RRI

The issue of responsible research and innovation has been introduced based on the history of the use of asbestos, thalidomide, chemical, fertilizer etc. In the year 2015/2016 studies have been conducted on one group of students participating in the project IRRESISTIBLE. The study sample consisted of 50 pupils aged 13 and 15 years old. Participants were asked to answer a questionnaire (a survey of work) prepared by the international consortium, which was supposed to examine the opinion of students in five categories:

1. Features of the scientist
2. The topics of research
3. Ethics in scientific research
4. Innovation and new technologies, ethics during implementation
5. Research and Innovation – information

Results

1. Features of the scientist
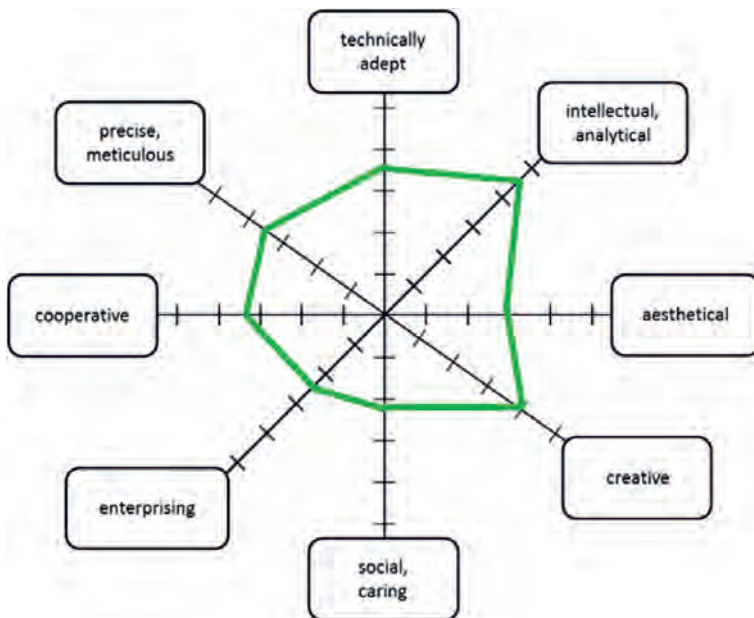   Task no. 1: How important are the following features for a scientist?

Fig. 4. Students' answers

Respondents jointly agreed that the most important feature characterizing the scientist should be creativity, intelligence, accuracy. According to the students it is equally important to be aesthetically pleasing and caring. Noteworthy response concerned cooperation with others. According to respondents, this capacity is not very important and not important for a scientist. With regard to the Research conducted by OPI (centre for processing information, http://www.opi.org.pl/ Analizy-statystyczne-i-ewaluacja/newsId/47.html) one of the most important features that scientist should have are: leadership, interpersonal skills, teamwork entrepreneurship, decision making, planning and organization.

2. The topics of research
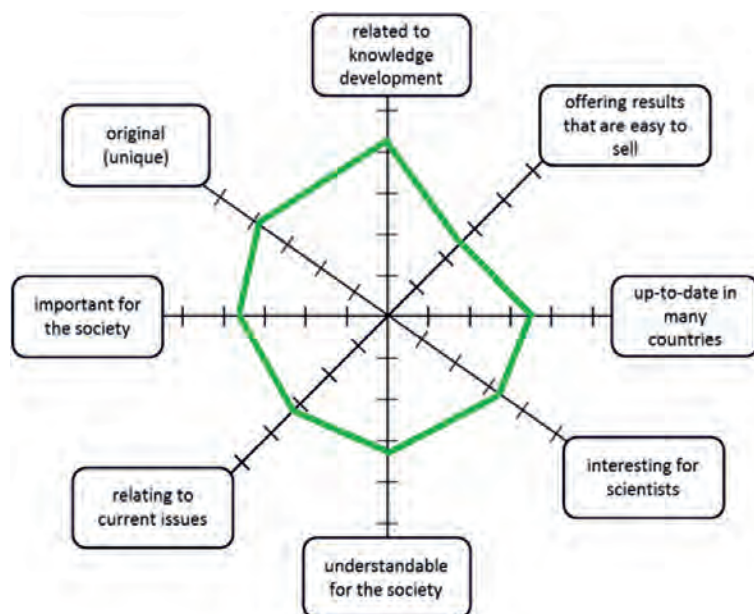   Task no. 2: What should be the features of a research topic?

Fig. 5. Students' answers

Particularly noteworthy is that students think that during choosing a topic of research it is not very important whether the results can be easy to sell. Much more important was whether the subject will be related to development of knowledge.

Task no. 3: Who should decide on the topic of the research, science development directions, industry development directions, financing research?

Tab. 1. Students' answers

	Scientists	Government	Society
a. the topic of the research	85,7%	28,6%	52,4%
b. science development directions	75,6%	43,9%	36,6%
c. industry development directions	26,2%	83,3%	45,2%
d. financing research	26,2%	90,5%	45,2%
The access to the research results should be granted to:	92,9%	90,5%	90,5%

Students agree that the results of research should be available for everyone. According to the students the choice of research topic (85.7%) and the direction of development of science (75.6%) should mainly be decided by scientists. The government has a greater right to make decisions on the directions of development of the industry (83.3%) and on the financing of research (90.5%).

3. Ethics in scientific research
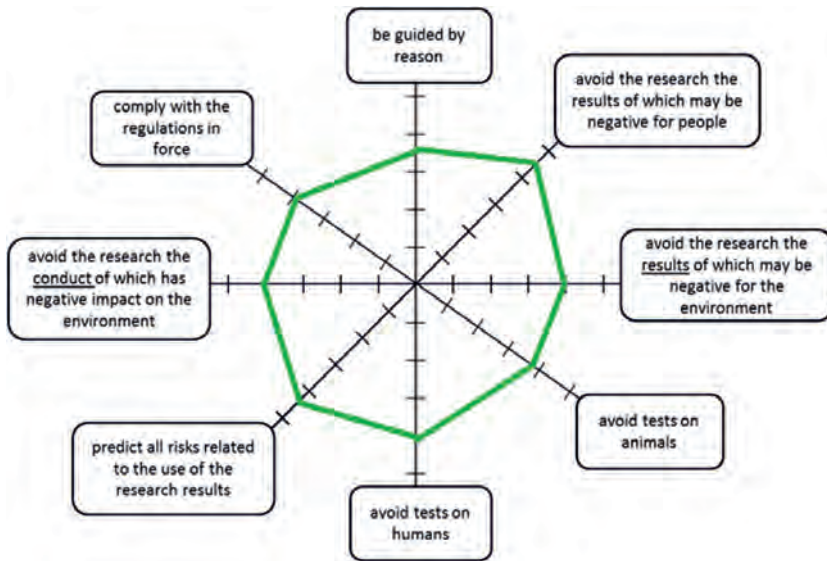   Task no. 4: Scientists, when planning and conducting research, should:

Fig. 6. Students' answers

According to the students during the planning and execution of research scientists should pay attention to many aspects. In their view, in particular testing on animals should be avoided, and the research which results can have negative effects for people.

4. Innovation and new technologies, ethics during implementation
    Task no. 5: Who bears the greatest responsibility for the consequences of the implementation of innovations and new technologies for widespread use?
    68% of respondents believe that the responsibility for the consequences of introduced innovations and new technologies to make the general public bear producers, 57% – sellers, 53% – users, 49% – investors, 33% – government or self--government, and 31% – non-governmental organizations.

5. Research and Innovation – information
    Task no. 6: In your opinion, where can one find information on the latest research results?
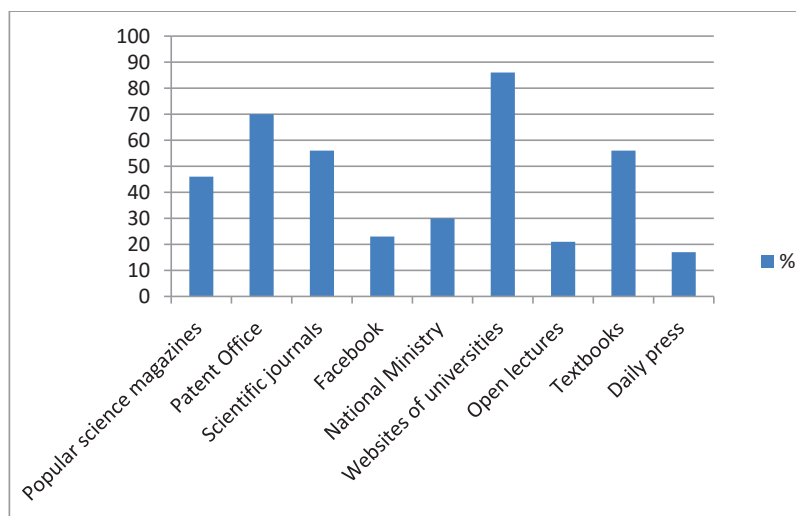
Fig. 7. Students' answers

Conclusions

The issue of RRI is a great way of pulling students in discussions about the future and scientific problems. An important element is the choice of subject, referring to the current scientific problems. Students often have a stereotypical image of a scientist who is working alone in the lab, does not wonder whether the results of his/her research will be to sell. According to the students researcher is mainly an intelligent person, creative and curious of the world, and his/her research is to develop the knowledge, and not desire to profit. Students are unanimous about the fact that the test results should be available not only to scientists and the government, but also for society. Noteworthy, however, is that on the choice of professional research, as well as on development directions of science or industry, should decide primarily one of the entities. The students do not see the need for cooperation and joint decision-making. According to the students ethics in scientific research plays an important role and scientists before they take up research must check and analyze the potential effects and risks that may carry their research. The respondents believe that the greatest responsibility for the consequences of the innovations bear the manufacturers and users. When it comes to searching for information on the results of the research, the students think the most reliable sources of knowledge are the websites of universities and research units, and the patent office, while social networking sites like Facebook and daily newspapers, despite the easy access, are not a source of information on scientific research.

According to the author, there is a strong need to get a social dialogue for those responsible for research and innovation. This subject is very important, and from an early age school should mention the issues related to the work of scientists. The

discussion could be hold, for example, during sports classes. The topics discussed should be about moral dilemmas in science, technology and the future of modern, scientific method and explanation of the world, history of scientific thought, great revolutionaries of science, Polish science researchers and their discoveries, science and technology, inventions that changed the world etc. (*Podstawa Programowa*, 2012).

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Abstract

This article presents research results of secondary school students taking part in the project IRRESISTIBLE (Including Responsible Research and innovation in cutting Edge Science and Inquiry-based Science education to improve Teacher's Ability of Bridging Learning Environment). In Poland, the goal of the project was to broaden the knowledge about Nanotechnology and draw attention to the topic in forthcoming issues responsible for Research and Innovation (RRI). Particularly noteworthy are the opinions of the students on the role of the scientist in society, what are the important qualities of a scientist, and who decides on the research and processing and the introduction of the innovation.

Key words: Responsible Research and Innovation, scientists, IRRESISTIBLE Project

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