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Bringing RRI in Science Lessons - Challenges and Benefits for Students in Learning Process

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Abstract

Nowadays the mankind is facing more and more difficult problems concerning the environment and life quality that ask for more and more people involved to solve them. In this context, education has a special role to bring in attention the importance of Science knowledge in each individual's development. Thus, there is very important to increase the students' interest and motivation to learn more about the Science and Technology and how to this in their daily life. One of the new concepts introduced in Science education was Responsible Research and Innovation (RRI) with the hope that involving teachers and students in understanding the role of RRI dimensions we'll obtain sustainable interactions between schools, research institutions, industry, governance and civil society organisations. It was proved that implementation of RRI principles in Science lessons enhance students' engagement in solving different scientific problems, increase the critical thinking and develop their collaborative skills. Introducing the ethics and governance as RRI dimensions in students' attention will develop their responsibility for solving the complex problems of our world. Due to these benefits, European Union decided to finance different projects to implement RRI in Science Education. One of those projects was the ENGAGE Project ("Equipping the Next Generation for Active Engagement in Science Equipping the Next Generation", www.engagingscience.eu), developed in the frame of Seventh Framework Programme. This paper presents the students' opinion obtained at the end of the ENGAGE project in Romania, during the ENGAGE RRI Festival held in Targoviste, on March 3rd, 2017.

Keywords: interactive-participative teaching strategies, RRI, Science education, students' opinion, ENGAGE project.

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1. Introduction

For many decades, all the national education systems have undergone a continuous, but not always coherent process, with changes followed by the effects at both macro-structural (system) and microstructural (process) levels. Frequently, terms such as reform, change, innovation, optimization, development, transformation etc. are used. The relationship between the terms reform-innovation-change-transformation can be understood by creating an institutional and legislative framework (reform) that allows the introduction of novelties or innovations able to produce changes that lead to the expected qualitative transformation. The term of curricular reform is increasingly used, and implies a change in the basic components of the curriculum, namely: outputs, content, methodology and evaluation.

From the perspective of Sorin Cristea, "the reform of education represents a superior type of changes necessary in the field of education, in the conditions of the emergence of the crisis phenomenon, systemically objectified". [1]

The same idea is mentioned by Constantin Cucoş, considering that "the key to solve many problems can be found in the way we articulate and reconcile school with life, realizing a compatibility of goals, an agreement between the values promoted by current modernity, a unitary way of conceiving and accepting excellence". [2]

Taking particularly in consideration the reform process needed to optimize Science education, this objective was introduced in the political agenda of many European countries since late 90's, and in recent years, different frameworks have been created to fulfil it. Thus, a big number of projects dedicated to this issue have been proposed and implemented. [3]

In this context, a number of objectives are targeted, such as: promoting a positive image of Sciences; improving the scientific knowledge of general public; improving teaching and learning processes in schools; increasing pupils' interest in Science disciplines correlated with assimilation of scientific knowledge at upper and tertiary secondary education levels; increasing the efforts to ensure a better balance between girls and boys in the field of Science and technology studies and professions; ability to form to the employees (science-based graduates) the skills they need and thus to help maintain competitiveness.

In order to implement those objectives, a number of operational strategies have been identified, involving: "the implementation of curricular reforms; the establishment of partnerships between schools and companies, scientists and research centres; the establishment of scientific centres and

other organizations; the provision of special measures on guidance, in order to encourage more young people, especially girls, to choose scientific careers; cooperation between ministry and universities to improve initial teacher education; promoting projects that emphasize continuous professional development. [3]

In the last decades, many countries reported a sharp decreasing of students' motivation for learning Sciences and this aspect became a major problem of our society when we are facing huge problems related to environment pollution and all its consequences, like climate changes, natural disasters, new maladies and so on. In this context, the researchers and stakeholders from the educational systems of many countries tried to find new ways for bringing back the interest of the young generation for the Science area. Thus, many researches are developed not only at national level in those countries, but also large studies are conducted in Science Education at the European and international levels, in order to encourage the young students to understand and to learn Science, but also to choose a career related to this area.

Trying to keep up with new developments in the field of Science Education and guide the Science teachers from Romania in the process of implementation of new teaching strategies, Valahia University Targoviste chose to participate as a coordinator or partner in different projects, in national and European frameworks like Socrates-Comenius, Lifelong Learning Programme, KA3 Transversal Programme, Seventh Framework Programme, trying to promote new teaching strategies for Science that proved to increase the students' motivation for understanding and learning the complex scientific problems. In the frame of those projects, many continuous professional development programmes for Science teachers were organized to promote new psycho-pedagogical paradigms and interactive strategies for teaching Science.

2. Problem Statement

Starting from the premise that a complex approach is needed to design, implement and develop an effective curriculum in Science (Physics, Chemistry and Biology) that meets the educational needs of educators within the context of contemporary society, researchers in the field identify as fundamental, the following principles of action [4]:

• *Promoting scientific literacy*. The scientific culture includes both the scientific knowledge and the ability of an individual to use this knowledge to identify questions / problems that science can answer, to explain

phenomena and to develop new knowledge, to draw grounded conclusions on facts. It includes also the understanding of the characteristic features of science as a field of research and human knowledge, the awareness of the role of science and technology on the material, intellectual and cultural environment and committed attitude, as a responsible citizen.

• *Stimulating students to practice critical thinking, metacognition, self-learning, and self-learning*. This means that students take control of their own learning process by defining objectives and monitoring progress in their achievements.

Thus, the curriculum of Science should include a series of learning experiences designed to put the learner to participate in an active way in the process of self-training, as a reality investigator, a problem solver, who possess the learning strategies based on metacognition, critical thinking, reflective analytics, and gradually become able to self-knowledge, self-training and self-evaluation.

Beyond the formal educational context offered by schools, we have witnessed - in the last decades - a real expansion of educational experiences in non-formal contexts, on the dimension of Science education and beyond. Thus, museums, science centres, exhibitions, science parks, cultural centres and other non-formal education institutions frequently open their doors to facilitate the access of the general public to the results of *avant-garde science*. In this respect, it is worth to note the events that have been done systematically in recent years at European level, such as: *Museums' Night*, *European Researchers' Night*, *Science and Technology Day* etc.

Interactive exhibitions are designed to stimulate the visitors' interest to the world around them, to know how all the phenomena and processes of life are working, starting from the basic principles of physics, chemistry or biology. The visitor actively participates in the process of knowledge, interacts with scientists or Science teachers, directly experiences a number of scientific phenomena, enriches his scientific culture, develops his/her competence to solve or address specific issues of daily life, cultivates his/her scientific interest, becomes - perhaps - even motivated for a research career in Sciences, spends a more qualitative time with educational, stimulating and entertaining effects.

Such exhibition was carried out by a group of teachers and researchers of Valahia University Targoviste, under the *Engage Project* ("*Equipping the Next Generation for Active Engagement in Science Equipping the Next Generation*", www.engagingscience.eu), developed in the frame of Seventh Framework Programme Project, under the action Science-in-Society, Activity "Young people and science" - Topic: Raising youth awareness to Responsible Research and Innovation (RRI) through Inquiry

Based Science Education. The main goals of the project were to help teachers to address contemporary science issues and applications relevant to students, to develop teachers' beliefs, knowledge and classroom practice for RRI and to provide students a strong foundation to engage in Science issues they will meet during their lives. [5]. During the project-life, the ENGAGE partnership came up with new and interesting face-to-face workshops and on-line courses for teachers, presenting different interactive-participatory teaching strategies and a lot of curricular materials as examples. The curricular materials were implemented to the level of Science lessons in all partner countries and, at the end of the project, each country organised a *RRI festival* to present and exhibit the most interesting and attractive results. The RRI Festival in Romania was organized by Valahia University Targoviste and took place on March the 3rd, 2017. As Figure 1 illustrates, a number of 157 participants (teachers, students, parents, representatives of Dambovita County School Inspectorate, scientists, RRI experts etc.) from Dambovita County, were involved in the festival activities.

During the RRI Festival, the main results of the ENGAGE project in Romania were presented. In addition, two new *TRANSFORM projects* designed by Romanian team were introduced to the participants: "*The City of the Future - The Sun Temple*" and "*The Nanocarbon - Our Ally or Our Invisible Enemy*?". After the presentation of those projects, free discussions took place and participants expressed their opinions about the content of materials and future possibilities to implement those materials in Science lessons, after the end of the ENGAGE project. Then, participants were invited to the exhibition of products where demonstrations and experiments were presented by Valahia University scientists.

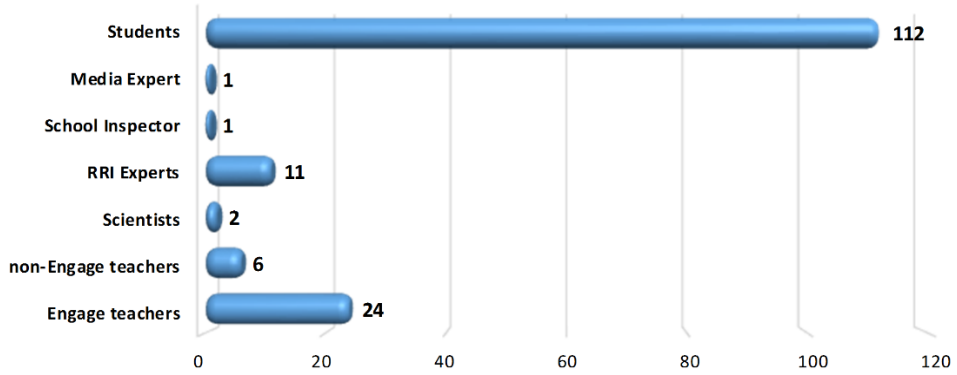


Fig. 1. Distribution of educational stakeholders involved in ENGAGE RRI Festival in Romania

3. Research Questions/Aims of the research

In this paper, we aim to capture the views of the students involved in the ENGAGE Festival of Responsible Research and Innovation in Romania, on the impact that the activities carried out in this context have produced on them. Also, the purpose of our research is to capture the formative and informative effects of such events, to identify the students' needs and expectations concerning such educational experiences, made beyond the doors of educational institutions, and to design similar events in the future, in an optimized manner.

4. Research Methods

The main research method was a survey based on a questionnaire, that was applied taking into account each student' consent, ensuring the confidentiality of the data collected and without violating the ethics principles of the research activity. Before applying the questionnaire to the subjects, all aspects related to the rights of participating / withdrawing from the research, but also the rights related to the confidentiality, data processing, and informed consent were presented to the students. In this context, we developed and applied to those 112 respondents - 3rd, 4th, 7th, 8th, 9th, 10th and 11th grade students -, a questionnaire with 9 items with predetermined closed responses, placed on a Likert type-scale with five steps: *to a very great extent*, *to a great extent*, *to a moderate degree*, *to a small extent*, *to a very small extent*, or respectively, *very good*, *good*, *medium*, *weak*, *very poor*. The responses were measured and processed by statistical and mathematical methods, correlated with qualitative type analysis, based on information from literature and on the experiences recorded in similar educational contexts. In addition, open answers were included in which respondents can add other personal opinions.

5. Findings and Discussions

In the following paragraphs, it is presented a short analysis of the students' answers to a few selected items with multiple answers, all of them pre-coded. Thus, the students' impression about the general organization of the event is presented in Figure 2. The illustrated figure proves that 94% of the students appreciated the organization of the event to be as good or very good. This fact encourages us to organise similar event in the future. However, when an exhibition is organised in a certain space and the number

of participants is very high, it is possible that some of the participants could not be able to see all and use or play with all the exhibits. In this sense, they can be unsatisfied by the organization.

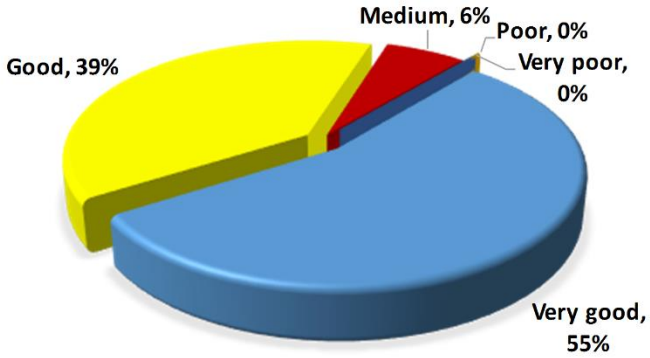


Fig. 2. Students' opinion concerning the general organization of the event

Figure 3 illustrates the students' feedback concerning the quality of the materials presented during the event. If we take into consideration that the students' age was between 9 and 18 years and their scientific knowledge was much different, it is explainable their difference of opinion. The content of the materials presented during the event seemed to be too high for the students from primary school. In addition, because some topics and materials were new for some of the participants, they could not appreciate correctly the quality of materials.

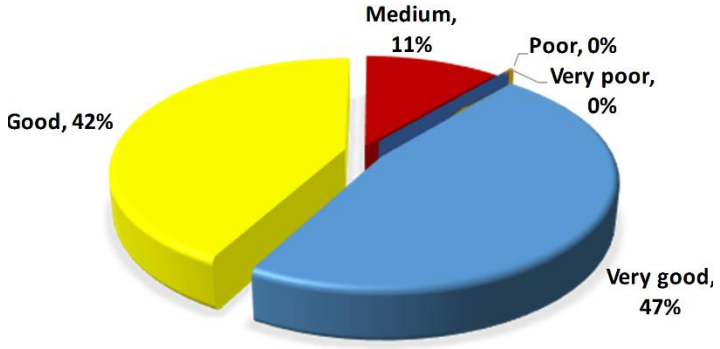


Fig. 3. Students' feedback related to the quality of the materials presented in the event

However, being asked about the novelty degree of the information, the students highly appreciated the cutting-edge topics presented during the

event, as Figure 4 shows. Having a short view on the figure, it can be seen that 96% of the participants appreciated the novelty degree as "very good" and "good". This means that most of the participants improved their knowledge through the activities organised during the event. This shows that students can build their knowledge in non-formal contexts and this can be also fun for them.

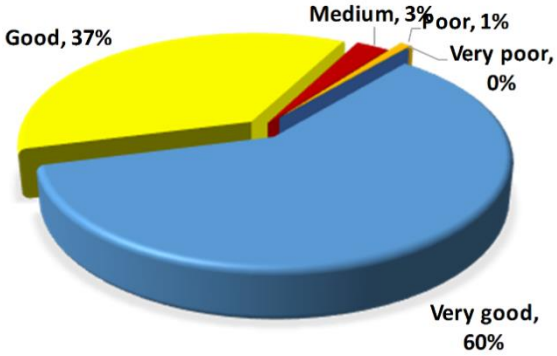


Fig. 4. Students' answers concerning the novelty degree of the materials presented in the event

Being focused to identify the students' feedback concerning the experience to learn more in non-formal contexts - like the organized festival - one of the questions designed was specifically addressed in the questionnaire. Thus, Figure 5 shows that students enjoyed a lot the event and more than 90% would like, at least to a great extent, to repeat the experience in following similar events.

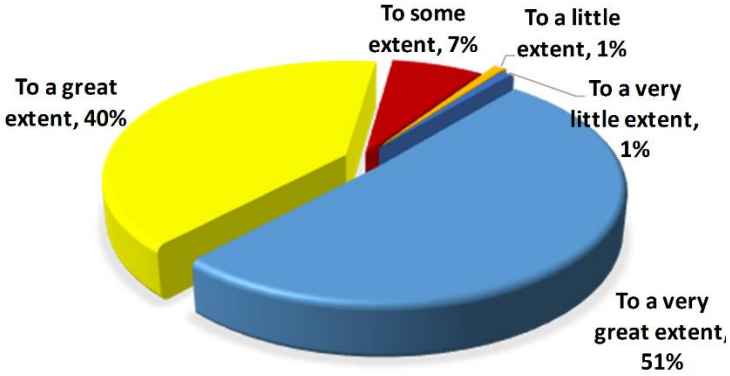


Fig. 5. Students' feedback concerning the opportunity to organize similar events in the future

Being asked to characterize in three words the ENGAGE RRI Festival, the students chose how they felt during the event, the results being presented in Figure 6. The obtained results encourage us to believe that

combining the Science lessons organised in traditional format with activities organised in non-formal context could help us to increase the students' motivation for learning Science.

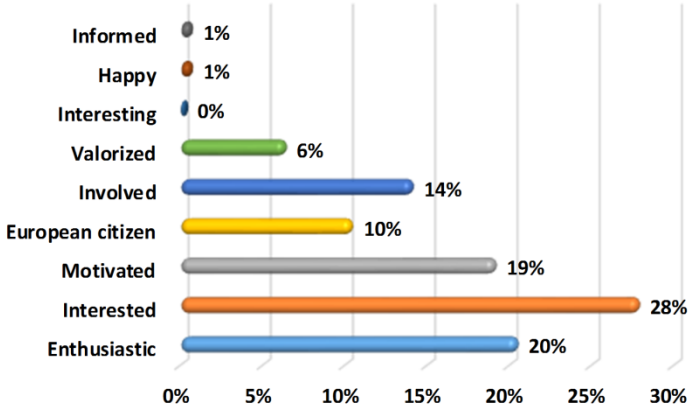


Fig. 6. Students' answers to the question "*If you had to describe in just three words how you felt as a participant in the ENGAGE RRI Festival, those should be … (choose only 3 words)*"

6. Conclusions

The results obtained at the end of the ENGAGE RRI Festival, correlated with the data gathered through discussions with teachers and students who participated to the festival, proved that students enjoyed the time spent during the festival and led to the idea that the implementation of RRI aspects in Science lessons develops the students' investigative, communicative, resolute and decision-making skills.

The students' feedback collected through different events (like RRI Festival, Science Day, Earth Day, Researchers' Night etc.) organized as non-formal education activities, proved us that non-formal contexts can be successfully used to complete the students' scientific knowledge and to increase their interest for new discoveries and scientific topics.

The students' answers demonstrate that Science teachers from Romania, absolutely need to reform the teaching of scientific disciplines, in line with European Commission policies and with the new type of citizen that must be trained by the contemporary education. In addition, the national curriculum for the Chemistry, Physics and Biology have to follow a process of reform at its basic components (outcomes, content, methodology, evaluation and training time).

Acknowledgements

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The authors of this paper stipulate, on their own responsibility, that the subjects who participated in the research have been informed related to the voluntary nature of their participation, the understanding of the received information and the fact that the withdrawal from the research process can be done at any time without any negative consequences on participants. The whole research respected the actual ethical standards and the participants expressed their consent to participate in the undertaken research.

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