

Citizen Science in School

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Abstract. One of the main problems facing European society is the decline of students who choose scientific or technological careers after finishing high school. Encouraging interest in science is essential to approach the current problem of shortage of scientific vocations. This paper describes a citizen science experience accomplished in a school located in the center of a city in the North of Spain. 42 Secondary students completed a questionnaire based on a previous study by RecerCaixa. The results show a significant positive change in the student's perception of science and scientists. In addition, students highly appreciated their participation in the activity.

Keywords. Citizen science, scientific vocations, secondary education, student perception.

1. Introduction

In recent years, a lack of experience or skills in young people is being observed. In fact, four out of ten employers in the European Union say they have difficulties in finding skilled workers with the skills required for a vacancy. The lack of skills in the scientific field is often mentioned in the European economic sphere. But, in addition to the lack of technical, practical or specific skills for a job, there is also a shortage of so-called soft skills, such as the ability to plan, organize, solve problems and work as a team. It is pointed out that some of the reasons for this problem are the inflexibility of the educational systems and the tendency to educate tomorrow's young people with the skills required by yesterday's industry [1-2]. Another major problem facing European society is the decline of the number of students who choose scientific or technological careers after finishing high school [3]. But this crisis, as shown in the literature [4-5], is also being perceived in secondary education, where many students do not choose scientific disciplines. Also, as indicated by Ribas [6], girls show less interest in science than their male classmates. The main factor of this cause is school science curriculum, which he connects with the

question Who decides what is relevant in school science? In that question he directly points to universities, according to which the teaching of sciences in secondary school must have the purpose of instructing students in scientific concepts that are necessary for higher education. For these reasons, it is necessary a transformation that implies the democratization of sciences, a vital task for students in order to make them understand how and why science is relevant to our lives [7]. As a result, new approaches to teaching have emerged, such as STEM (Science, Technology, Engineering and Mathematics), STS (Science, Technology and Society) and new methodologies, such as PBL (Problem/Projects Based Learning), IBL (Inquiry Based Learning), etc. designed to prepare students in the development of these skills and abilities needed in the 21st century. Within this framework, Citizen Science is born as a form of democratic participation in science, in which citizens are an active part of a scientific project. In this way, Citizen Science acts as a link between scientific education and democratic participation, in addition to originating the acquisition of new knowledge and scientific skills. It also encourages a change of attitude towards science in which we can all participate and contribute to the resolution of a common problem. And, as if that were not enough, Citizen Science projects allow a participation in the training of agents of non-formal education [8], as well as a development of many scientific skills (Figure 1).



Figure 1. Some of the scientific skills developed in non-formal education [8]

1.1. Contributions of Citizen Science

The most direct impact of Citizen Science is the increase in scientific knowledge experienced by participating members. Engaging in these projects gives citizens the opportunity to ask and respond to certain questions that arise from the curiosity of their

daily experiences, as well as describe, predict and explain various natural phenomena [9]. In a study [10] an increase in knowledge about ecology was perceived simply through the observations required by the project. For instance, the participants of a bird-breeding observation project improved their knowledge about poultry and local ecology.

However, two factors are presented as the most influential when developing scientific knowledge in a Citizen Science project, which are: the motivation and interest of the participants and the level of interaction between professional researchers and citizens [11]. In the communications between researchers and citizens a sign of interest on the part of the participants was seen in relation to aspects of the scientific method, own observations and conclusions and other questions that arose without being the main objective of the study. Within the interactions, those that were made face to face were the most valued by the participants. Finally, one of the repercussions perceived by the people involved after participating in a Citizen Science project, was a change in their attitude [10-12]. Although, it has been seen that attitude changes do not occur significantly if a certain level of knowledge about the subject is not acquired. The most common reaction among participants is to talk about the object of study with people around them, showing some concern or sharing their experience. These conversations reinforce the participant's learning and expand the impact of the project to the rest of the community.

1.2. Citizen Science in the school: AQUA Project

There are many benefits of Citizen Science, already mentioned above, but there are other positive aspects that directly affect students who are involved in a project of this kind. The repercussions of using Citizen Science in the classroom that are presented in the literature [9,13-15] are mentioned below in the following paragraphs.

The participation of students in real scientific studies fosters interest in science and develops scientific knowledge. In these experiences, students are using the scientific method and working with science as a way of understanding the world around them. In addition, interaction with professional scientists encourages them to

consider scientific careers as a possibility for the future, which otherwise would not have been considered.

No less important than generating new scientific knowledge, students are developing new scientific skills. Through collaboration with researchers, they learn how to plan a data collection, how to collect it and how to interpret it in a way that gives us relevant information about the environment and/or our daily life.

Direct contact with scientists and being involved in an investigation results in a transformative experience that helps them to modify false preconceptions. For example, the term biodiversity not only refers to wild animals in faraway places, but also to those which are in the school garden.

On the other hand, direct exposure to the environment around us, especially during childhood, helps us to improve skills such as creativity and problem solving, as well as involving emotional and intellectual development. Adolescents who have been involved in a Citizen Science project present a greater understanding of scientific concepts, improve cooperation, the ability to resolve conflicts, self-esteem and behavior in the classroom.

Citizen Science is a tool that allows students to experience for themselves damages and disturbances in their localities and understand how it affects the environment and biodiversity. In this way, they come to understand global problems and develop a critical thinking based on.

2. Aim and methodology: description of the AQUA project

The aim of this research was to elaborate a study based on the change in student's opinion after their participation in a Citizen Science project carried out in their educational center.

AQUA is a Citizen Science project of the Ibercivis Foundation, funded by the FECYT (Spanish Foundation for Science and Technology) of the Spanish Ministry of Economy, Industry and Competitiveness [16]. The aim of the project is to study the quality of the water of our homes, for which it has had the collaboration of thousands of students from all over the country. The results of their

measurements are shown in an online map of free access for the entire population (Figure 2).



Figure 2. Map of Spain where the AQUA project data are geolocated [16]

In particular, the parameters analyzed were the chlorine content, pH, taste and smell of the water. To make the measurements of these parameters, each student has received an experimental kit (Figure 3), and an explanation of the procedure that they should follow to analyze the water in their homes. In addition, the students had to determine the value of the water parameters and upload them to the project website.



Figure 3. The kit provided to students allows to analyze drinking water

So, directly, students apply the scientific method using different biochemical tools (Figure 4); and also record a video and take photographs of the process acquiring the habit of documenting their research experiences.



Figure 4. Students learn science by playing the role of scientists

In addition to the specified purpose, with the participation in this project other concepts are implied such as the main pollutants that deteriorate the water quality and the purification process prior to the water reaching our homes. On the other hand, this project allows the diffusion of the clean drinking water problem. Pollution is the reason why this problem has been experienced year after year and this project emphasized that only a minimum part of the whole amount of water on our planet can be used for that purpose.

3. Evaluation

In order to assess the repercussions derived from the participation of students in a Citizen Science project, a survey has been prepared. It is based on a previous study with the same purpose which was implemented in Catalonia [17].

The aspects analyzed in the survey were: a) the previous ideas of the students about science, b) the perception about science, scientists and a scientific project, c) the competences that the student believes he has acquired after participating in the project, and d) the overall assessment of the experience. 42 students (22 girls and 20 boys) from a school in Burgos aged between 14 and 16 years, who are studying 3rd or 4th of ESO, have been surveyed. A quantitative methodology was used by test questions or specific answer (yes or no), and also a qualitative methodology with open questions that allow students to provide more personal information and ideas.

Analysis of the results reveals that students show a great change in their perception about science and scientists, they believe they have improved their scientific skills, and they all appreciated the experience saying that they

would like to participate in more projects of Science. We should note that the beliefs of the student regarding their confidence and precision are the major precursor of learning [18].

4. Conclusions

Citizen Science offers a new approach of collective participation in science with very positive repercussions in different areas [19-20]. In addition, it offers the population the opportunity to learn more about science and thus achieve a better understanding of the world around us. That is, Citizen Science is a kind of non-formal education open to all society.

Citizen Science allows the development of skills and abilities necessary and required in the 21st century, both scientific or technical skills (*hard skills*) and others related to planning, problem solving, teamwork, etc. (*soft skills*). In the literature it is exposed [2] that it is important to work these at an early age, since it is easier to acquire them when you still have a more open mind to new ideas, than when you have already acquired certain patterns and habits. At an educational level, the Citizen Science addresses the proposals indicated by UNESCO on education for the 21st century, which structures four basic learnings: learning to know, learning to do, learning to live together and learning to be [21].

At school, Citizen Science is an innovative science learning tool, presented to students as a social activity. It is necessary that society is involved in science and that science is open to society. Statistics show that, in general, citizens feel little informed about scientific issues. Specifically, Spain ranks 20th out of the 32 European countries analyzed in relation to this issue [22].

The results obtained from the study in the educational center agree with those presented in the literature [9,13-15] implying a knowledge development, improvement of the scientific capacities and a change in the perception on the science of the students. In addition, one of the impacts caused by the fact of participating in a real scientific study in the classroom is the promotion of interest in science [13]. This interest is fundamental to address the current problem of scarcity of scientific vocations [3-4].

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