

The Power of Water. How Hands-on Activities Can Foster Learning and Communication of Science

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Abstract. Scientia.com.pt is a science communication and outreach project born at the Universidade do Minho, in Braga, Portugal. One of its initiatives during 2016 was the celebration of the World Water Day by organizing an exhibition that engaged undergraduate students in an active hands-on but also learning activity focused on the value and the importance of water. Students worked in groups and created about 30 artworks that were placed in several different locals at the University Campus. In the present communication, we will present and evaluate this Science.com.pt initiative, in particular regarding aspects related with the idea/concept, the involved actors as well as the exhibition itself and its first impacts. Different aspects regarding the informal and active learning methods used, the science communication processes, and the Scientia.com.pt outcomes will also be considered.

Keywords. Formal & non-formal learning science, hands-on activities, society, university, water.

1. Introduction

Science communication is part of the everyday life of any scientist [1]. Scientists must give talks and conferences, should publish their research results writing scientific papers, must write proposals to apply for funding, and need to communicate with a variety of audiences. Thus, scientists should know how to communicate and must learn to do it in an effective way.

At the same time, employment agencies and committees are increasingly voicing their concerns about the communication skills of recent graduates, stressing the need to develop such skills in students, particularly the ones engaged in undergraduate and graduation programs of sciences, engineering and technology [2].

Science communication is undoubtedly important for this (the) scientific community but is also extremely important for society. Although the importance of science may not always be obvious, countless science-based choices are made every day – whether to make informed decisions about our health care and well-being or to choose products to consume considering their impact on the environment. Thus, people need some understanding of science, an overall awareness of the way science and technology encompass modern life - the so called scientific literacy – in order to make conscious and informed decisions about science related questions.

1.1. Scientia.com.pt

Scientia.com.pt is a science communication and outreach project, developed in 2015 by three professors of the Escola de Ciências (School of Sciences) of the Universidade do Minho (Braga, Portugal), aware of the importance, and committed with science communication in today's society. This project was born as a scientific, educational and cultural vision and venture, embracing university and society as interfaces and with research and education as strategic tools. *Scientia.com.pt* has two main action plans - the one more experimental-oriented was designed Experiment@Ciência (*Experiment@Science*) and focuses multidisciplinary science hands-on activities for public of all ages.

Scientia.com.pt team believes that in- and out-university learning can be bridged. Museums, libraries or science centres are just examples of out-of-university learning environments and this idea may be broadened to other environments as well. Gerber et al. [3] argue that, “in essence, the informal learning can be defined as the sum of activities that comprise the time individuals are not in the formal classroom in the presence of a teacher”. We know that, whether we plan it or not, informal learning occurs everywhere and at all the time and we cannot avoid it. In addition, visits to museums, exhibitions, etc., have become part of our way of life. If we experience informal learning anyway, why put effort into doing so during university time? Wouldn't it be a waste of money and precious university time? [4]. We think that this kind of learning reinforces and expands the class *curriculum* by providing new perspectives and more meaningful

connections that can help students, while simultaneously promotes lifelong learning and enjoyment. This sort of activities can generate a sense of wonder, interest, enthusiasm, motivation, and eagerness to learn, which are much neglected in traditional formal university science [5].

1.2. Experiment@Science and the initiative “The Power of Water”

Aiming the definition of the Experiment@Science main tasks for 2016, it was decided that one important project action should draw the attention to a more conscious consumption and use of water, a limited and vital resource that belongs to all of us. The action would be developed on behalf of the World Water Day, celebrated worldwide and yearly on the 22nd of March.

At the University Campus water is plentiful and its relevance for life is easily forgotten and often not correctly respected. As one of the members of the Scientia.com.pt team is the teacher of Biochemistry, a 1st year course of the Biology-Geology graduation program, and as “Water” is a program topic, she decided to challenge her students and to engage them in a non-formal, active and hands-on learning activity in the scope of that syllabus unit. As it was not the first time that this teacher had the mentioned group of students, she knew that it was very important to engage them with innovative strategies, different from the ones used in the formal learning process traditionally used at our university. At the same time, informal quotes from the students warned the teacher and the remaining project team members that the real value and finitude of water were far from being perceived, even by part of that small particular academic community of 60 students. So, the main idea of “The Power of Water” initiative was to make a set of artworks under the aegis of the theme water. The pieces should be created by the students and should communicate a scientific message or fact they considered important and wished to share with the public, ideally reflecting something learnt through the active learning process and collaborative group work in the Biochemistry course.

Active, collaborative and informal learning After explaining the idea and discussing numerous aspects within the project, 16 groups

of three-four students were formed in order to create the artworks of expository character linked with the theme “Water”. One of the main ideas was to expose all the different artworks at several locations, at the University Campus. The students had a lot of decisions to make: to decide the messages they wanted to disseminate, to choose the type of work and to define the way they will to do it, to select an appropriate title to the respective pieces and to think about the place where they would like to show their works. Students were also advised that their endeavours would contribute globally to the exhibition that was later named “The Power of Water” and that was registered in the ONU site for this purpose [6] (Figure 1).

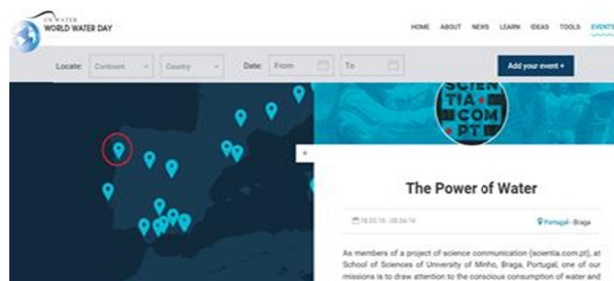


Figure 1. The “Power of Water” in the Un-water World Water Day map of events

As above suggested the students involved in this project have a deficient scientific preparation and considered Biochemistry a difficult subject and, therefore, they hardly engage in the study of the covered topics. With students having difficulties in being attentive and focused, different strategies and activities are needed to involve them both individually and in groups and to get a meaningful learning. As they also have no clear notion of what is teamwork, the teacher of this course decided to divide these students into small groups (three to four elements) to encourage the work of all members of the group.

The teacher wanted students to understand the importance of water/ the water molecule for life, and decided that engaging students in creative activities related with the theme “water” could be a good start. Hands on activities - generally perceived as enjoyable and considered an effective form of learning - seemed to be a good search engine to accomplish teacher’s goals, driving students search and work, and ultimately improving students learning of several aspects that would be impracticable during classes in this course.

As active learning is generally defined as any instructional method that engages students in the learning process [7], and collaborative learning refers to any instructional method in which students work together in small groups towards a common goal [8], we may say that, in short, active learning requires students to do meaningful learning activities and think about what they are doing [9] which was exactly what was intended!

The difficulties teachers find in teaching and learning inside the university must lead them to consider that universities have the potential to play a leading role in enabling communities to develop more sustainable ways of living and working. Elements of program plan and evaluation on one hand, and capacity building on the other, are needed. The latter entails approaches and processes that may contribute to community empowerment - universities may either lead such approaches, or be key partners in an endeavour to empower communities to address the challenges posed by the need for sustainable development [10]. Why this engagement is educationally effective? First and foremost, students who participate in this kind of engagement learn more academic contents [11]. Through academic praxis (application of theoretical concepts to action), students shift from being knowledge receivers to idea creators. Abstract concepts come into relief against the background of situation and context as students consider, apply, test, assess, and re-evaluate multiple disciplinary approaches to solve an array of human, mechanical and environmental challenges.

Literature refers that the reasons why informal learning is becoming popular have to do with immediacy and relevancy. Informal methods of learning are often found in the work environment as they are seen as techniques that a learner can take advantage of right away and with immediate application to their job. Another reason consists in the fact that learners can drive their learning in a more meaningful and self-directed manner [12].

During this hands-on experience students appreciated the opportunity to learn and practiced a thoughtful and structured process for problem solving, valued the safety of the group process in sharing a diversity of perspectives on topics in Biochemistry, and

acknowledged the importance of addressing real and challenging problems that are rarely addressed in formal lectures and other planned small-group settings. Additionally they had the challenge of communicating what they had learnt to a particular public, needing to think about the best way to share that particular message, in a particular way, without losing the scientific accuracy

2. The exhibition

The exhibition was implemented by students and the members of the Scientia.com.pt project and it was inaugurated on March 18, 2016. At that moment, the role of the project members was to coordinate the work, helping students to choose the better title and selecting/ adjusting the pieces to the available spaces.



Figure 2. Artwork "Moving Water"

During 13 working days (March-April), 3 000 people should have passed through about the 30 pieces exhibited and located at six different places in the University Campus: Hall of Pedagogic Complex I, Hall of Pedagogic Complex II, Canteen, Grill, Sport Complex and Library Lounge. The artworks displayed were very eclectic and of very diverse nature: some had just an informative character while others were much more challenging, but all approached and dealt with several topics related to "Water", such as its uses, composition, pollution, reuse, water footprint, ...

In the lounge of the campus library, it was displayed a series of 40 images showing the different uses of water by humanity, a work entitled "The water and its utility throughout the ages". In the library it was also exposed the

"Moving water", a 3-D model of the water cycle along with an explicative and permanent video (Figure 2).



Figure 3. "Water chemical composition"



Figure 4. "19002100: Evolution of drinking water"

In the hall of the pedagogic complex, a water vase divided into several glasses, representing the chemical composition of water, was hanging from the ceiling (Figure 3).

Bellow this installation, a green and blue 3-D model of three globes representing the evolution of continents and water distribution on earth since 1900 through 2100 was placed. There were also three rectangular parallelepipeds presenting both the worldwide affordable drinking water and water accessibility (Figure 4).

One of the main points stressed by students when choosing the artworks for the pedagogic complexes was the problem of pollution. So a huge installation (1,5 mx 1 m) made with empty plastic water bottles and pictures showing how pollution affects several world areas was placed in one of the campus pedagogic

buildings (Figure 5). Named "Bottled water: prosper or perish" that artwork wanted also to alert for the need and the importance of recycling.



Figure 5. "Bottled water: prosper or perish"

The Water Footprint (WF) was not forgotten. As an indicator of the direct and indirect use of fresh water by a consumer or a producer, it is defined as the total volume needed to produce goods. To illustrate the urgent need to preserve and save water, two different groups of students have performed two different installations. In the sportive complex a mannequin dressed with jeans, a T-shirt, a pair of shoes and a smartphone showed the respective WFs translated in sets of bottles, symbolizing the corresponding water volume. In the cafeteria, the same idea was used for the installation designed "Water extent carboy", where several cardboard-made goods such as sugar, coffee or cakes indicated the respective WFs.

3. Closing Comments and Future Perspectives

At the places where the exhibition was displayed it was expected that visitors would get involved, leaving comments and

suggestions, proposing changes to some pieces, eventually advising to remove some of the artworks or even suggesting the creation of new ones. This was one of the most relevant outputs of this initiative, because *Scientia.com.pt* believes that this is an effective dynamic process of flowing knowledge from university to society and vice-versa, improving scientific literacy of both public and students. At this stage *Science.com.pt* is collecting the suggestions, comments and ideas to reformulate artworks and/ or to create new and different material that are being made along the various locations of the exhibition. This way, *Science.com.pt* assumes another active role in this process, feeding the cycle, while reshaping, renewing, adding, and so enhancing the initial exhibition. In this long way, from university to community/ society, both actors get engaged in the renovation of the exhibition: all curious and interested people in “water science” that see the exhibition (either children or adults) can not only learn but also give feedback in a dynamic, engaged and participated process of renewal and reconstruction.

Students made their auto and hetero-evaluation and said that “this was an interesting way of learning” because “they haven’t to be inside the class”, “they’ve learnt more about science” and, “they’ve learnt in different ways how to do hands-on activities” while they realize the difficulty of “communicating an idea or a scientific concept” in order that other people could understand the topic. They mentioned that the fact that their works have an expository nature, allowing everyone to see and evaluate the work of all of them, put a lot of pressure but also a sense of “pride” in this challenging task. Still, students commented that “we could always do work of this kind”, that “it is better to do things in a group” and that “it could be important what I do” concluding that “these things take time to do but give us joy”.

In the meantime the Library Lúcio Craveiro da Silva, in Braga, booked the exhibition for the celebrations of the World Water Day in 2017. Meanwhile, the Municipality of Braga invited *Scientia.com.pt* to join the AQUACÁVADO, an educational project running at Tibães Monastery, also in Braga. During 2016 *Scientia.com.pt* also expects that some basic and secondary schools request some or all of the artworks, in order to improve some

materials of the exhibition and also to increase the number and the diversity of pieces.

4. Acknowledgements

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