

Raising Awareness for Sustainable Development Goals through Hands-on Experiments

Maria C. Costa^{1[0000-0002-3274-6056]} Dina M.R. Mateus^{2[0000-0001-8374-3384]} and Henrique J.O. Pinho^{1[0000-0002-1344-6517]}

¹ Ci2 - Smart Cities Research Center, Instituto Politécnico de Tomar, Portugal

² Techn&Art - Technology, Restoration and Arts Enhancement Center,
Instituto Politécnico de Tomar, Portugal
E-mail: ccosta@ipt.pt

Abstract. With the aim of protecting our planet, the United Nations defined 17 Sustainable Development Goals (SDG), which requires the involvement of all countries to make an endeavour to achieve better living conditions. In this regard, stakeholders such as governments, regional and international organizations, and civil society need to work together to make efforts to meet these objectives. In addition, Higher Education Institutions have a crucial role, not only in developing research and disseminating SDG practices but also in intervening in society. This paper presents a collaborative project led by a Higher Education Institute and targeted to the school community. With the objective of strengthening consciousness for the development of good practices related to SDG, a workshop was prepared and implemented with primary school teachers. Besides providing knowledge about SDG, several hands-on experiments were presented to teachers to be reproduced with their students. Based on participant observation and enquiry forms applied to teachers and students, it was verified that the project was effective in enhancing recognition of teachers and students about the importance of providing good practices related to SDG. It is concluded that collaboration between higher education institutions and schools can trigger the implementation of sustainable development practices in the community.

Keywords: Sustainable Development Goals, Hands-on, Sustainability.

1 Introduction

The 2030 Sustainable Development Goals (SDG) [1] were outlined to provide better living conditions for all and ensure the sustainability of our planet. Achieving these objectives requires cooperation and collaboration between various stakeholders from civil society to government, among others [2,3]. Therefore, efforts and actions are needed among all countries to correspond to the referred goals. In this regard, Higher Education Institutions have a crucial role not only in developing research on this topic, as well as disseminating and promoting SDG practices; but also in intervening in society, where it can be an example and a driving force for the implementation of good practices [4-7]. This paper presents a collaborative project led by a Higher Education

Institute (HEI) and targeted to the school community, with the objective of strengthening consciousness for the development of actions related to SDG. The project includes one workshop targeted at teachers from different levels of primary school (First to sixth grade, 6 to 11 years old) and 20 workshops targeted at students from the first cycle of six primary schools (about 400 students, from first to fourth grade, 6 to 9 years old). Because it is related to education for sustainability and promotes partnerships in this sense, the project is related to Goal 4, Quality Education, and goal 17, Partnerships for the Goals.

In a preliminary work, the authors of this paper described several hands-on experiments related to SDG that were developed by researchers of the HEI, in the context of funded projects in Portugal [8]. In particular, the experiments were focused mainly in goals 6, 7, 11, 12, 13, 14, and 15: Clean Water and Sanitation, Affordable and Clean Energy, and Responsible Consumption and Production, among others. These experiments were introduced in a workshop targeted to teachers with the aim of increasing their knowledge about SDG and strengthening consciousness of their role and the role of schools in promoting actions and good practices related to this thematic.

The present study extends the previous research by providing a more comprehensive intervention project that, in addition to workshops for teachers, also involves workshops for primary school students regarding the need to promote initiatives and practices related to measures necessary to protect our planet and improve our quality of life. Thus, two dimensions are approached. On the one hand, teachers' perceptions about the SDG, and on the other hand the students' perceptions about the same topic. Moreover, it is provided the impact of the SDG workshops on teachers and students. In this regard, the following research questions are raised: Does a collaborative project between Higher Education and the school community can change teachers' and students' knowledge and perceptions about SDG? What are the insights regarding attitudes and the promotion of good practices in the community?

The empirical study was developed with teachers and students who participated in the workshops and voluntarily answered enquiry forms before and after the workshops. Also, it gives insights about the hands-on experiments developed at the workshops. This paper adds an important contribution to the literature on community intervention projects and their role in contributing to the implementation of good practices related to the theme under study.

The paper is organized as follows. Section two describes the methodology and the hands-on experiments implemented in the workshops, section three the analysis and discussion of enquiry forms responses. Finally, in section four conclusions and future work are presented.

2 Methodology and description of the hands-on experiments

This study employs a mixed methodology approach, combining both quantitative and qualitative methods [9]. The participants in this research consist of teachers who willingly enrolled in a workshop related to the SDG, as well as the students who engaged in the workshop led by facilitators at the request of their teachers. The qualitative

component of the study involves participant observation during the workshops attended by both teachers and students. For the quantitative aspect, the research team designed questionnaires using Google Forms, and these questionnaires were administered during the teacher's workshop and at one of the workshops conducted for students. The collected questionnaire data was analysed using the SPSS® software package, version 27. A total of 63 teachers, who actively participated in the teacher's workshop, voluntarily completed the questionnaires both before and after the workshop.

Approximately 90% of the teachers possess over 40 years, with 65% of them dedicated to teaching students in the primary cycle (comprising the first cycle), and a significant majority, 92.9%, are female.

Table 1 summarizes the topics provided in some questions of the enquiry forms applied to teachers, where questions numbered with 1 were applied before the workshop and numbered with 2 were applied after the workshop. The questions with a Likert scale were classified with 1 for “Not at all” to 5 for “Very high”.

Table 1. Topics of the questions applied to teachers before and after the workshop.

Code	Question topic
1_a/2_a	Confidence and knowledge to introduce SDG to students.
1_b/2_b	Need of professional development in SDG topics.
1_c/2_c	Role of schools in promoting SD practices in the community.
2_d	Relevance of hands-on experiments in encouraging students to carry out SDG practices.
2_e	Role of teachers in sensitizing students to develop SD practices

In addition, 27 students who participated in one of the 20 student-oriented workshops completed additional questionnaires during the workshop held in their classroom. Of these students, 15 were in the 4th year of elementary school, while 12 were in the 3rd year, almost 67% of whom were male. Table 2 shows the questions included in the students' enquiry forms.

Table 2. Questions applied to students.

Code	Question	Proposed answers
3_a	Why our planet needs help?	Climate changes Forest fires People do not understand each other High consumption of natural resources Greenhouse effect Too much waste Air pollution Oceans and forests pollution Effects of pollution on animals and plants Too much pollution Earth temperature increase

3_b	How can we help the planet?	Scarcity of potable water
		Reducing water consumption
		Reducing energy consumption
		Reducing all waste and recycling
		Separating the garbage
		Avoiding food waste
		Having a responsible consumption
		Make use of public mobility
		Teaching people to protect the Earth
		Planting more trees
		Doing studies and experiments
		Make use of renewable energy
		Actively monitor threats to the planet

The hands-on experiments carried out during these workshops are detailed in Table 3.

Table 3. Short description of the hands-on experiments implemented in the workshops.

Experiment	Description	Covered SDG	Message
A filtration system for greywater made from greener and re-used materials-	Filtration of wastewater through filters constructed from recycled plastic bottles that are filled with various natural or repurposed granular materials.	6, 11, 12, 13, 14, 15	Implementing eco-friendly and sustainable technologies in wastewater treatment plays a crucial role in achieving cost-effective and universal water sanitation solutions, while also safeguarding freshwater resources. The repurposing of solid waste aids in reducing resource usage and waste disposal, serving as a proactive measure against climate change.
Reuse of plastic lids.	Creation of diverse ornamental objects crafted from plastic caps.	11, 12, 13, 14, 15	This experience aimed to raise awareness and encourage positive attitudes towards the responsible use of plastics, with particular emphasis on their reuse and recycling as a way of combating pollution and tackling climate change.
Sustainable energy sources	The peel of citrus fruits is pressed close to the flame of a candle, producing a radiant effect. In addition, citrus fruits were used as batteries, using the electricity	7, 11, 12, 13	Citrus peel was selected as an example of food waste with the potential for generating energy. The objective of this experiment is to show children, engagingly and straightforwardly, that food waste can serve as a sustainable energy source.

generated to light an
LED lamp.

More details of the hands-on experiments are available in the referred previous work [8].

3 Analysis and discussion of the answers to the enquiry forms

This section is divided into three subsections. The first and second subsections give an account of teachers' and students' answers to the enquiry forms. The third subsection presents an outline of the discussion providing more information based on the qualitative approach.

3.1 Analysis of teachers' responses to the enquiry forms

The following figures provide results regarding teachers' responses to the questions whose topics can be found in Table 1. In Figure 1, it can be observed that teachers' confidence and knowledge regarding the introduction of SDG topics to students has increased after the workshop. For example, from 40% to 60% in the “High confidence (4)” option, and from 3% to 14% in the “Very high confidence (5)” option. It should be noticed that before the workshop most teachers had responded they have “Enough (3)” (43%) or “Some (2)” (11%) confidence, which reveals lack of confidence in this matter. This is very important because without confidence and knowledge teachers will not be able to develop this approach in class.

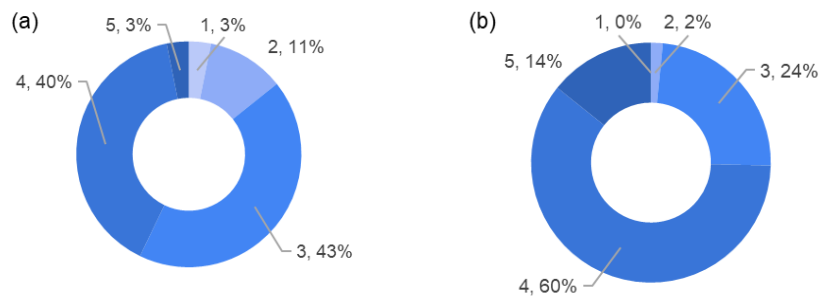


Fig. 1. Results from questions 1_a (a) and 2_a (b).

Regarding recognition of necessity for professional development related to SDG, all teachers acknowledged they need training in this matter before and also after the workshop (Questions 1_b e 2_b, Figure 2). In fact, after the workshop there was an increase in this recognition; for example, from 29% to 75% in the “Very high (5)” option. This result shows that besides needing to improve knowledge about SDG, they recognize the importance of this subject matter.

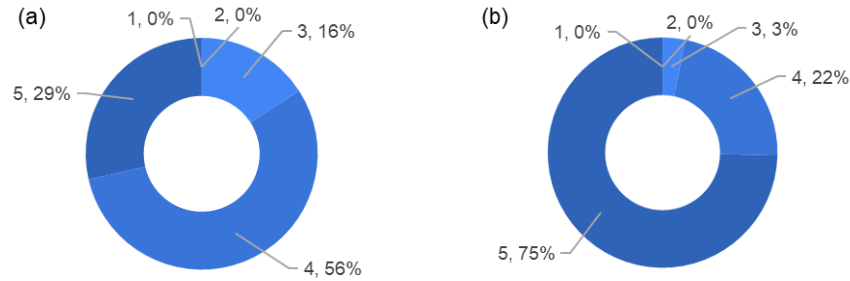


Fig. 2. Results from questions 1_b (a) and 2_b (b).

This result is reinforced by the teachers' realisation of their role and that of the schools in promoting SD practices in the community (Questions 1_c e 2_c, Figure 3). Indeed, about 90% find this role “Very high” or “High”, which means they are very aware of the importance of their mission in this approach.

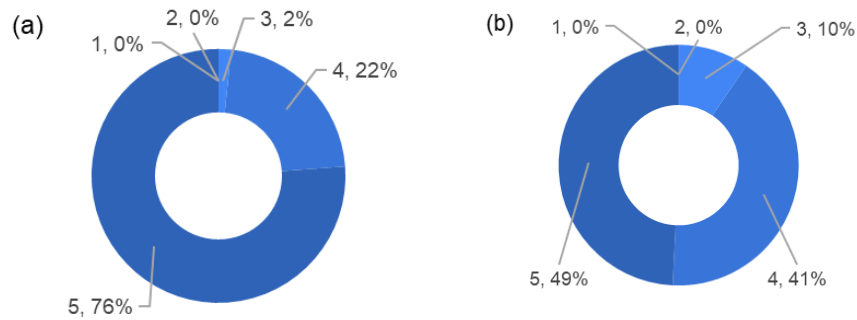


Fig. 3. Distribution of answers to questions 1_c (a), and 2_c (b).

In addition, teachers find the relevance of the hands-on experiments (Table 3) in encouraging students to carry out SDG practices, and also that they have a relevant role in sensitizing students to develop SD practices (Questions 2_d e 2_e, Figure 4).

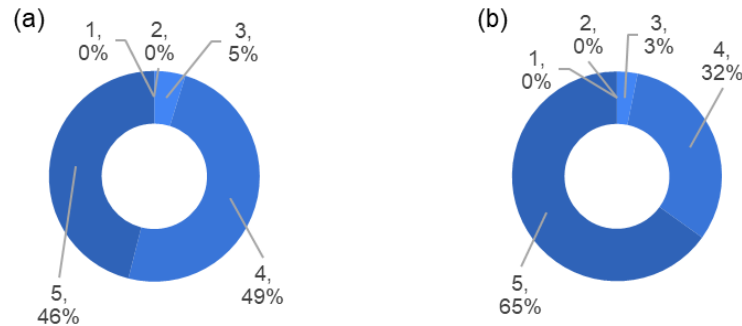


Fig. 4. Distribution of answers to questions 2_d (a), and 2_e (b).

Indeed, more than 90% responded “Very high” or “High”, which reveals that they find the experiments developed by the facilitators very relevant to students and also that they can sensitize students to develop SD practices.

Based on the results of teachers’ responses to the enquiry forms, it was verified that there was an increase in their knowledge regarding SDG and also in the recognition of their mission and of schools in promoting actions related to this matter.

3.2 Analysis of students' answers to the enquiry forms

Figure 5 presents the results of the answers of students to the questions applied after the workshop implemented in their class.

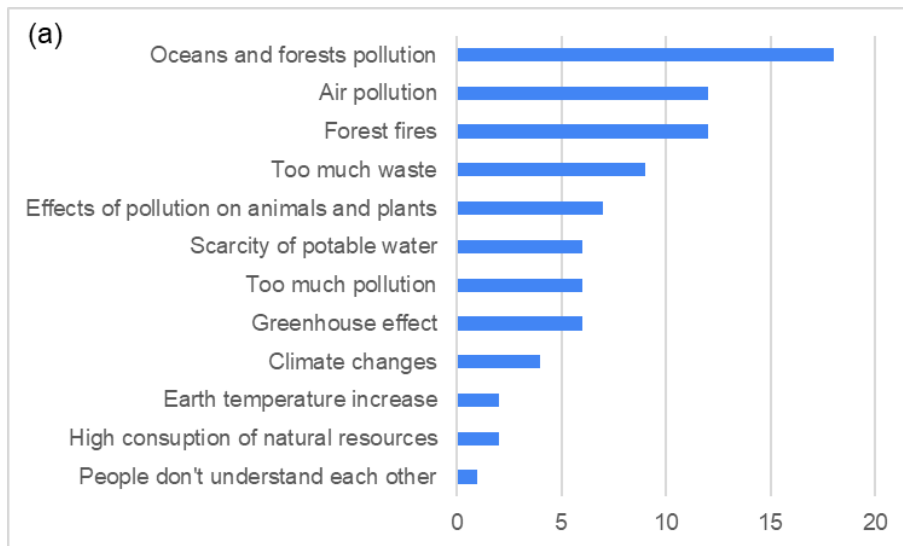


Fig. 5. Distribution of student’s answers to the question “Why do you think the Planet needs help?”.

As can be observed in Figure 5, most students selected “Oceans and forests pollution” as the main reason why our planet needs help, followed by “Air pollution”, “Forest fires” and too much waste.

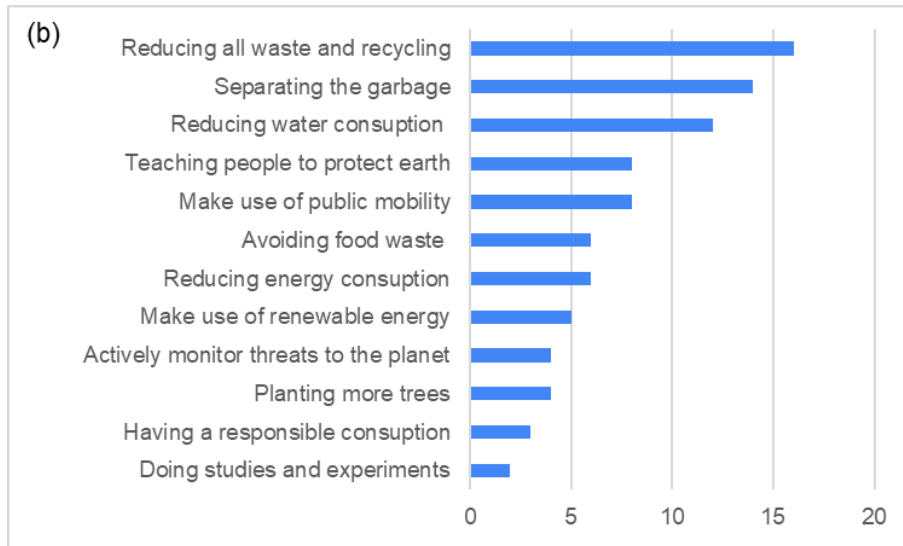


Fig. 6. Distribution of student’s answers to the question “What can we do to protect the environment and help the planet?”.

Regarding measures to help the planet, most students selected “Reducing all waste and recycling”, followed by “Separating the garbage” and “Reducing water consumption” (Fig. 6).

These answers show that the hands-on experiments were effective in raising awareness of the ODS addressed, namely: The need to reuse and recycle materials (11 and 12) to prevent pollution of forests, oceans, and air (14 and 15) as well as climate change (13); The problems associated with water scarcity (6, 13, 14); The need to look for greener energy sources (7, 13).

3.3 Outline and more insights about the discussion

Besides the enquiry forms, participant observation was performed during the workshops with teachers and students. Regarding the focus group that was performed with the teachers during the workshop, we highlight the appreciation of teachers for the training that made them be able to develop experiments with students. Most of them expressed interest in more training in this area and said they wanted to implement this approach in their school, namely the experiments presented at the workshop. Moreover, they refer to the hands-on experiments as adequate to be implemented in schools and useful to better help students to understand this subject matter.

Therefore, the workshop had impact on teachers namely by improving their knowledge about the subject matter approached and also motivated them to develop

this approach in their schools. Indeed, they revealed consciousness of their role and of schools regarding the development of actions related to SDG with students and in the community.

In what concerns students, before the workshop an open question related to measures about how to help our planet was posed to them. Several responses were similar to usual ones such as “Pollution”, “Reducing waste”, and “Recycling”, among others. After the workshop, the same open question was placed and other answers, related to the examples approached in the workshop, were observed. For example: “Watering our plants with the water we already use”, “Collect rainwater to water the plants and wash the floor”; “We should start reusing bottles”, “Riding in hydrogen cars”, “We need to walk and cycle” and “Building hydrogen cars”, Don't buy more stuff than we need, among others. Therefore, the workshop provided knowledge to students, and hopefully, they will be motivated to promote SD practices that will help to protect our planet.

4 Final considerations and future work

The 17 SDG were defined to face the need for measures to protect our planet and provide better living conditions for all [1]. This paper presents an empirical study that resulted from a collaborative project led by a HEI and targeted to the school community. In this context, theoretical contents and hands-on experiments related to SDG (Table 3) was presented to teachers in a workshop, with the objective of strengthening consciousness for the development of good practices related to SDG. Also, 20 workshops were implemented with about 400 students in six schools to help teachers in their mission to provide knowledge and raise awareness of SDG with students.

It was verified that the workshop improved teachers' knowledge, motivation, and confidence to introduce SDG content to students. Besides acknowledging the necessity of professional development, teachers strengthened consciousness of their role and of schools in promoting actions and good practices related to SDG.

Furthermore, the students also extended their knowledge about SDG and understood the need to protect our planet, namely by measures such as reutilizing water among other actions.

Therefore, both workshops had impact in teachers and students by improving their knowledge in this matter and also about the need to be active in taking measures to improve our quality of life.

Although it has already been demonstrated by previous work that higher education students' participation in sustainability-related research projects improves their awareness of good practices [10], the present work extends this approach to lower levels of education and the community. So, it was verified that the project was effective in raising awareness of teachers and students about the importance of implementing good practices related to SDG. It is concluded that collaboration between HEI and schools can trigger the implementation of SDG practices in the community.

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