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Lockdown in Mars †

Laureen Vanessa Pérez Pinto * and Antonio Eff-Darwich

Specific Teaching Department, Faculty of Education, University of La Laguna (ULL), 38204 Tenerife, Spain; adarwich@ull.edu.es

* Correspondence: lvperezpinto@gmail.com; Tel.: +34-686-492-325

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Abstract: In this work, we present a series of educational activities that rely on geological tools to dive into the science of core standards. In this sense, Geology is not the subject to be studied, but the educational resource: we learn with Geology, rather than about Geology. Water is the common element to all activities, and the exploration of Mars (its geology, atmosphere, life conditions, etc.) becomes the engaging background. The primary objective of these activities consists of promoting the basis of scientific reasoning in students. Hence, we tested them with pre-service teachers, in order to investigate their opinions and comments about the strengths and weaknesses of our proposal as regards critical reasoning. Since the activities are so easy to carry out and they could be adapted to an online format, they might become an example of the kind of teaching-learning resources teachers should implement and/or carry out during lockdown conditions.

Keywords: science teaching; Mars; water; pandemic

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1. Introduction

One of the main objectives of the latest educational reform carried out in Spain [1] is "to contribute to the foundation of a basic scientific culture and scientific literacy, both from a qualitative and experimental point of view". Hence, it is expected that citizens will understand and use the tools of scientific reasoning in their daily life, to face problems and come up with ways to solve them.

Experimental activities represent a key factor within the science learning-teaching process at all educational levels, since they favour a more positive attitude towards school science [2], increasing motivation and the development of scientific competences [3]. However, science teachers in Spain often encounter difficulties in implementing laboratory activities due to the lack of facilities and adequate material, excessive number of students and the "encyclopaedic" nature of the scientific–technological curriculum [4,5]. Nowadays, as the result of the restrictions imposed by the health and educational authorities to control the spread of the COVID-19 pandemic, many spaces in educational centres, such as laboratories, computer classrooms and technology workshops have been transformed into standard classrooms. Henceforth, the time spent by students in classical science-related practical activities has dropped dramatically. This problem is expected to be partially overcome by incorporating technological tools (software, internet applications, etc.) into the science teaching process [6]. All these educational technologies, as well as other didactical methodologies, have certainly played (and will play) an important role during the pandemic. In this sense, Foundation La Caixa [7] carried out a large survey among more than 16,000 Spanish teachers about the didactical materials and resources used during the first wave of the pandemic. There is an interesting and contradictory result in this study: teachers are using new technologies and internet-related resources, but there has been a significant reduction in the number of activities that promote group work; namely only 24% of the respondents used this didactical method-

ology.

The pandemic will certainly change the way science is (and will be) taught at all educational levels. Old problems, such the lack of practical activities, might persist and new challenges will arise. Pre-service science teachers will face all these changes, and hence, it is necessary to provide them with tools and resources to overcome these difficulties. In this work, we present the design and the results of a workshop, "The last survivor", where a group of pre-service primary school teachers from the Universidad de La Laguna (Tenerife, Spain) learned how to dive into the Spanish educational science curriculum through practical activities about geology and planetary exploration, where water is the common element to all activities [8]. All these practical activities, based on low cost and easy to find materials, could be carried out in any standard classroom, or even at home. They are intended to enhance scientific reasoning rather than memorization in a planetary exploration context. In other words, all the activities are designed to engage students and raise their curiosity in the classroom or at home (during or outside of lockdown).

2. Methodology

This work consisted of the design and evaluation of a series of practical activities for pre-service primary school teachers about scientific reasoning and how to implement engaging and didactical science-related resources. The workshop "The last survivor" was included in a more general course about Education in Astrobiology that was hosted by the Universidad de La Laguna. A total of 14 pre-service teachers, distributed in 4 working groups, enrolled in the 55 min long workshop.

The workshop was split into 6 steps, where different didactical techniques were used. In this sense, the participants had first-hand experience about the impact of various teaching-learning approaches.

- Step 1: The participants were introduced to brainstorming. This is a group activity where the teachers possess a question or problem. This is followed by a flow of ideas from the students that end up with possible answers and/or ideas. In our case, the participants were asked to share what they thought the workshop was about, based on the title ("the last survivor"), and also what they know about Mars. The participants (pre-service teachers) could analyse how ideas and arguments flow in a debate and the capital importance of making good questions.
- Step 2: The four working groups received a "time capsule"; this is a kit containing all the materials needed to carry out the activities contained in the workshop. It consisted of a measuring tape, a stone, a magnifying glass, a wooden stick, a magnet, a needle, four different minerals, a plastic glass, a piece of glass, and finally, a piece of cloth. The participants had to analyse the kits and devise a way to find North on Mars. Since the kit contains a magnet and a needle—and by analogy to what happens on Earth—one may think that a compass is the solution to the problem. A compass relies on the existence of a global scale magnetic field (like on Earth), but Mars does not have such a field. The way to find North on Mars is to use the relative position of the shadow cast by the wooden stick. Both Mars and Earth have a similar rotational motion, and hence, the path of the Sun in the sky is analogous. In this activity, the participants analysed how to learn by doing and also by using similes (Earth–Mars) in the teaching-learning process.
- Step 3: A 1 m × 2 m mat (see Figure 1) with a printed scaled map of the Elysium Basin [9] on Mars, was used to analyse graphical data, in this case, cartographic data. This map was used as a blackboard to give general information about the Geology and Chemistry of Mars. Participants were asked to measure distances between different locations, taking into account the scale of the map. From a didactical point of view, the participants in the workshop learned how to combine direct instruction by a teacher with practical measurements carried out by them.

- Step 4: The participants learned how to use a dichotomous key to identify the minerals contained in the kit (see Figure 2). Moreover, and based on the chemical composition of the minerals, they had to discern which samples were in close contact with water and even the environmental conditions. This part of the activity is intended to show a more practical and engaging view of mineralogy, away from the standard learning by memorisation.
- Step 5: In the previous step, the participants in the workshop learned how to find evidence of water in mineral samples. Back to the mat, how to find the effect of water on the Martian landscape was explained. In analogy to what happens on Earth, the participants were asked to explain some geological features in terms of water dynamics. In this case, there is a combination of direct instruction by the teacher and observational skills by the students.
- Step 6: The participants filled an anonymous questionnaire to evaluate the quality of the workshop and ways to improve it.

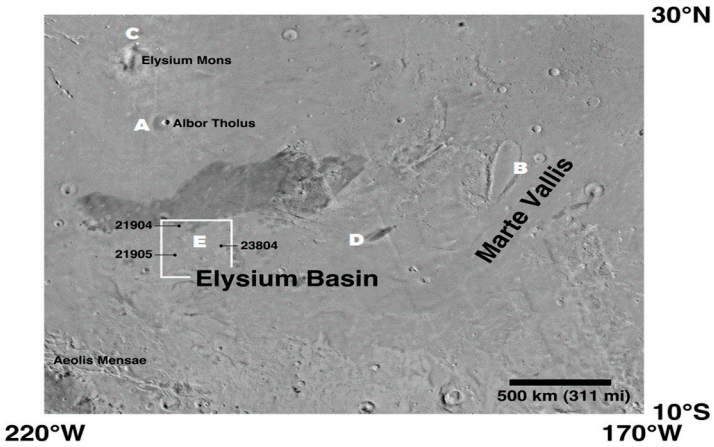

Figure 1. Map of Elysium Basin [9] printed on a 1 m × 2 m mat.

Figure 2. Participants in the workshop analysing the mineral samples.

3. Results and Discussion

This workshop was not designed to give an overall picture of the Geology and Chemistry of Mars, but rather to illustrate different practical teaching–learning techniques using an engaging topic, in this case. planetary exploration and the search for water. In this sense, the evaluation is designed to measure the quality of the workshop and the ways to improve it. The evaluation consisted of a questionnaire that could be divided into four items:

- A series of seven evaluative questions: Did you learn anything new? Was the workshop useful and interesting? Was it what you expected? Would you like to participate in similar activities? What is your rating of the content? What is your rating in terms of the length of the workshop? Was it a fun activity? All the answers were rated from zero to 10, with zero being the most negative value.
- Two open questions: which aspect did you like the most? Additionally, which aspects would you change to improve the workshop? The answers were analysed by looking for the most repeated words, using the free online tool Textalyser [10]. The input information for this application consists of the set of answers given by the participants. The output of the application corresponds to the words most frequently used in the set of answers.
- General evaluation of the workshop, in terms of degree of satisfaction, with five possible answers, two positive (very high, high), two negative (very low, low) and one neutral.
- Other comments not included in the rest of the questionnaire, name "it was fun", "it was boring".

The content of the workshop was rated 8.8 out of 10, with a deviation of 1.35 (see Figure 3). The highest rating (9.7 out of 10) corresponds to the question "would you like to participate in similar activities?". These are encouraging results, recalling that the participants are pre-service teachers that could export these methodologies to their near future teaching–learning strategies, in particular practical science-related activities.

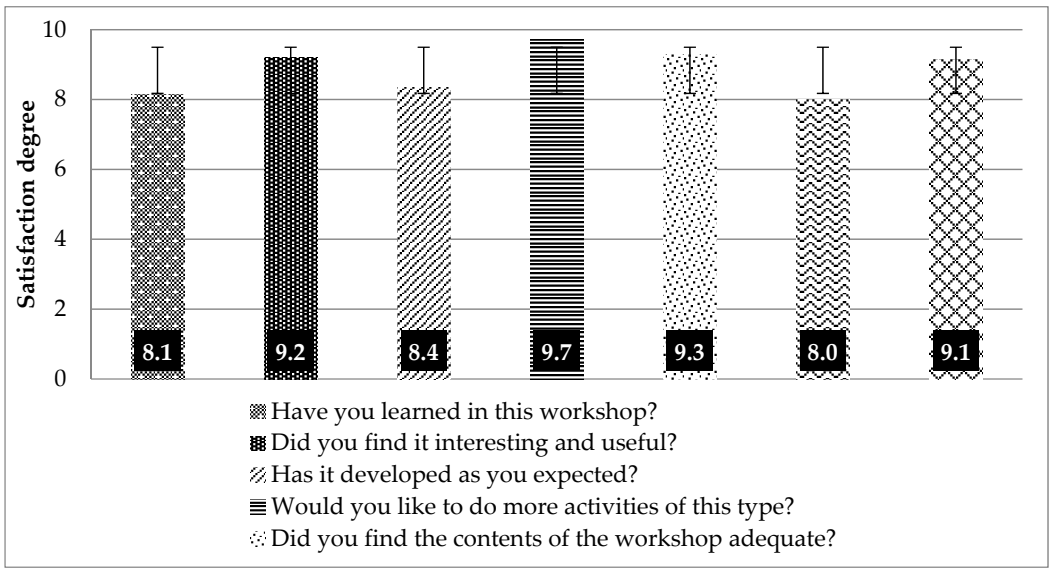

Figure 3. Results from the first block of seven evaluative questions about the quality of the workshop. Vertical bars correspond to the standard deviation.

The most repeated words found in the answers to the open question "which aspect did you like the most?" are all related to experimental procedures, in particular, the characterisation of minerals (see Table 1). In this sense, the workshop was a success, since the participants (pre-service teachers) realised that practical activities could enhance the teaching–learning process, even in topics they had never worked with before (neither studied), such as mineralogy. Here, we list some of the answers:

- Student 1: the design of the workshop as an adventure game could be engaging for kids.
- Student 2: the analysis of materials might raise the student's curiosity.
- Student 3: to observe and manipulate minerals in a gamification context.

The most repeated words related to the open question "which aspects would you change to improve the workshop?" have to do with the timing of the workshop (see Table 1). The majority of participants would increase the time devoted to some of the activities, in particular, the analysis of minerals and the observation of geological features on the map. This is also encouraging, since the participants asked for more time because they were enjoying the activities. Examples of their answers are listed below:

- Student 5: I rated the workshop eight out of 10, because I think it was short in time and we could have also spent more time working with the map
- Student 11: It should be longer
- Student 12: More time for activities related to exploration

Table 1. Analysis of the most frequent words found in the two open questions.

Question	Answer	Frequency	Percentage (%)
Which aspect did you like the most?	Mineral analysis.	10	71
	Practical content.	3	21
	Working in different areas.	2	14
	Gamification.	2	14
Which aspects would you change to improve the workshop?	Duration of the workshop, more time.	5	36
	Working with the map more time.	3	21
	Introduction to minerals.	2	14

The general evaluation of the workshop (see Figure 4) was "very high" for nearly 60% of the participants and "high" for the rest. The general comment was that they would indeed put into practise these strategies to engage their students and also to improve the assimilation of scientific content through observation, experimentation and analysis of different natural phenomena. All participants also realised that the implementation of these kinds of methodologies is only possible if there is a change in the attitude of both teachers and students. The design of these practical activities is time consuming for teachers and from the point of view of the students, the learning process goes from the standardised individual memorisation to scientific reasoning and collaborative working. However, the reward for both teachers and students is worth the effort.

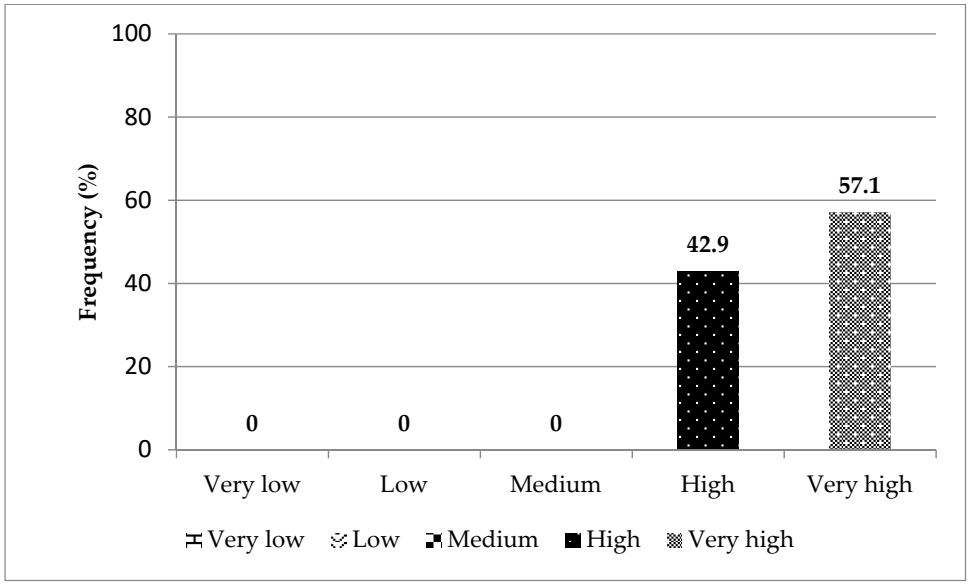

Figure 4. Degree of satisfaction about the workshop.

4. Conclusions

The degree of satisfaction of the participants in the workshop is an encouraging result. The pre-service teacher realised that it is possible to learn science by doing science. The concepts and tools of science might by teach not only through memorisation, but by reinforcing the key role of scientific reasoning and the connection of ideas. Primary or secondary students engage with practical activities, and those presented in the workshop "the last survivor" are easy to implement and could be exported as homework and/or online exercises. It is an adventure-like set of challenges, and hence, it is attractive and motivating for students. This is of capital importance if the students have to stay at home due to lockdown or other circumstances.

Geology is dramatically losing its presence in the Spanish science curriculum at all educational levels. Pre-service teachers feel uncomfortable with this subject, since they all have a minimal experience in Geology. It is necessary to expose them to all the fields in Science, where Geology plays a key role. Among them, planetary exploration is an engaging and multidisciplinary field that might become a framework to recover and foster the teaching–learning of geological concepts and tools within the science curriculum in Spain.

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References

1. DECRETO 83/2016, de 4 de julio, por el que se Establece el Currículo de la Educación Secundaria Obligatoria y el Bachillerato en la Comunidad Autónoma de Canarias. Available online: http://www.gobiernodecanarias.org/boc/2016/136/001.html (accessed on 20 August 2019).

2. Bennett, J.; Lubben, F.; Hogarth, S. Bringing science to life: A synthesis of the research evidence on the effects of context-based and STS approaches to science teaching. *Sci. Educ.* **2007**, *91*, 347–370. Available online: http://doi.org/bbss6k (accessed on 30 September 2019).
3. Alonso, M.B.A.; Aguado, M.E.G.; Martínez, M.T.L.; Galindez, M.C.M.; Uliarte, A.M. *84 Experimentos de Química Cotidiana en Secundaria;* Graó: Barcelona, Spain, 2013; Volume 302.
4. De Pro Bueno, A. Los contenidos de los proyectos curriculares de física y química en secundaria en la implantación de la reforma LOGSE. *Enseñanza de las Ciencias* **2007**, *25*, 367–386.
5. Sanmartí, N. *Didáctica de las Ciencias en la Educación Secundaria Obligatoria*; Editorial Síntesis S.A.: Madrid, Spain, 2002.
6. Moreno Mediavilla, D.; Pascual López, V.; Palacios Ortega, A. Uso de los laboratorios virtuales como TAC para el desarrollo de la competencia científica. In *Jornadas sobre Investigación y Didáctica en ESO y Bachillerato, Proceedings of the Actas del IV Congreso de Docentes de Ciencias de la Naturaleza, Spain, 12–15 April 2016*; González Montero, M., Baratas Díaz, A., Brand Fernándezi, A., Eds.; Santillana: Madrid, Spain, 2017; pp. 257–277.
7. Foundation La Caixa. EduCaixa. Docentes en época de Confinamiento: ¿Cómo Percibieron los Docentes el Nuevo Escenario educativo? Available online: https://educaixa.org/es/-/docentes-en-%C3%A9poca-de-confinamiento-1 (accessed on 15 October 2020).
8. Pérez Pinto, L.V.; Eff-Darwich Peña, A.M. *Tan Claro Como el Agua: Su Potencial Didáctico en la enseñanza de la Física y Química*; Universidad de La Laguna: Tenerife, Spain, 2019. Available online: https://riull.ull.es/xmlui/handle/915/14893 (accessed on 16 November 2020).
9. Jet Propulsion Laboratory. Ancient Lakes on Mars? Results for Elysium Basin. Available online: https://photojournal.jpl.nasa.gov/figures/PIA01494_fig1.gif (accessed on 29 October 2020).
10. Textalyser.net. (s.f.). Textalyser. Available online: http://textalyser.net/ (accessed on 31 October 2018).