ESEB Outreach Initiative Funds - Report

Title

Winter Camp for Peruvian children: teaching basic concepts on evolution

Nature of activity

Educational workshop.

Location

Universidad Nacional de Ingeniería, Lima (Peru).

Number of participants

18 girls between 12-15 years old.

Number of volunteers

17 people involved in the coordination, development of activities, translation of documents and teaching.

Date

2, 3, 4 and 6 of March, 2020.

Summary

Science education is the landmark to encourage critical thinking and should be introduced in early stages of school training. However, bringing the scientific process to the classroom through the application of inquiry-based learning methodologies and hands-on experimentation is still often difficult and consequently neglected. This workshop intended to improve the scientific knowledge of young Peruvian students because we highly support the idea that education and scientific knowledge should be for everyone – regardless of social status and gender. Given the negative impact that gender stereotypes has in girls' attitudes towards science we therefore decided to focus on teaching girls about a subject that is typically under-represented in the curriculum but that help us to have an integrative and multidisciplinary understanding of the world – Evolution.

We organized four days of training to teach different aspects of the evolutionary process: from the production of genetic variation (at the DNA level) to the selection of variants (at the population level) and adaptations (at the species level). Several hands-on experiments and games were developed in order to turn students into active players in their learning process. They were be encouraged to work in teams, and stimulated to question, to formulate hypothesis, to design experiments, to record observations, to communicate results and to draw conclusions. This teaching methodology intended to improve their understanding about the scientific process and Evolution, and to encourage critical thinking. In addition, we aimed to show that evolutionary principles can be applied into various contexts of our daily life. Hence, we looked at the different adaptations of the unicellular organism that allows the production of many fermented foods (yeast).

Overall, we observed that this workshop had positive effects as all students showed interest to participate in future workshops of this nature, confirmed that they learned new things, and described sessions as fun or amazing. In addition, for 33% of the participants this was the first contact they had with a female scientist; we observed an increase in students' interest in science and in their motivation to continue studies after secondary school. These observations justify our intention to extend the project to other participants including the rural areas of Peru – where school drop rate after completing secondary school is higher – and to other countries including Portugal – where we already established partnerships with Cova do Mar (https://www.covadomar.pt/), a non-profit organization working with children in need, and PAJE (https://www.paje.pt/), a platform that helps foster children.

Schedule

	Monday	Tuesday	Wednesday	Thursday	Friday
10:00	Introduction	Genetic Variation & Heredity	Yeast Experiment		Student's oral presentation
10:30	Cell Biology				
11:00		Break	Break		Break
11:30	Break	Natural Selection	Visit to the laboratories		Final remarks
12:00	DNA				
12:30	Lunch	Lunch	Lunch		Lunch
13:00					
13:30	DNA	Adaptations			
14:00					
14:30		Animal Classification & Phylogenetics			
15:00	Genetic Variation & Heredity				
15:30		Break			
16:00	Break	Yeast Experiment			
16:30	Yeast Experiment				
17:00		Discussion			

Activities done

1) Cell Biology
   - Look at an onion skin under the microscope
   - Look at mouth epithelial cells under the microscope
   - Make cell models with Play-dough

Figure 1. Cell Biology session. Material prepared for the class (a), observation of cells under the microscope (b) and cellular models made by students (c).

2) Genetic material (DNA)
   - Build DNA molecules
   - Extract DNA from fruits

Figure 2. Genetic material (DNA) session. Material prepared for the class (a), nucleotides to build DNA molecule (b) DNA molecule (c), and DNA extraction from different fruits (d).

3. Genetic Variation and Heredity
   - Translate information coded in the DNA into protein (game)
   - Introduce mutations and see consequences in the protein by building amino acid molecules
   - Assess intraspecific variability
   - Draw genealogical trees

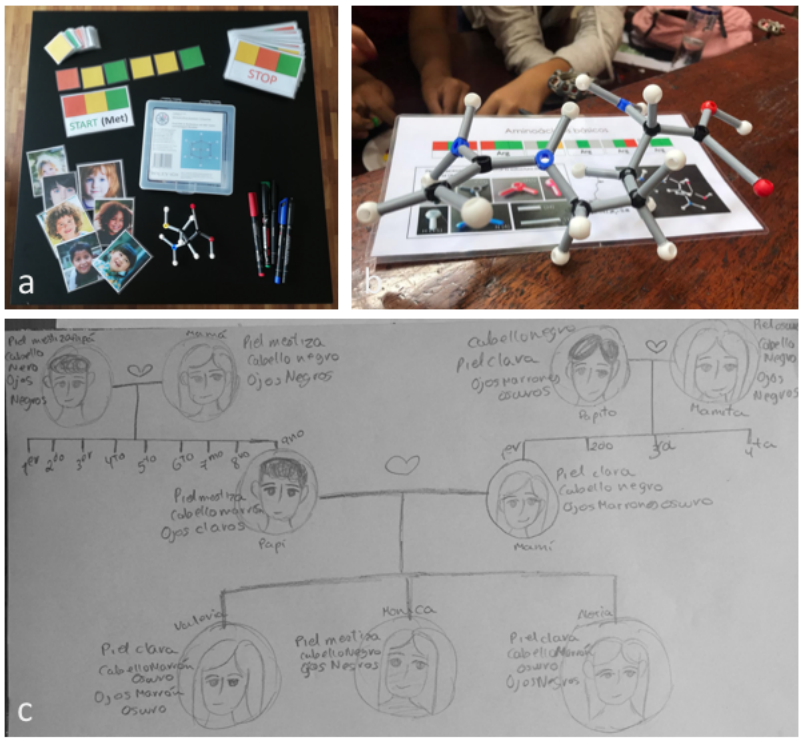

Figure 3. Genetic variation and heredity session. Material prepared for the class (a), amino acid molecule (b), and student genealogical tree (c).

4. Natural Selection
    - See Natural Selection in action (game)
    - Play *Biston betularia* game

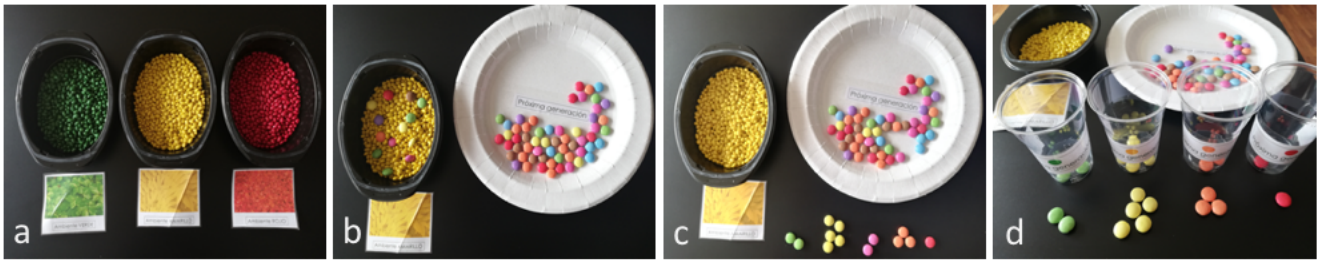

Figure 4. Natural Selection game. Different environments (a), population with genetic variation in an environment (b), number of individuals that survived after predation (c), and next generation (d).

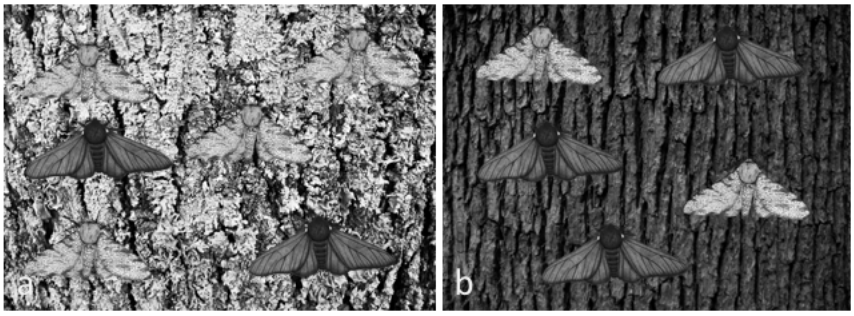

Figure 5. *Biston betularia* game. Peppered moth population with wing color variation laying in a tree bark full with lichens (a), and Peppered moth population with wing color variation laying in a dark tree bark after industrial revolution (b).

5. Adaptations
    - Explore bird beak adaptations (game)
    - Understand how artic animals stay warm in icy water
    - See yeast adaptations

Figure 6. Adaptations session. Explore bird beak adaptations by using different foods and different tools representing bird beaks (a). Experiment demonstrating how fat can keep animals warm (b). Observe yeast growth in different environments (c).

6. Animal Classification and Phylogenetic Relationships

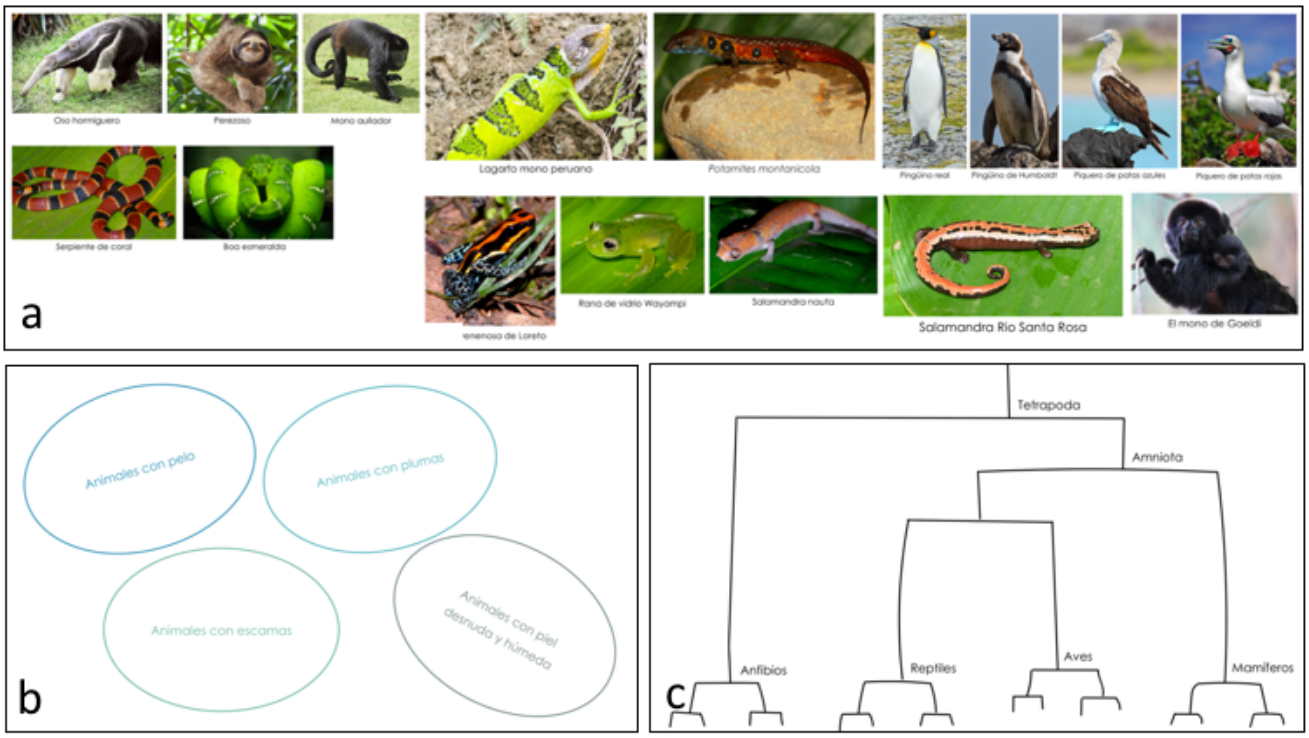

Figure 7. Animal classification and phylogenetic relationships. Cards with animal species that live in Peru (a) that needed to be classified according to their body coverage (b) and phylogenetic relationship (c).

Evaluation

To have an overall idea for the impact that this workshop had on students, we asked them to answer six questions. In general, this event proved to have positive effects as most of the students (14 out of 15) showed definite interest to participate in future workshops of this nature (Figure 8a), all students confirmed that they learned new things (Figure 8b), and described sessions as fun (11 students) or amazing (4 students) (Figure 8c). Regarding the likability of each topic addressed, we see that all subjects captivated pupils' interest (Figure 8d), with Cell Biology and DNA, and Animal Classification and Phylogeny scoring as the most difficult subjects (Figure 8e). In addition, and given our interest to promote girls' interest in science and to broaden their perspectives for the future, it was particularly important to observe that for 33% of the participants this was the first contact they had with a female scientist (Figure 8f).

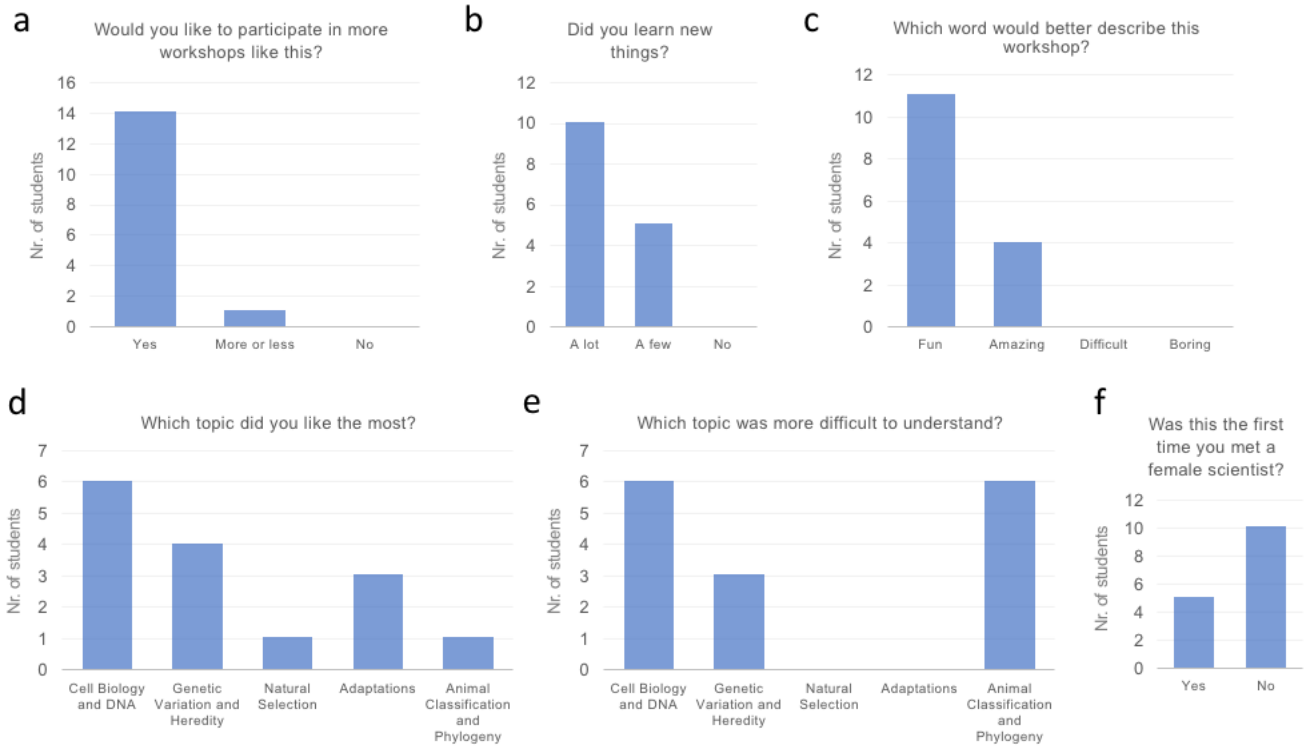

Figure 8. Students' opinion about the workshop. Number of participants that would like to participate in more events like this one (a), and learned new things (b). Number of pupils that described the workshop as fun, amazing, difficult or boring (c). Classification of topics addressed in terms of which one students' liked the most (d), and which one they find more difficult to understand (e). Number of participants that met a female scientist for the first time during the event (f).

To understand how these activities influenced the way participants think, how they feel and where do they see themselves in the future, we asked students to answer three open questions (Table 1).

Table 1. Students' answer to three open questions. Here we show a selection of answers from seven participants.

What did these activities made you think about?	**How these activities made you feel?**	**Has the project given you ideas for the future or changed the way you see things?**
The workshop made me think about my body, how it is structured and how I can do many things thanks to Evolution.	*Comfortable as I did not feel pressured to learn and all explanations were simple.*	*Mostly, it changed the way I see Biology, Chemistry and Physics.*
I thought about the amount of new things I learned because workshop was fun and interactive. At school we are only asked to copy and memorize things.	*I felt good because I could understand that science can also be fun.*	*This project arose my interest for science, and I think that I will be working on that in the future.*
I thought about DNA and that the processes of Evolution are very interesting.	*Very good and that I can explore more my knowledge.*	*I now want to finish secondary school and go to the University.*

Table 1. (Cont.)

What did these activities made you think about?	How these activities made you feel?	Has the project given you ideas for the future or changed the way you see things?
I thought about my career and which subject I should study at the University. I did not feel that I learned a lot because I already knew most things, but I liked the activities and how things were explained.	*Emotional, I loved to use the microscope for the first time and the way the workshop was taught. It made me feel more confident in my love towards Biology.*	*I am still not sure which subject I want to study, but I do know that it has to be related to science.*
The workshop taught me how to see beyond something, that there are microorganisms we cannot see with the naked eye but that are very diverse.	*Good, I interacted with other girls and above everything else I had a good learning experience.*	*This workshop gave me more ideas and from now on I want to go to more events like this one.*
It made me think about future opportunities, I could learn a lot although I do not see myself studying this subject in the future.	*I felt happy because I learned many things that I would have not learned at school. I also had the chance meet new people that I liked very much.*	*I will keep studying and achieve my goals in life.*
I thought about all the things I still don't know about.	*I felt good and happy because I could learn new things.*	*I will investigate more about interesting subjects.*

Future perspectives

High number of Peruvian students discontinues to their education after completing secondary school. Tackling this issue requires challenging ideas to improve student's expectations for future, especially at early stage of their education. Hands-on science activities and interaction(s) with role models (scientists) appear as an innovative approach to inspire pupils to pursue higher education. Additionally, we aimed at demonstrating the benefits of teaching Evolution to encourage participants' ability to question and wonder.

After the completion of this project, we saw that our teaching methodology not only elevated students' interest in science but also their motivation to continue studies after secondary school (Table 1). Furthermore, many participants also demonstrated that learning about Evolution changed the way they think about the world and increased their motivation to learn new things. These observations justify our intention to extend the project to other participants including the rural areas of Peru – where school drop rate after completing secondary school is higher – and to other countries including Portugal – where we already established partnerships with Cova do Mar (https://www.covadomar.pt/), a non-profit organization working with children in need, and PAJE (https://www.paje.pt/), a platform that helps foster children.

People involved

Main organizer:
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Costs

Material: 918,93 €
Transport: 394,11 €
Food: 248,96 €

Collaborations

This project counted with the collaboration established between Ginkgo-Educa and WiSTEM UNI from the Universidad Nacional de Ingeniería, Lima (Peru).

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