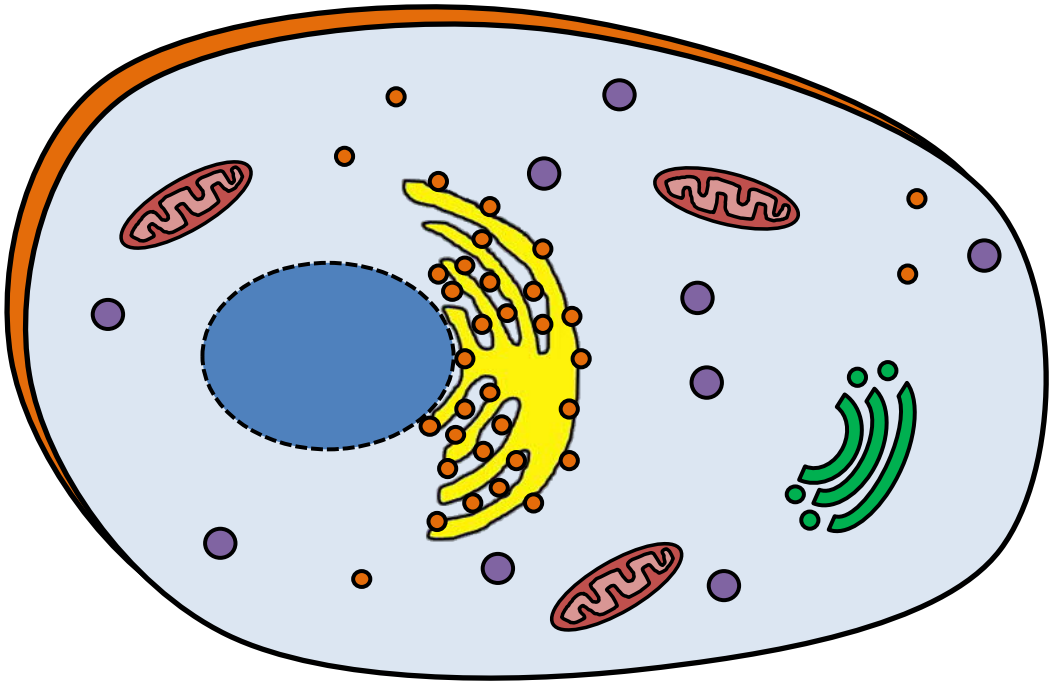
BIOCHEMICAL SOCIETY

Biochemical Society Outreach Event:

Inside the Cell



Evaluation Report

Covadonga Huidobro and Asta Valanciute

Gijón, 8-12 May 2017

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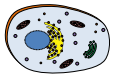
Inside the Cell



1. Introduction

Science outreach activities are essential to increase awareness and understanding about scientific research. This is particularly relevant when it targets young audiences, who could build up the future generations of scientists. In countries like Spain, lack of funding hinders public engagement events to happen in public schools. The experience that we, Dr. Covadonga Huidobro and Dr. Asta Valanciute, have acquired by volunteering in outreach events in parallel to our work as postdoctoral Scientists in the United Kingdom, has encouraged us to apply for funding to organise our own events in audiences that are hard to reach.

Our application to carry out the event "Inside the Cell" was awarded with one of the Biochemical Society Outreach Grants. The event was performed in May 2017 in two state-funded primary schools in Gijon (Principality of Asturias, Spain), "Colegio Publico Clarin" and "Colegio Publico Rio Piles". It was the first time that the schools hosted a Scientific Outreach event. We carried out a total of 21 sessions of 45 minutes long, reaching 516 students aged between 6 and 14 years old, and the corresponding teachers.

2. Aims

The main aim of this event was to bring Cell Biology closer to young students through a series of dynamic presentations and exciting hands-on activities. This represented an alternative to traditional methods based on lectures, which were very engaging for the targeted audience. Most of the children were unaware of the concepts taught by the researchers. This, together with the hands-on activities, generated enough interest and excitement not only among children but also teachers, who were enormously impressed with the protocols and techniques involved in the workshops and would be very keen to host similar events in collaborations with scientists in future years.

In order to achieve the main aim of this event, we had the following as partial objectives:

- To promote public awareness about Biological Sciences among primary school children and the teaching community
- To contribute to Science education through fun and vibrant hands-on activities, giving children the opportunity to perform real experiments, and become familiar with the scientific method
- To inspire school teachers to participate in the workshops, where they would be able to learn alternative strategies to engage students more vividly with Science
- To take advantage of lessons learnt from experience of previous projects to improve the quality of our deliverables
- To improve our expertise as scientists in public communication and to adapt ourselves to children from different cultures
- To develop links at the international level between research institutes and primary schools
- To introduce the Biochemical Society not only as the funding body but also as an educational institution
- To perform the event within the projected budget

All the aims were successfully achieved, as explained below.

3. Workshop

Different hands-on activities were run during 45-minutes sessions. We, Dr. Covadonga Huidobro and Dr. Asta Valanciute, were leading the activities in the presence of the corresponding teacher at all times.

Each activity began with a brief and dynamic presentation by Dr. Covadonga Huidobro using screen projectors and digital boards available at the schools and was followed by different hands-on activities. At the beginning of the talks, Covadonga briefly described her role as a researcher and acknowledged those who made this event possible, the Biochemical Society as the funding body, the supervisors who allowed the researchers to carry out these activities outside the lab, and the schools, which were happy to be involved. Asta and Covadonga created a friendly and relaxed atmosphere, checking how students were coping with English (foreign language) and the new vocabulary, and trying to address all their questions. Both schools have recently started Spanish-English bilingual teaching system, so children in general spoke fluent English but were not familiar with the scientific words.

The main focus of every talk was the cell: what it is, what their components are and what they do within the cell, how cells work and how we go from single cells to multicellular organisms. Due to the expertise of Covadonga in Genetics, special emphasis was given to the DNA and how it is packed to fit inside the nucleus. The complexity of these talks increased accordingly with the age of the students. In Spain, primary school is organised into 6 years, and the hands-on activities were slightly different depending on the year:

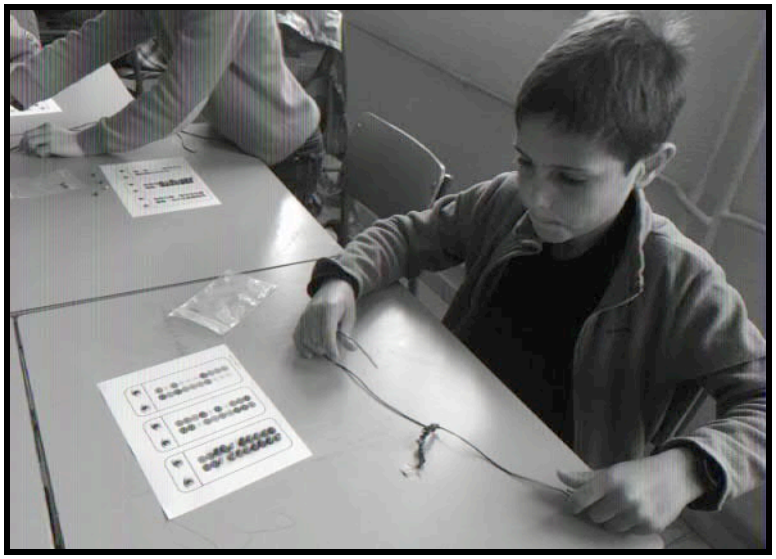
- **Cell colouring**, for 6-7 years old children (1st year). After learning about the cell, a template with the illustration of a cell highlighting the main components was distributed within children to give colour. Children also needed to write down on the template the names of each component and were allowed to take home their projects.

Picture 1. Children are showing their cell colouring projects. At the back, Covadonga is wrapping up the session by revising the new words the students had learnt throughout the activity.

- **Cell modelling**, for 7-8 years old children (2nd year). After a brief talk about the cell, 10-centimetre Petri dishes were given to the children together with some air dry dough of different colours. Children built their own cell inside the Petri dish, following guidelines from the Scientists. Children were allowed to take their projects home.

Picture 2. Students showing their 3D cell model. In the square, detailed picture of one of them.

- **DNA bracelets/keyrings**, for 8-10 years old (3rd and 4th year). Children learnt about the DNA, its structure and function within the cell. Following the pattern of some DNA sequences, children learned about DNA structure and complementary base-pairing using beads and wire to make bracelets or keyrings. Pupils wore proudly their DNA bracelets and keyrings, and some girls suggested a different use, hair decoration!



Picture 3. After identifying the eye colour they got, students build DNA bracelets or keyrings following the sequence and complementary base pairing rules.

Picture 4. Some pupils wore their DNA beads on a string in their ponytails.

- **Visualization of cheek cells under microscopes**, for 10-11 years old (5th year). A general introduction was given about cell structure and cell types to the children. For the activity, children were arranged in pairs. They used cotton swabs to get the cells from the inner side of their cheeks, put them on to microscope slides and stained them with food dyes to observe them under the microscope. Children were not allowed to take home the slides with their own cells, which upset some of them.

Picture 5. Students getting cells from their mouth.

Picture 6. Students trying to see cells after staining with food colorants by naked eye (left), and observing them under a microscope (right).

- **DNA extraction from peas**, for 11-12 years old (6th year). Using soap, lemon juice, a pinch of salt and a little bit of alcohol (alcohol was exclusively manipulated by the scientists), students extracted DNA from smashed peas. Children were not allowed to take the laboratory tubes with the DNA samples home, but one of the teachers asked if she could wash them to repeat the experiment with the students, so tubes were donated to the school.

Picture 7. Students were grouped by pairs to perform the DNA extraction. In the square, detailed of one of the DNA samples.

4. Evaluation of the activity

The scientists were warmly welcome at the schools. From the minute they arrived, they could feel the enthusiasm from both students and teachers; everyone was looking forward to starting the experiments.

As the hands-on activities went along, it was easy to tell that children were acquiring new knowledge while having fun. The atmosphere was very friendly and students did not hesitate in asking all short of questions related with the activities and the underlying Science. The scientists tried to address all the questions raised. Children's behaviour was in general extraordinary, being respectful by raising their hands and calling researchers for help when required. In some activities, like the DNA bracelets, more volunteers would have been extremely helpful. In order to compensate for that, researchers kept a very close eye to the students making sure everyone was following the activity. Activities were carried out at a slow pace and all together, step by step, and this strategy worked quite well. If someone got stuck, not only scientists and teachers helped, but also neighbouring students, showing a great sense of companionship.

However, the scientists faced some challenges. The first one was the ratio scientist- student ratio, which was a bit low. There were just 2 Scientists per 25 students (on average), so it was good that scientists asked teachers to stay in the classroom during the activities. Most of the teachers engaged really well with the Scientists and got involved in the workshops from the very beginning. Some teachers carried out the task in parallel with children while others adopted a more supportive role (helping children that were struggling, keeping the restless ones under control, and so on). A few teachers even asked for the slides of the presentations and the protocols to go over the activity with children to consolidate the new knowledge. Counting on teachers was particularly useful when we faced children with learning disabilities or behaviour disorders. For instance, one boy was extremely demanding in terms of attention, and even though he had a tutor assigned at all times, the scientists realised he required "more action". The boy was offered to hand in the materials and surveys for his colleagues. He happily agreed to do it, and his colleagues were very comprehensive. The situation was successfully overcome, which we had not thought about it before hand.

In the first school, the scientists were not allocated in a classroom but instead they needed to carry their stuff from one classroom to another, where the children were waiting. This was slightly stressful since scientists were not familiar with the school and also needed to pack and unpack different materials depending on the session, and carry their stuff all around the school. However, in the second school, the researchers were allocated in one classroom and the students headed by the corresponding teacher were the ones who need to move. This made the transition from one session to the next one easier and quicker.

Regarding the activity of the cheek cells, scientists provided just two microscopes. Since there were around 25 students per session, observing the cells under the microscope was a bit of a bottleneck. Thankfully, this was something that had been beard in mind beforehand and students were entertained with magnifiers and cell models. This waiting time was also used to ask students about the experiments, making sure they were understanding the procedure.

The activities were successfully completed within the schedule with exception of one of the cell modelling groups, which was extremely restless and scientists need to stop a few times asking students

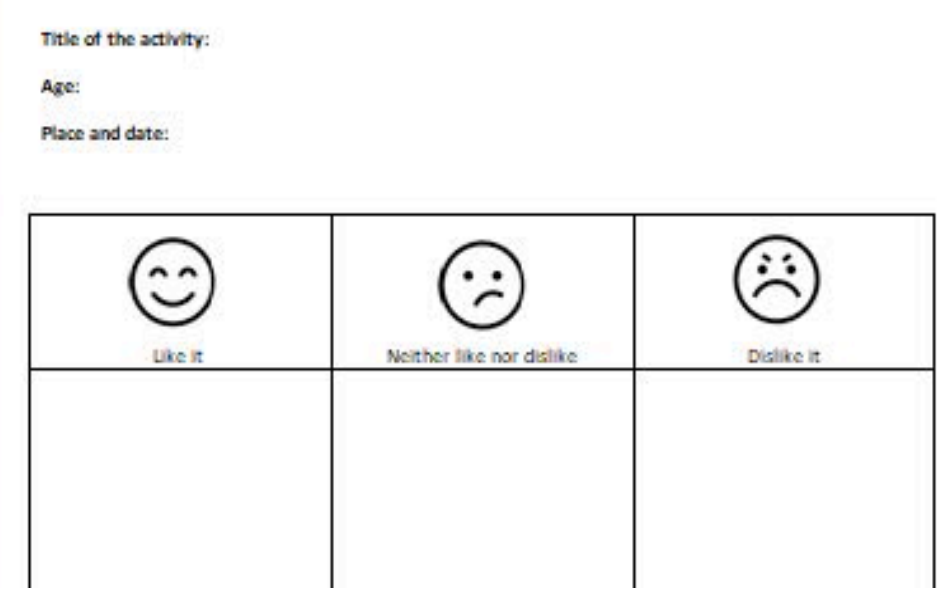
to keep calm. They students managed to finish the cell model, but did not have the time to write names in their notebooks.

In order to assess how successful the workshops had been in a more accurate way, the researchers had prepared a survey, which was given to the students at the end of the activity. The surveys allowed estimating easily the number of students who took part in "Inside the cell":

Activity	Number of Students
Cell colouring	47
Cell modelling	126
DNA bracelets/ keyrings	175
Cheek cells	120
DNA extraction	48
TOTAL	516

Table 1. Number of students who participated in the workshops.

To capture a response quickly and easily from younger children ("cell colouring" and "cell modelling" activities), smiley faces were used as a scale to rate the activity as shown below:



Picture 8. Template that was distributed among children after the hands-on activity to assess how they had found the activity. Children just needed to draw a mark in the column whose smiley face best described their feelings towards the activity.

As shown in the pie charts (Figure 9 and Figure 10), the cell colouring and the cell modelling hands-on activities were outstanding: 96 and 95% of the children liked the activity, respectively.

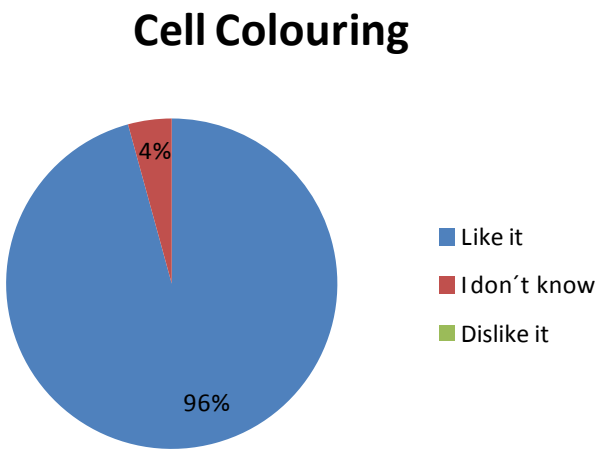


Figure 9. Pie chart showing results of the activity "Cell colouring" survey

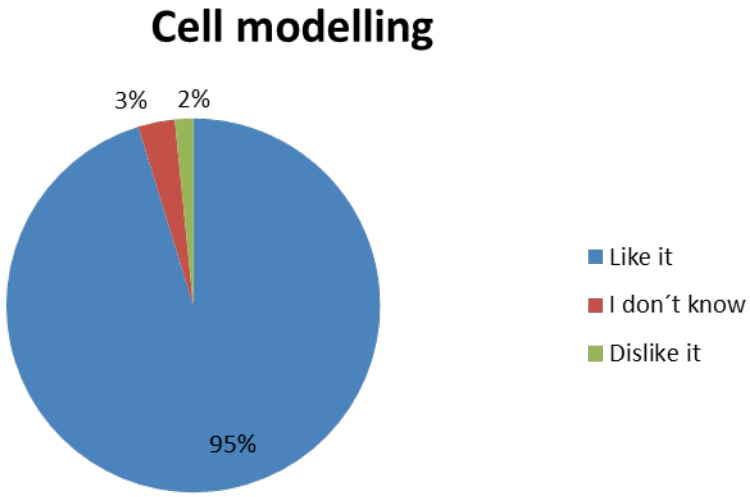


Figure 10. Pie chart showing results of the activity "Cell modelling" survey.

Regarding the rest of the activities, including DNA bracelets, Cheek cells and DNA extraction, a more elaborated survey was prepared, which consisted in the following questions:

1. What did you like most about this event?

   a. New knowledge

   b. Materials used

   c. Facilitators

   d. Other

2. What did you like least about this event?

   a. New knowledge

   b. Materials used

   c. Facilitators

   d. Other

3. How did you find the event on a scale of 1 to 10, being 1 very boring and 10 very entertaining?

   Very boring Very entertaining

1	2	3	4	5	6	7	8	9	10

4. Would you like to attend a similar event in the future?

   a. Yes

   b. No

   c. I don´t know

5. Would you recommend this event to friends/ colleagues?

   a. Yes

   b. No

   c. I don´t know

6. Do you have any suggestions, comments or concerns about the event?

This survey turned out to be too difficult for some students because of the multiple-choice answer. Explaining how the questionnaire worked required slightly more time than initially expected. The plan was to let the children fill the survey on their own, but the strategy needed to be modified. Questions were read out loud one by one and further explanations were provided regarding the multiple-choice answers, specially option “d” (others) in questions 1 and 2, in which students were expected to specify what they had liked the most or the least if it that was not among the previous options.

Regarding the DNA bracelets (Figure 11), 35% of the students liked the most learning something new. Around 50% picked the option others from which the majority said they had liked everything. Regarding what the liked the least, the vast majority said that nothing. There is a 10% who chose the materials used. This is related to the fact that some children struggled to make knots, but received help from scientist and teachers in order to improve and everyone managed to finish their DNA bracelet. The activity was found very enjoyable, since more that 95% of the students gave a mark of 8 points or higher. Children would definitively like to participate in a similar event (97% said yes) and recommend the activity (95% said yes).

With respect to the observation of cheek cells (Figure 12), similar results were obtained. The most popular answer was that they liked learning something new (46%) or that they liked everything (77% out of the 25% who picked others). In question number 2, the results are overwhelming: most of the students said there was nothing they did not like (95% of 88%). Again, the activity was considered very enjoyable (marks 8, 9 and 10 gathered more than 95% of the students), and everyone would like to attend a similar workshop or recommend the activity to friends and colleagues (95% and 92% of children gave positive answer).

Finally, taking the DNA extraction experiment into account (Figure 13), a wider range of answers was obtained. Once more, around half of the students like everything (47% out of 56%) but the rest of the answers regarding question 1 was more equally distributed: 21% liked learning something new and the instructors, and another 21% liked the most learning something new and the materials used. Nothing was answered by 67% out of the students who picked others (88%) to the question about what they had liked the least. Regarding the rest of the aspects they did not like, interesting things were raised. It seems our “young researchers” need to be more patient, since some did not like the introductory talk (9%), thought the experiment was too short (5%) or did not enjoy the waiting times (2%), which were used to discuss about the theoretical aspects of the experiment. Once more, the activity was considered very enjoyable (95% of the students gave the activity a mark of 8 or higher). Also, the students would be willing to get involved in similar events (96% said yes) and would recommend the activity as well (98% said yes).

DNA bracelets/keyrings

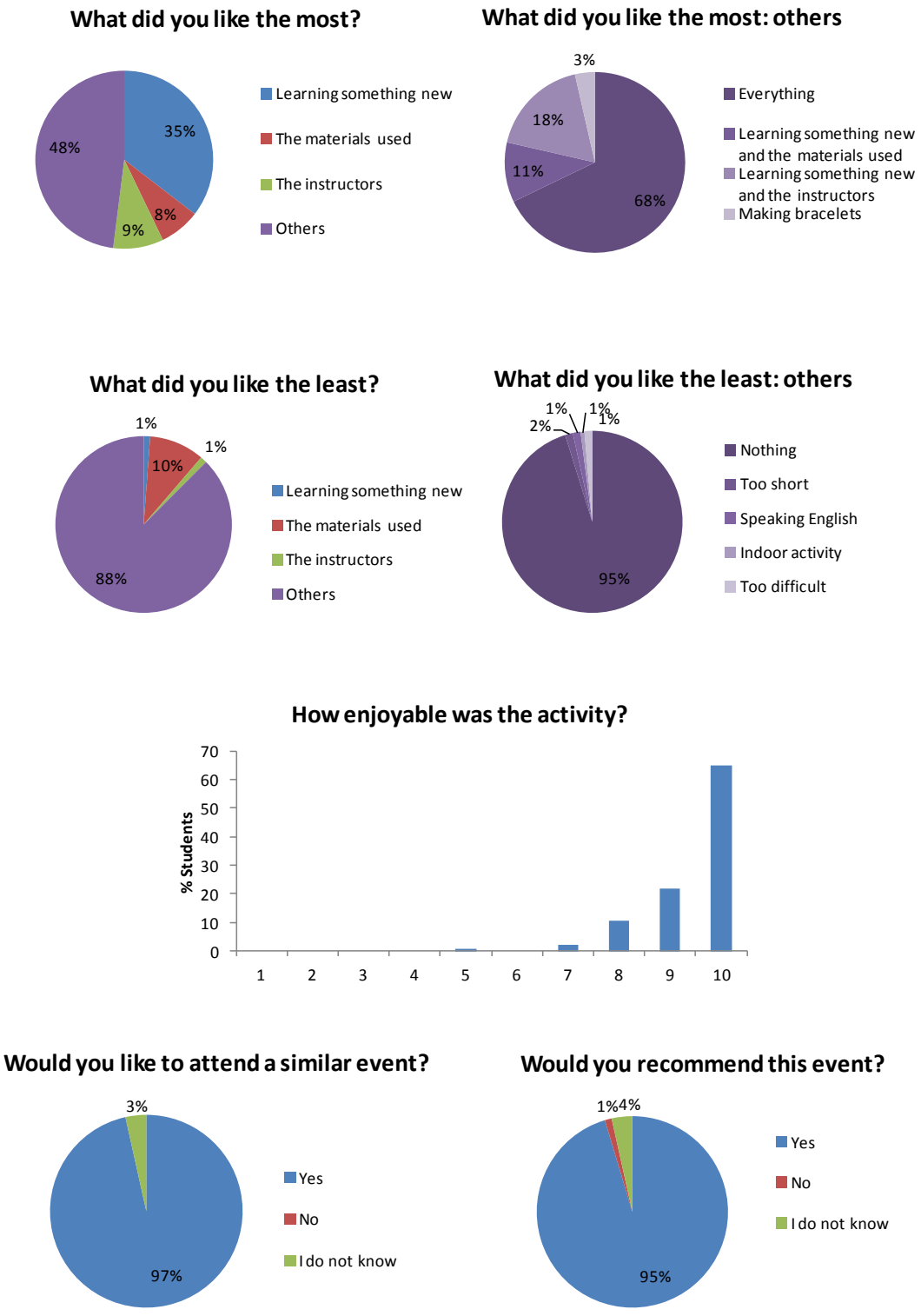


Figure 11. Results from the survey to assess the DNA bracelets/keyrings activity.

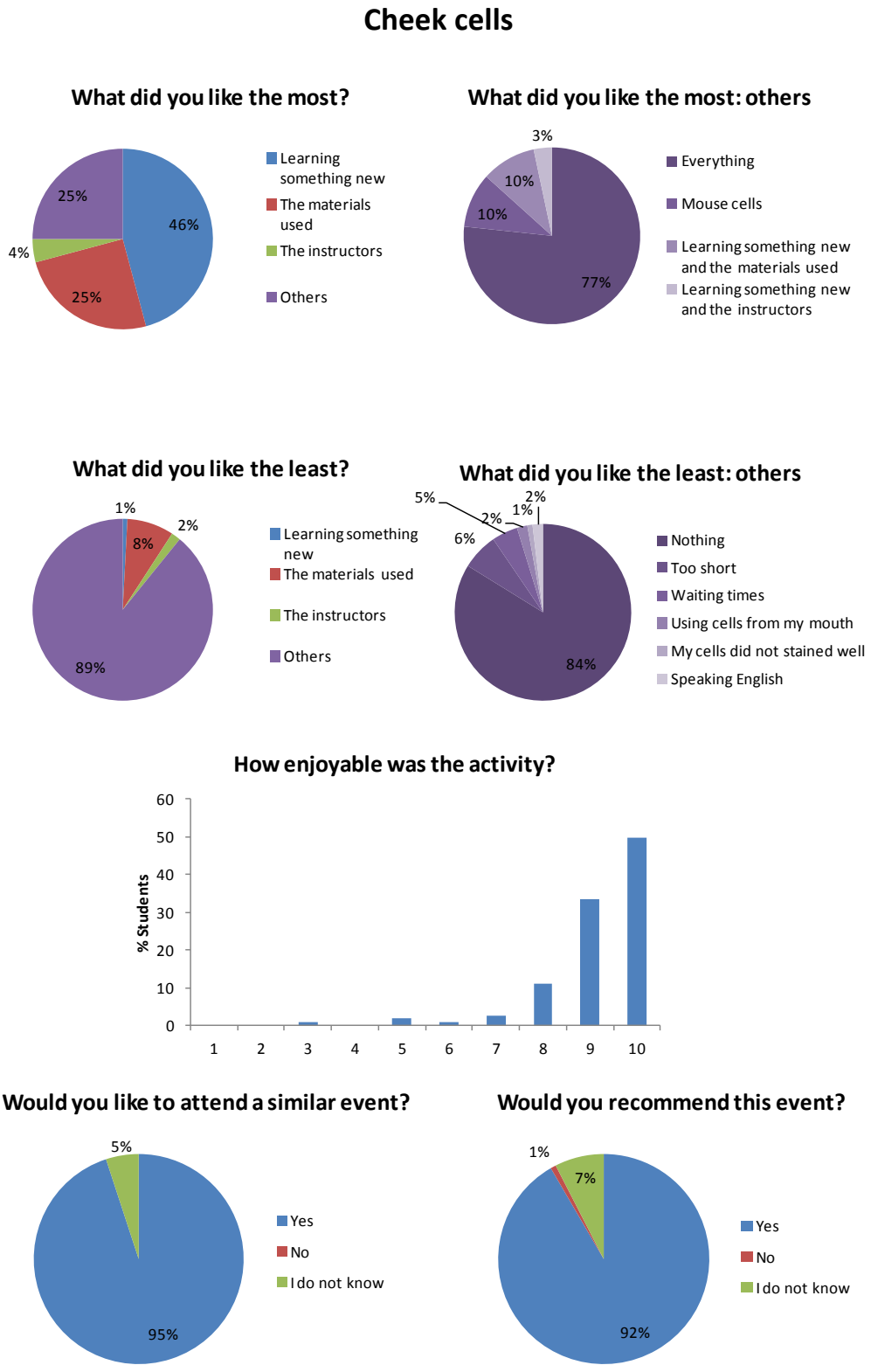


Figure 12. Results from the survey to assess the experiment, which consisted in observing cheek cells under the microscope.

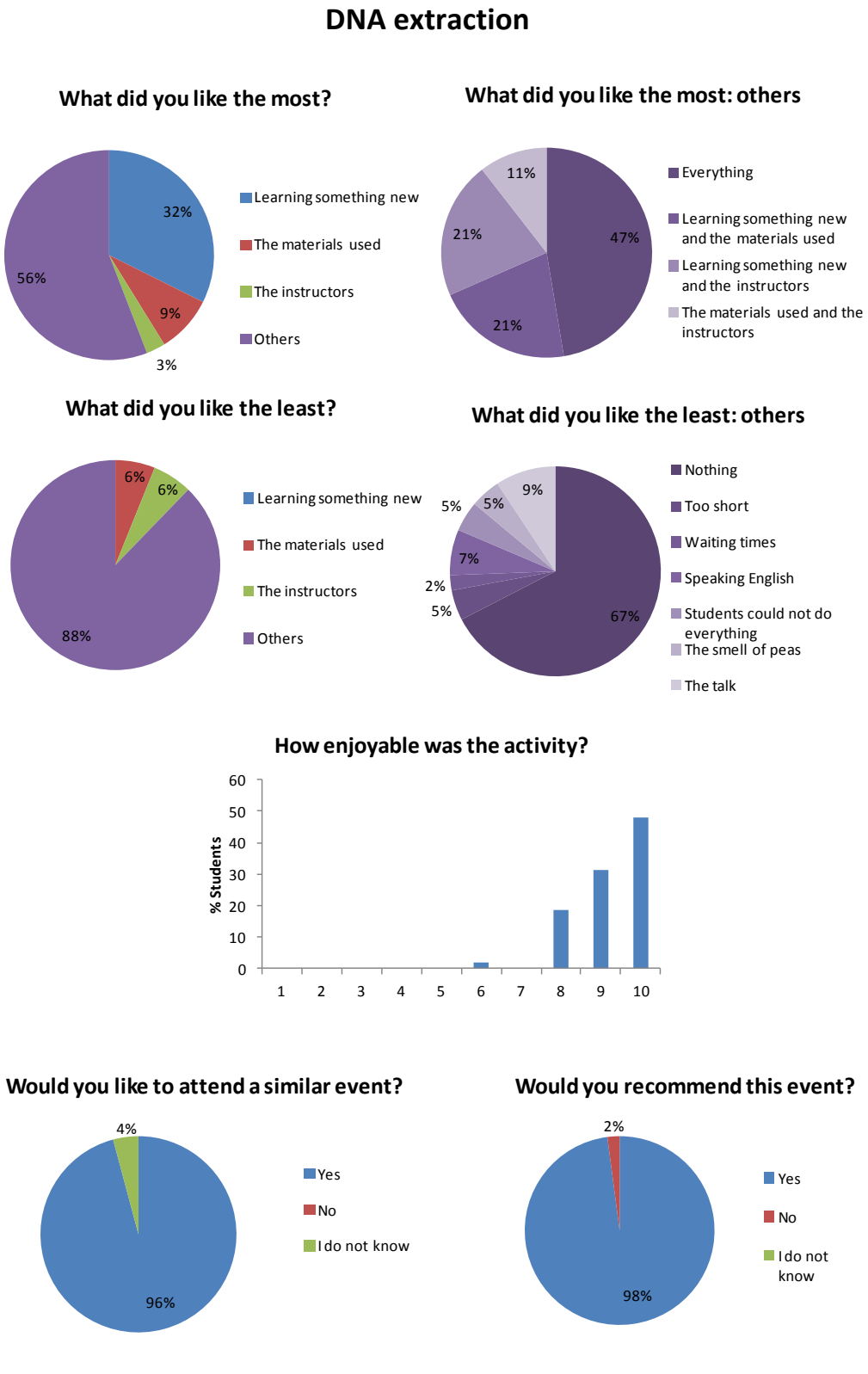


Figure 13. Results from the survey to assess the DNA extraction experiment.

Regarding the last question, by which scientist pursued to get some feedback on how to improve the workshop, some of the students' comments and suggestions are shown here:

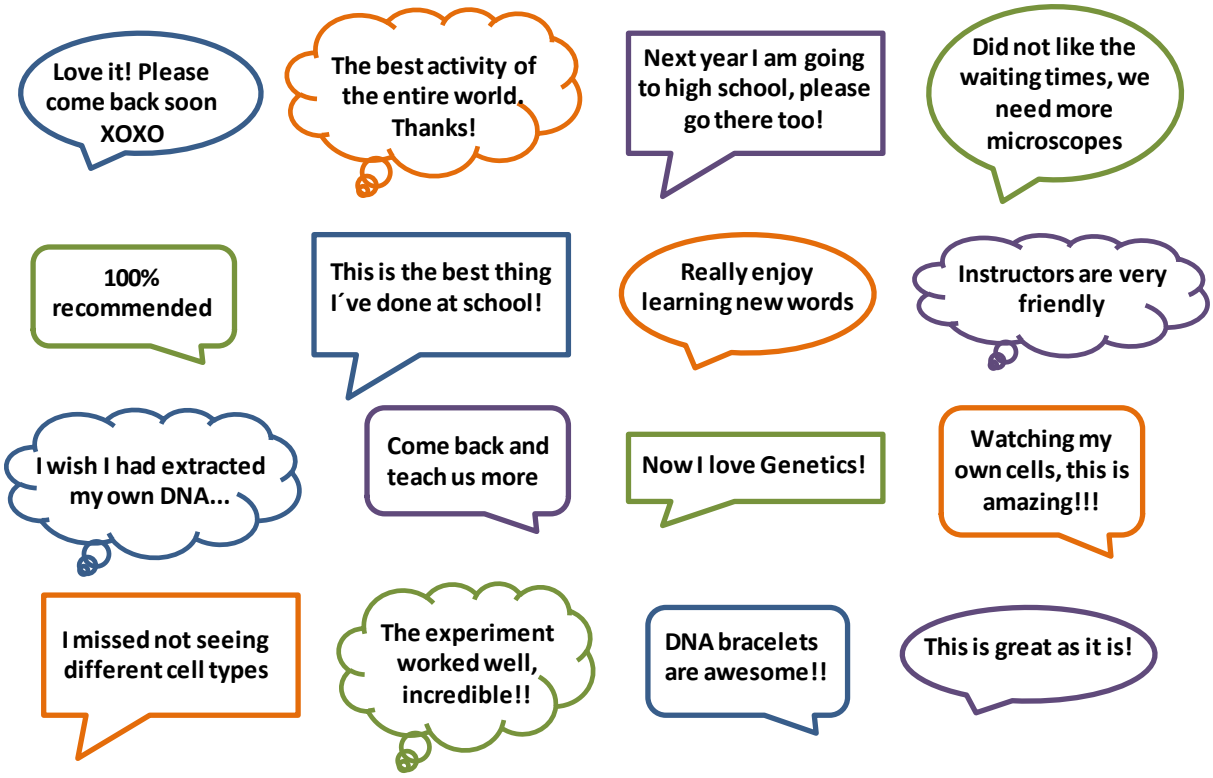


Figure 14. Some of the answers for question 6 "Do you have any suggestions, comments or concerns about the event " in the survey for the activities DNA bracelets/keyrings, Cheek cells and DNA extraction.

While performing the hands-on activities, the general impression was that not only children but also teachers loved the workshops. This is now supported by the results obtained in the survey. For the first time, these two schools could offer to their students a scientific outreach event and it has been an extraordinary success. Headmasters and teachers were really impressed with our work, since they repeatedly congratulated us on the workshop. To corroborate this, the headmasters of one of the schools even contacted local media and we were interviewed about the events by two newspapers. To highlight, we all discussed how useful would be to have the funding to run this workshop every year.

As scientists this experience has been very rewarding. We have learnt how to adapt to very different situations to the ones we live in our work every day life. We have without question improved our communication skills and we have shown that scientists are reachable to public audiences.

The positive feedback is an amazing reward for our effort in visiting these schools and really appreciated the opportunity the Biochemical Society is giving in order to promote Science outreach event.

5. Media coverage

Covadonga posted some twits while the project was been performed, with permission from the schools to include pictures of participants.

Local press heard about the event and two newspapers interviewed Covadonga. Articles were published both in printed and online versions:

- El Comercio: http://www.elcomercio.es/gijon/201705/13/pulseras-piles-20170513024202.html
- La Nueva España: http://www.lne.es/gijon/2017/05/13/extraer-adn-guisante-detergente/2103785.html

6. Plans for the future

With "Inside the Cell", Covadonga and Asta have laid the foundation for Science outreach events to happen in public schools in Gijón, a small town in the North of Spain. The schools that hosted this event were delighted with the workshop, and they will remain in contact with the researchers so that similar events could be organised. In addition, since "Inside the Cell" appeared on local newspapers, different schools have already contacted Covadonga. They are offering new audiences public engagement.

Covadonga and Asta would like to keep organising similar events in future years, but the fact that we depend exclusively on external funding is a very limiting factor. There are not many Science outreach calls, so the one held by the Biochemical Society sustains our hope to continue our role as public engagement facilitators.

For future events, improvements to implement from this experience are:

- Recruit more volunteers if working with more than 10 students per scientist.
- Also, the number of microscopes available was a bit of a bottleneck. Again, this was due to the budget available. Covadonga is now aware of the foldable microscopes co-invented by Manu Prakash and Jim Cybulski in Manu´s laboratory, available at www.foldscope.com. This microscope is made from paper, durable and affordable. It emerges as an ideal replacement for traditional research microscopes in this type of public engagement activities, as the expenses will significantly decrease.
- If the event is run in schools, scientists will ask to be allocated in one classroom, so that transition between the different sessions goes smoothly.
- Regarding experiments, like the observation of cheek cells under the microscope and DNA extraction, promote health and safety measures like wearing safety glasses, lab coat and gloves would have been more correct. Due to budget constraint, this was not included this time but it is something that should be taken into consideration for future workshops.
- Simplify the survey.

7. Acknowledgements

We, Covadonga Huidobro and Asta Valanciute as the scientists involved in “Inside the Cell”, are enormously grateful to the Biochemical Society for providing the economical support to develop the project.

We also would like to acknowledge the Headmasters’ of the two schools that hosted the event, Amalio Nuñez from the school Río Piles and Soledad García from the school Clarín, who took the risk to enrol in the project without any hesitation and were very supportive from the moment we met. We also thanked every teacher who sacrificed one of their sessions with their students so that we could carry out the workshop and because they were very helpful and made our stay extremely enjoyable. Finally, we need to thank as well every child for their enthusiasm while developing their projects. It has truly been a pleasure to work with all of them.