What scientists know about the microcosmos of your tongue's flora could help keep people healthy. In this opinion piece, genomics expert Toni Gabaldón, explains how crowdsourcing samples of microbes from people's tongue will contribute to advancing our understanding of the flora in our mouth. Read on about this exciting citizen science project.

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Stick out your tongue!

Citizen science project studying the microorganisms flora found at the tip of our tongue

Saca La Lengua--which means stick out your tongue in Spanish--is an expression that typically refers to the rebellious, but playful, facial expression that kids use to defy authority. It is also the name of an eponymous *citizen-science project* which aims to provoke teenagers and engage them to work with microbes.

Citizen-science is an approach to research that breaks the usual barrier that exist between scientists and citizens. Instead, both work as partners to pursue a common research goal. This approach replaces the indirect connection whereby citizens pay taxes that support science and know about what scientist do from reports in the media.

Microbiome study

The *Saca La Lengua* project targets the microbiome: a complex subject focusing on discovering the diverse communities of microbes in our body. Until now, we did not know whether these microbes outnumber our own cells. However, we are increasingly realising the importance of the microbiome in keeping us healthy. Microbiome studies have progressed tremendously in the last few years, mostly due to developments in sequencing and bioinformatics techniques.

Current techniques make it possible to quickly profile which microbial species and/or genes are present and in what relative amounts in any given sample. This so-called metagenomics approach, based on DNA sequencing, works even with species that cannot be cultured in the lab and thus has unveiled a previously hidden world.

Thanks to these advances, the media have been carrying news on how our diet, our microbiome and our health are inter-related. However, citizens still have a limited understanding of the real implications of such discoveries. With *Saca La Lengua*, we reach out to high-school students to get them involved in all aspects of the scientific study of their own oral microbiome.

This is the first comprehensive study of its kind. It has been targeting an age-range of healthy people largely neglected from most existing studies. We have collected about 1,500 samples together with environmental and lifestyle information. We have then used state-of-the-art metagenomics and bioinformatics techniques to analyse samples.

Educational role

Students have been involved from the stage of hypothesis building to the statistical analyses of results, involving them via diverse “challenges” in which they could participate. The engagement of biology teachers, who were trained on the subject during two workshops, was crucial for the success of the project. They transmitted their enthusiasm to the students.

The project reached its peak at the time of collecting the samples from all over Spain. A committed member of our team traveled during four months throughout the country in a van. It transported the necessary equipment and served as his home during this period.

I visited several of the high-schools during that time and witnessed the excitement of the students. They also posed challenging questions. The discussions did not solely revolved around the importance of microbes in our lives. They also were revolving around the nature of the life as a scientist.

In a final phase, the students had access to the data. They could formulate their own questions and directly assess whether the observations helped to resolve these. Overall, the project reached over 3,000 students, between 14 and 15 years old. This is a key period in which they are to choose

whether they enrol in science related studies.

Perhaps this experience served to tilt the balance and encourage some of them towards science-related studies. Regardless of the path they choose to pursue, they will be citizens with a better knowledge of the scientific method.

Societal impact

In parallel to this educational approach, a large communication effort took place, targeting the citizens, as a whole. We engaged in talks, science cafés, social media, the production of video and web-based materials. The aim was to communicate important concepts related to microbiology, sequencing, health, and bioinformatics.

For the team of researchers involved, used to comfortably interact with its peers, this project was certainly a challenge. We had to make an effort to communicate our science to non-experts. We also struggled to keep the demanding deadlines of a project that necessarily needs to follow the high-school course cycle and the planned interaction with the media. We, however, enjoyed meeting enthusiastic students and teachers. We also gained access to a valuable dataset otherwise difficult to obtain by the usual means available to researchers.

Researchers like to complain about how little politicians appreciate science. In my view, the problem is not so much related to the level of appreciation. Rather, it is linked to a distorted appreciation, which results from the lack of understanding of how scientific progress works.

Part of the public and politicians perceive science as an acivity performed by a few isolated geniuses that will eventually get a Nobel prize for discoveries that immediately impact society. When citizens meet researchers their attitude changes, as they have the opportunity to experience the realities of a scientific project from within.

A society that better understands the scientific process--with its struggles, uncertainties and limitations--is more likely to support a realistic scientific sector. It will also be more prepared to critically assess information from scientific discoveries and understand their implications.

Conversely, researchers that make the effort to partner with society to reach a common scientific goal will be likely more prepared to consider the societal implications of their research. Citizen-science is a useful approach to empower both citizens and scientists and a necessary element in a knowledge-based society, in which knowledge is not the privilege of a few.

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