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INSPIRING PRACTICES | FINALIST 2024 | COSTA RICA

#ENVIRONMENT

Students develop smart beehive to promote sustainable beekeeping

Using STEM methodologies and reflection on the Sustainable Development Goals, the team created a technological solution to optimize beekeeping and preserve bees.

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COMMUNITY/CITY
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SCHOOL
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PROJECT NAME
Apyphore, smart beehive for the extraction of apitoxin

STEM AREAS
Science, Technology and Engineering

OTHERS AREAS OF KNOWLEDGE
Environmental Education

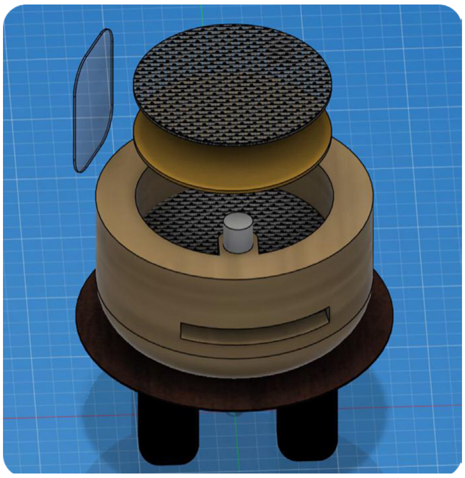
Humans are constantly looking for new ways of using technology to improve the quality of life and work, right? So why not do the same for animals, such as bees, which are essential for maintaining ecosystems? This was the thought of the five students from Costa Rica, regional finalists of the 2024 edition of Solve for Tomorrow – Central America and the Caribbean Region, which brings together 11 countries: Barbados, Belize, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Dominican Republic and Venezuela.

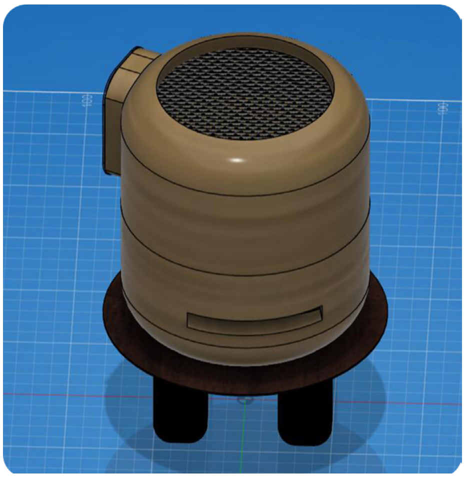
The teenagers created the "Apyphore" project, a smart hive with sensors and cameras for monitoring bees, providing real-time data to ensure the well-being of bees and facilitate remote management by beekeepers, promoting sustainability in beekeeping and the conservation of these insects.

Beekeeping is an important source of income in rural economies and the Western honeybee is the most widespread pollinator worldwide. According to the Food and Agriculture Organization of the United Nations (FAO), one third of the world's food production depends on bees.

Taking this into account, one of the approaches of "Apyphore" is to perform an automated and non-invasive extraction of apitoxin. This is the venom produced by the bee and has anti-inflammatory components and is sold for cosmetic use, such as facial creams. Although apitoxin has therapeutic properties, its extraction often causes stress within the hive and among its individuals; since the bees are pushed against the glass of the collector, because the substance is only released as a form of protection. In “Apyphore” the process is done through electrostatic discharges, which is less hostile.

The students were 16 and 17 years old and were in their second year of six in technical training. According to Teacher Yamil Vega, the project mediator, they had several strong ideas for the application. So they mapped out possibilities until they chose “Apyphore,” primarily as a project dedicated to preserving bees.





The prototype presents an intelligent hive divided into two sections: one for the bees’ habitat and another for the automated and non-invasive extraction of apitoxin using electrostatic discharges.

Initially, they analyzed the importance of bees in the world. “We learned a lot and saw that bees also have diseases. And in the first instance, we had the goal of creating a hive that would be like a bee hotel,” recalls the educator.

Then, other ideas emerged: "We began to analyze what else we could contribute with the beekeeping technology we already had." Thus, they developed each of the United Nations Sustainable Development Goals (SDG) that had a direct link, such as Health and Wellbeing. "It was not just a matter of thinking about one problem, but based on it, what other problems we could take into account to make a project sustainable in its entirety," he highlights.

Designing the prototype, they studied the averages of natural hives and saw that they had two options: one very large or several small ones. "We decided to make them in various sizes, because we may have a future market with different beekeeper needs," he explains. The team created a model of the casing and commissioned its manufacture to a local artisanal chamber. Then, they installed the electronic part, combining technical knowledge with traditional knowledge.

Eureka moment!

The assembly of the prototype was going well, with the casing already having the necessary cables and sensors, but in practice it did not work. "In the integration part with the software we had more than 800 lines of code in a program. It was not easy to find what the error could be," describes the educator. Each line indicates a specific action that the program must perform. There, the team had an interface that integrated all the information, but to make it work, they had to be very patient and segment the programming, changing their method to reach the expected result.

The group continued to make improvements until the end, and the prototype ended up being of higher quality than they had initially expected: with an integrated computer vision system and a camera that wirelessly communicated in real time what was happening inside the smart hive. The whole thing cost around 120 to 150 US dollars.

They made a market projection based on a survey of beekeepers and estimated that the product could be sold for 200 dollars. "Normally, beekeepers buy a product that does not have all the technology we implement for 300 dollars. We managed to optimize the prototype in such a way that the price could be sustainable for them," says the teacher.

Beyond a lower price than usual for a smart hive, the method used is safer, preserves the bees and, as a consequence, has more apitoxin extractions and other by-products, such as honey.

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"That was what I loved about the competition: we trained and experimented with a lot of technology to use it. It's very nice."

says Vega.

Learning to work as a team above all

Vega adopts a pedagogical methodology of collective learning that allows students to discover and focus on the skills they have the most affinity with, without forgetting an overview of the project. To discover the strengths of each one, the educator decided to vary the roles at the beginning of the project, including the responsibility of group leader.

At the end of the STEM project, some of the group members were in charge of the technical part, while others were in charge of programming and some of communication, so that the skills converged into a final result. "They don't have to get to the end, learning how to connect a cable but rather knowing how to make at solution truly integral to a work team," he says.

Las alumnas tuvieron la oportunidad de conocer de cerca el funcionamiento de la apicultura.

In addition to completing all the stages of the project route, the team carried out marketing actions for "Apyphore". They created a logo, uniforms, a website and social media. "Although it had no connection with the program, they believed that it could give a corporate image and make the exercise as if it were a company," he explains.

To raise funds for the promotional pieces, they campaigned at school and Vega notes that it was also a good way to improve their speaking skills and overcome their fear of public speaking, in preparation for the Solve for Tomorrow Grand Final.

Everyone in search of gender equality in STEM

The teacher chose to mediate a team of girls only. “I am a father of two daughters and this career has the particularity of having more men. I see few girls linked to STEM and I try to work so that they see this path as a possibility too,” he says.

Vega is proud to accompany the group’s potential development and now, with the result, the teacher assesses that more and more, when students (boys or girls) from school come to represent their country at an international level, it serves as inspiration for others. “This creates a lot of impact and a great expectation for the other students to see that they can achieve it too,” he concludes.

Advice for teachers!

Teacher Yamil Vega, the project’s facilitator, is an engineer in Industrial Electronics. He had already won in the 2022 edition and took advantage of the experience as well. “I think that that one difference at the time was not only making a functional prototype, but doing a proof of concept,” he says. Therefore, as a piece of advice for those who are interested in participating, the educator stresses the importance of testing with potential users, as they also did in “Apyphore”. Vega also suggests studying previous editions to learn from the winners of other years and create their own strategies.

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Focus on practice!

Take a look at the teacher's guide on how to create a smart beehive with students.

1 Empathy

The teens started their project by researching beekeeping and the importance of bees in the world. They learned that traditional methods of extracting apitoxin cause stress in bees and affect the health of the hives. Thus, they sought to develop something that could improve their quality of life and well-being.

2 Definition

The first idea was to create a kind of "hotel for bees". Through research and consultation with beekeepers, they defined the need for a system that would allow them to monitor hives efficiently and extract apitoxin without causing harm, focusing on sustainability and bee conservation

3 Ideation

The young women developed ideas to solve the identified problems. They created the concept of "Apyphore", a hive equipped with sensors and cameras for constant monitoring of bees. They devised a method of extracting apitoxin using electrostatic discharges, which allows automated and less invasive extraction, integrating technology that facilitates remote management by beekeepers.

4 Prototype

The students designed a prototype of “Apyphore” based on different sizes of hives to suit the needs of beekeepers. They commissioned a home-made cameraman to make the housing and added electronic components such as sensors and cameras. The prototype included a computer vision system and a wireless camera that transmitted data in real time, combining traditional beekeeping elements with modern technology.

5 Testing

During testing, the team encountered difficulties integrating the software with the prototype hardware. They reviewed over 800 lines of code to identify and correct errors, segmenting the programming to improve its performance. They made adjustments that allowed the vision system and data transmission to operate correctly. In addition, they conducted a survey with beekeepers to assess the potential market, validating the economic viability of the project and preparing its launch.