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INSPIRING PRACTICE | WINNER 2024 | BOLÍVIA

#ENVIRONMENT

Students design and build a biodigester that converts waste into biogas, irrigation water, and fertilizer

The diversity of the student group, with its distinct skills and personalities, contributed to the success in overcoming frustrations and persevering in the creation of the prototype.

TEACHER
Liliam Rocio Coronel Botello

STUDENTS
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COMMUNITY/CITY
Apaña/La Paz

SCHOOL
Catholic University of La Paz

PROJECT NAME
Biotransformers

STEM AREAS
Technology, Science, Engineering

OTHERS AREAS OF KNOWLEDGE
Environmental Education, Chemistry

Diversity is a value that can make the difference when it comes to creating creative solutions to collective problems. Young students with diverse personalities came together to address the issue of gas shortages in the Apaña community in La Paz, Bolivia. In this sense, they proposed the creation of a biodigester that transforms organic waste from plantations and livestock into biogas, irrigation water, and fertilizer, generating sustainable resources and avoiding waste.

The biodigester from the Biotransformadores team, winner of the Solve for Tomorrow 2024 Bolivia, was mediated by teacher Liliam Rocio Coronel Botello at the Reverendo Padre Walter Strub Educational Unit (UE). She issued an open call to create a STEM (Science, Technology, Engineering, and Mathematics) project with secondary education students, aged 14 and 15, which in Bolivia has a humanistic and technical focus. She was surprised when three young people, who weren't very active in her classes, agreed to participate.

They were students with some learning difficulties and who didn't find much space for expression, but needing just an opportunity to showcase their diverse skills. "I think that (the project) has been a catalyst for them to truly understand the importance of knowledge and study" Coronel reports.

The group was made up of young people with distinct personalities: shy, outgoing, cheerful,

dreamy, and resilient. They were united by their desire to work in STEM for the first time, using the fundamentals of science to solve a problem directly affecting the communities where they lived.

Using a project-based learning methodology, the mentor teacher and the team chose their topic based on news reports announcing the decrease of oil and gas deposits in the country, causing rationing in the communities where students lived. The group also shared the idea of researching garbage as a raw material for biogas production. Thus, the idea of creating a biodigester made of simple and inexpensive materials was born.

The team tested various materials to build the ideal biodigester prototype.

There are many ways to build a biodigester: it generally consists of a container, such as a drum or water tank, where the hermetically sealed waste undergoes a decomposition process. One pipe carries the biogas. Another pipe holds the sticky, dark liquid, which is often used as fertilizer or irrigation water. The magic inside the container is done by anaerobic bacteria, microorganisms that are capable of surviving and multiplying in oxygen-free environments.

A biodigester made from waste, creativity, and mistakes

The team began extensive bibliographic research to build the biodigester prototype. The girls were responsible for theoretical research, such as ideal types of bacteria and waste. The boy in the group was responsible for researching the ideal materials to assemble the biodigester. Since the team had a lot of schoolwork during the day, they met in the evening via virtual meetings to present their findings.

It was within this small but determined group that the opportunity to collect waste also arose. One of the students lives in Apaña, a rural community near La Paz, and discovered that there was a large amount of waste from crops, cattle, and pigs. She also explained that the neighborhood already suffered from lack of gas deposits, and that the trucks doing delivery came only once a month.

With the territory and raw materials chosen, it was time to begin assembling the first prototype. “We don’t need to introduce any additional substances, just the remains of organic waste. It’s not just any garbage, and you can’t use eggshells, bones, or onion peels, for example, in organic waste, because they can kill the bacteria working inside the biodigester. And that’s the project. It’s that simple,” explains Coronel.

But building a functioning biodigester wasn’t easy. In the first prototype, built with a small plastic tank, the seal wasn’t complete, and the rotten waste gave off a foul odor. In the second attempt, a drum was chosen, but it had only one outlet on the original lid, which made the construction of the pipes complex. The prototype also didn’t work as the students hoped.

The team’s story was filled with frustration, but the professor encouraged them to continue their research and not to give up on the project. When the problem seemed hopeless and one of the students was considering giving up, the opportunity came to present the biodigester to the Chemistry Department at the Catholic University of La Paz.

With the help of an engineer, the third prototype was made from a drum with a larger lid to accommodate the taps and outlets. The third prototype was a success achieved through learning and error.

Eureka Moment!

Sometimes all what a project needs is an outside perspective, from knowledgeable people who can listen and support the students. When the Biotransformers team spoke with a chemical engineer from the Catholic University of La Paz, the prototype’s horizons expanded. Together, they came up with the idea of making a more robust prototype, with more space for the necessary pipes and seals.

A biotransformation in the students themselves

“Against all odds, we continued,” recalls the mediator teacher. After mistakes, unpleasant surprises, and near-abandonment, the prototype was the winner of Solve for Tomorrow Bolivia 2024. The change in the students was impressive. “This has helped them mature a lot, and that’s what makes me happy. One of the students, for example, had a health problem and a lot of

shyness. Now the student's different, talkative with their classmates and always smiling".

The school community supported the Biotransformers team's work and even promoted healthy competition between them and a physics team that also participated in the Solve for Tomorrow program. "When we arrived at school with our prizes, the television we won for the unit, all the students were waiting for us," Coronel recalls.

Winning Solve For Tomorrow Bolivia changed the lives of the three students. Their grades improved, and they felt more motivated to take part in extracurricular activities.

The internal changes were extraordinary. The three students improved their grades in virtually every subject, showed more interest in class, and were eager to participate in other extracurricular activities. The team's determination inspired other students to begin STEM projects to solve problems affecting their communities. "We gained experience, we gained knowledge. We gained a lot from the project. Even better if we encouraged the students. Working with young people is a beautiful experience," Coronel concludes.

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Advice for teachers!

The Coronel's advice to teachers who want to start a project-based learning project is to use humor and fun as tools to encourage students not to give up in the face of mistakes and frustrations, which are a fundamental part of a project. To achieve this, creating an amicable, student-friendly environment is the best way to do it.

Focus on practice!

Take a look at the teacher's guide on how to develop a biodigester that converts waste into biogas, irrigation water, and fertilizer.

1 Empathy

The mentor teacher and the team chose their topic based on news reports announcing rationing of oil and gas in the country. The group also shared the idea of researching garbage as a raw material for biogas production. Empathy also emerged when choosing the location for the waste collection: a student from Apaña, a community far from the school which was already suffering with the gas rationing, shared that in her neighborhood there was a large amount of waste from crops, cattle, and pigs manure available.

2 Definition

After the idea of creating a biodigester made from simple and inexpensive materials was born, the team began extensive bibliographic research to build the biodigester prototype. The girls were responsible for theoretical research, such as ideal types of bacteria and waste. The only boy in the group was responsible for researching the ideal materials for assembling the biodigester.

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3 Ideation

There are many ways to build a biodigester: it can be done with large or small containers, such as drums, and various types of pipes. The most important thing is that the waste is hermetically sealed so that the anaerobic bacteria can work. The students initially considered building a long biodigester, but realized that a smaller prototype would cost less and allow for more testing.

4 Prototype

In the first prototype, built with a small plastic tank, the seal was not complete, and the rotten waste gave off a foul odor. In the second attempt, a drum was chosen, but with only one outlet on the original lid, which made the piping complex. The third prototype, the final and functioning one, was built with the help of an engineer from the Catholic University of La Paz, using a drum with a larger lid to accommodate the taps and outlets.

5 Testing

The first tests produced a lot of fermentation and little gas, as well as a foul odor that made the work difficult. They experimented with switching cow dung for pig dung, which contains more nitrogen. The students persevered, intending to light a stove with the gas. In the final tests, they inflated a balloon and finally managed to light the flame. It was an exciting moment when they held the match close, and the flame ignited!