

# How can community engagement projects empower STEM students?

In cities around the world, air pollution poses a major risk both to the environment and to human health. This has severe consequences for many people, particularly those in underserved and minority communities. At **Xavier University of Louisiana, USA**, **Associate Professor Morewell Gasseller** leads a community-oriented STEM education project that aims to address air pollution in New Orleans while giving students the skills they need for successful careers in STEM.



**Associate Professor  
Morewell Gasseller**

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## Fields of research

Environmental Physics, STEM Education

## Research project

Developing a STEM education programme that gives undergraduate students vital skills and empowers local communities to tackle environmental problems

## Funder

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## TALK LIKE AN ...

## ENVIRONMENTAL PHYSICIST

**Arduino** — a small, simple computer that is simplified to a single board and commonly used for teaching purposes

**Desiccant** — a substance that absorbs moisture, leaving the surrounding area dry

**Environmental injustice** — the differences in how groups of people are affected by environmental issues. Underserved or minority groups

tend to be at greater risk from many environmental problems, such as air pollution

**Particulate matter (PM)** — tiny solid particles or liquid droplets in the atmosphere

**STEM** — science, technology, engineering and mathematics

In 2016, a young entrepreneur from the UK made headlines by selling jars of fresh, countryside air. Customers could choose from the 'naturally filtered and unblemished' air of Somerset, the 'pure and splendid' air of Yorkshire, or the 'vibrant and flavoursome' air of South Wales. The scheme was surprisingly successful and the company, Aethaer, is still active today, selling most of its products to East Asian countries such as China and South Korea.

Although this may sound like a practical joke, Aethaer's success is based on a serious issue. In many Chinese cities, air pollution poses a real threat to human health. In fact, according to the World Health Organization, air pollution in China is responsible for around 2 million deaths every year. It is no surprise, then, that some people are willing to pay up to £80 for a single jar of fresh air.

Unfortunately, there is no evidence to suggest these jars of air have any health benefits. And even if they did, most people cannot afford to spend their hard-earned money on a few breaths of clean air. That is why Aethaer reinvests all its profits into anti-pollution initiatives such as anti-pollution face masks and an air quality monitoring app.

Monitoring air quality is a vital step in the process of reducing air pollution. It is important to identify areas of low air quality so that measures can be put in place to reduce pollution. ECOSTEM is one such air quality monitoring scheme, run by Associate Professor Morewell Gasseller, an environmental physicist at Xavier University of Louisiana, alongside Dr David Brooks and Dr Timothy Glaude. Undergraduate students taking part in ECOSTEM learn how to build and deploy sensors that monitor air pollution. They use the data from these sensors to conduct their own

research projects to investigate air quality in New Orleans, and they work closely with high schools to deploy the sensors around their local community.

Through ECOSTEM, Morewell, David and Timothy help students develop important practical skills and help the local community learn about, and protect themselves from, the dangers of air pollution and particulate matter.

## What is particulate matter?

Particulate matter refers to any solid particles or liquid droplets in the air. "Some particles, such as dust, dirt or smoke, are large enough to be seen with the naked eye when they become concentrated," says Morewell. Other particles are so tiny that they can only be detected using specialist equipment such as electron microscopes.





Particulate matter is categorised according to the size of the particles. “PM10 refers to particles smaller than 10 micrometres,” explains Morewell, “while PM2.5 refers to particles smaller than 2.5 micrometres.” A micrometre is a thousand times smaller than a millimetre, so these particles can be inhaled by a person without them noticing.

“Any type of burning or dust-generating activities produces particulate matter,” explains Morewell. “This includes traffic, construction and agriculture.” Particulate matter poses serious health risks, especially in cities where these microscopic particles accumulate.

### Why is air quality an issue for communities around Xavier University?

Xavier University is located in the heart of New Orleans, Louisiana’s most populated city. Many underserved and minority communities in Louisiana are disproportionately affected by environmental issues. This is known as environmental injustice and is a pressing issue in New Orleans. “Of the many environmental injustices facing underserved and minority communities around Xavier, air quality is at the top of the list of significant problems,” says Morewell.

The health risks posed by air pollution are numerous. Scientific studies have linked particulate matter to a variety of health problems, primarily affecting the lungs and heart, including asthma, breathing difficulties, irregular heartbeat and premature death for people with heart or lung disease.

### What do ECOSTEM students do?

ECOSTEM students build particulate matter sensors based on a prototype Arduino (an open-source hardware and software electronics platform) system designed by David. Through this process, students learn practical skills in electronics, such as soldering circuits, and in computing, such as programming the Arduino system for environmental monitoring.

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They also learn how to identify and evaluate sources of particulates and the importance of environmental monitoring for addressing health issues, and they develop problem-solving skills as they overcome practical challenges. For example, the humid environment of New Orleans caused some of the electronics to fail, so students added desiccants to the sensors to keep them dry. These hard and soft skills set ECOSTEM students up for future careers in STEM.

Once built, ECOSTEM students deploy their particulate matter sensors around New Orleans, including across the Xavier University campus and at local high schools. Timothy coordinates the high school involvement in ECOSTEM, in which high school teachers participate in training workshops to learn how to incorporate the air quality data into their classes. ECOSTEM students visit local schools to teach high school students how to use the particulate matter sensors to monitor the air quality in their neighbourhood. Not only does this increase community awareness of air pollution, but it also enables younger students to

get involved in locally relevant, practical science projects. Morewell hopes these experiences will inspire young people to pursue careers in STEM and empower them to address the issues that impact their community.

ECOSTEM students also conduct research projects by analysing the data collected from their air quality monitoring network. This includes investigating the spatial and temporal variations in particulate matter around the Xavier campus and across New Orleans. These data show that air quality can vary dramatically, even between places that are only a few miles apart. “This is the main reason that we advocate for a high density of these sensors to be deployed in the Greater New Orleans area,” explains Morewell. The more sensors there are, the more understanding and awareness residents will have about how their neighbourhoods are affected by air pollution. This is particularly important for low-income and environmentally at-risk communities.

### The importance of ECOSTEM

Xavier University is committed to supporting a more just and humane society. The ECOSTEM project is an extension of this commitment that uses education and research to serve its local community. “By focusing on community environmental issues, ECOSTEM provides the motivation that is essential to increase undergraduate participation in STEM fields,” says Morewell.

Empowering students to pursue careers in STEM will be key to solving many of the world’s problems, including air pollution. But community engagement is just as important as scientific research. At the heart of the ECOSTEM project is the aspiration to give young people the skills and opportunities they need to take science into their own hands and protect their own communities.



# ABOUT STEM EDUCATION

**F**or many students, STEM subjects can be a challenge. Even on a good day, the intricacies of particle physics and inorganic chemistry can be difficult to grasp. But science, technology, engineering and mathematics are key to understanding the world around us and to addressing the problems we face, so it is important to inspire the next generation of socially engaged STEM students.

If you have a passion for a particular STEM subject, the chances are that you had a teacher who inspired you. This is the art of STEM education – transforming complex theories and concepts into experiences that students not only understand, but also enjoy.

## Why are practical, community-oriented STEM projects important?

“ECOSTEM gives high school teachers the opportunity to infuse their lessons with data collection from real-world scenarios that affect the communities where their students live,” says Timothy. Providing students with learning experiences that are relevant to their lives and their communities makes learning more meaningful. Most people find it easier to retain new information if it is given context, especially if that context is something they can relate to on a personal level. “It is always exciting to see the passion in students when they believe they are working on a project that actually matters,” says Morewell.

This is the key aspect of ECOSTEM. It teaches its students about electronics, environmental physics and social health issues in the context of their local communities. Research has shown that involvement in such projects not only increases student engagement but can encourage students to consider STEM-related careers.

## Why is STEM education important?

“STEM education is a gateway for creating critical thinkers and it plants the seeds for the next generation of innovators,” explains Morewell. Students learn how to solve problems and how to apply their skills and knowledge to new situations. “I want to impart this education to our children for the future of all humankind,” he says.

## Meet Morewell

**Growing up in Zimbabwe, my favourite subject was history.** At first, I wanted to know about Zimbabwean history but, when I went to secondary school, I started learning about world history, and I loved the subject even more!

**I wanted to study physics and chemistry, but I was very bad at maths** and I realised maths is key to understanding physics and chemistry. So, a fellow student coached me in maths, and I started doing well in both physics and chemistry. Eventually, I won a prize as the top physics student, which was a big surprise to me and all my friends!

**Initially, I studied general science at the University of Zimbabwe**, before focusing on physics, then doing a master’s in applied physics. I moved to the US to do my PhD in experimental condensed matter physics. I used scanning probe techniques to study nanoscale systems and structures. After several short teaching positions at two universities in the US, I landed my dream teaching job at Xavier University of Louisiana.

**I have always believed that research programmes should provide opportunities for undergraduates to make contributions to society.** While teaching an Earth science class, I saw the opportunity to link my research with what I was teaching my students. This started my focus on applied environmental physics research. I am motivated by the fact that what I am doing matters to the community I live in and appeals to the students I serve.

**Until a few years ago, I was an experimental condensed matter physicist to the core.** I wanted to discover things that had not been discovered before. However, I gravitated towards applied physics, such as environmental

physics, and I have since found that to be very rewarding. I can research things that benefit the community right now.

**I am a member of the GLOBE Program** (Global Learning and Observations to Benefit the Environment), an international science and education initiative that provides students worldwide with the opportunity to participate in environmental data collection. I help the GLOBE team design air quality monitoring protocols and I mentor high school students around the world (e.g., Saudi Arabia, Oman, Czech Republic, Argentina and Thailand) as they conduct environmental science research projects.

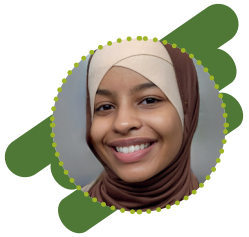
**In my free time I love to play tennis.** I also enjoy watching TV shows with my wife, Pauline, and playing chess and mind games with my two boys, Takudzwa and Anashe.

**“I AM MOTIVATED BY THE FACT THAT WHAT I AM DOING MATTERS TO THE COMMUNITY I LIVE IN.”**

## Morewell’s top tips

1. Be curious about the world around you.
2. Figure out what you’re really passionate about.
3. Persevere and don’t give up.

# Meet some ECOSTEM students



**Ranaar**  
*Hashi*

I enjoyed the hands-on learning approach in **ECOSTEM**, which allowed me, a kinaesthetic learner, to explore environmental issues in an engaging way. Learning about environmental issues while working with community members allowed me to develop a deeper appreciation for the world and a feeling that I have positively impacted my community.

**ECOSTEM helped me gain skills** that are necessary for many STEM-related fields, such as problem-solving, critical thinking, data analysis and scientific inquiry. I hope to work in a STEM-related field, so ECOSTEM has opened a variety of opportunities for me.



**Jade**  
*Ravare*

**ECOSTEM gave me a head start on learning skills** such as programming, conducting research and working with a research group. As a public health student, my research focuses on respiratory issues, specifically asthma and how PM2.5 affects the New Orleans community.

**ECOSTEM has given me amazing opportunities.** Public health is such a broad field, so being able to gain experience this early in my educational career is fantastic. I also never thought I would have the opportunity to be a mentor to high school students and to be engaged in the New Orleans community.

I hope to pursue a master's degree in **environmental science and policy**, where I can make a positive change to the world.



**Hiba**  
*Abdelazizz*

During **ECOSTEM**, I enjoyed building the **particulate matter sensors**. I especially liked learning how to use Arduinos and gaining practical skills in soldering the circuit components together.

After graduating, I plan to study for a master's degree in **mechanical engineering**. I then hope to work for NASA or Microsoft.



**Ghefua**  
*Yembu*

Participating in **ECOSTEM** has enriched my **awareness of the environment** and of the factors affecting it. I really enjoyed presenting the research data at workshops and the festival of scholars.

I **aspire to become a data scientist**. I hope to make data more relevant for and easily understood by those who need it, by using different analytical tools and methods.

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**Dr Morewell Gasseller**

