Data and Sensing:
A curriculum for understanding air quality data and sensing technology

Edited and Compiled by Evelyn Roman-Lazen and Kendra Krueger
May 2023

Contributing authors include all of our co-teachers, students and community interns who participated in our train-the-trainer program during which they develop training documents and workshop materials: Dr Ricardo Toledo-Crow (ASRC), Amalia Torres (Queens College), Carolyn Ferguson (Red Hook Initiative), Eden Chan (City College), Hannah Grunfeld (City College), Marisa Prefer (Pioneer Works), Angileena Mathura (City College), Sm Nihal (City College), Mikaela Charalambous (Queens College), Fadimatou Mossi (City Tech), Jonathan Zou (John Jay), Luisanny Marinez (City College), Sophia Jao (Barnard), Jaquawn Miller (City Tech), Jason Clarke (Queens College), Jaien Abtahy (BMCC), Knowledge Westbrook (RHI), Nelly Burgos (RHI)

The following is a summary and overview of our curriculum materials. Activities and lesson plans will be available starting June 30th by registering with our online community

About the Community Sensor Lab

The Community Sensor Lab (C-SensLab) at the Advanced Science Research Center of the CUNY Graduate Center is taking action to address environmental health risks and promote community empowerment. By launching an innovative training initiative, the lab provides accessible and affordable environmental sensing devices to young people, educators, and community members. Through these DIY monitors, trainees can collect and analyze air quality data in their neighborhoods and use the information to raise awareness about environmental health risks. By advocating for pollution reduction measures, community members can help safeguard their health, protect local ecosystems, and reduce the impact of climate change. Moreover, this initiative will enable communities to seek funding to address environmental justice issues, creating a more sustainable and equitable future for all. Overall, this initiative can help build resilient communities and promote environmental justice.

The Community Sensing Lab's program aligns with the Advanced Science Research Center's broader mission to promote interdisciplinary scientific research in various fields, including Environmental Science, Nanoscience, Neuroscience, Photonics, and Structural Biology.

Through the C-SensLab, the ASRC aims to foster community engagement and share scientific knowledge and technology with various stakeholders, including schools, community-based organizations, and underrepresented undergraduate and graduate students. This project also aims to provide underrepresented undergraduate and graduate students with opportunities to gain experience in community-based learning. By providing experiential learning opportunities, the C-SensLab hopes to create pathways for students to pursue academic or industry careers in science and enhance their science training. By sharing scientific knowledge, the ASRC hopes to promote environmental justice and stewardship while advancing scientific research.

The C-SensLab Training Program

The C-SensLab training program is a 6-week train-the-trainer program based at CUNY's Advanced Science Research Center in Harlem, NY. Through building low-cost, arduino-based sensors, trainees can gain hands-on experience and learn about the scientific principles behind environmental air quality parameters and the air monitor itself. In doing so, participants can gain an understanding of the air quality conditions in their communities. By imparting foundational knowledge, the C-SenseLab initiative aims to equip participants with a thorough understanding of air quality issues and the tools to address them. Participants will also learn how to use open-source data analysis tools to graph and lend interpretation to the data as they identify patterns and trends. This approach provides a unique opportunity to understand the connections between human activities and their impact on the environment and how environmental data can inform decision-making and advocacy efforts. By promoting environmental literacy and empowering community members, the C-SensLab is making significant strides toward promoting a sustainable and equitable future.

The lab aims to demystify environmental science and improve science literacy through experiential and interdisciplinary learning modalities while promoting environmental justice and stewardship. By engaging in a bidirectional exchange of knowledge, the C-SensLab and its community partners will co-create strategies and resources for collecting, sharing, and understanding environmental data at a grassroots level. This collaborative approach to environmental data literacy will lead to a more informed and empowered citizenry capable of advocating for environmental justice.

The Curriculum

As environmental monitoring has become more ubiquitous and local governments have taken on initiatives to collect more hyper-local data, there has become a greater request from community members to be equipped to understand and engage with all this newly collected data. The development of this curriculum seeks to provide an entry-level of literacy and comfort with terminology and techniques for interpreting essential information from various forms of raw or processed data.

The overarching goal of the curriculum is to introduce non-expert-citizens, including young people, educators, and community members with limited science backgrounds, to how to engage in environmental data science and gain awareness of digital sensing technology.

The curriculum includes discussion prompts, activities, and a library of data resources.

Critical skills in this curriculum include:

- What is Air Quality & Connections to Climate Change
- What is good versus bad air quality
- Accessible online air quality datasets & live measurements
- Tools for measuring air quality
- How to build an Arduino-based air quality sensor
- The physics of how sensors work
- How to use Google spreadsheets for basic graphing & analysis of self-collected data
- How to tell a story and present data

Air quality monitoring is vital for protecting public health and the ecosystems all living organisms depend on. As part of the training, participants will learn basic science concepts and principles behind how the technology works and the effects of air pollution on health, ecosystems, and the environment. The opportunity to learn how to plot data in geographic mapping open source tools will also be available.

Curriculum Goals

Participants with have the opportunity to:

1. Increase data literacy skills in order to understand both environmental and data sets in general for the purpose of engaging in public discourse. This literacy can assist in

engaging policymakers and community stakeholders to promote sustainable and equitable solutions to environmental and social challenges.

2. Learn about the Community Sensor Lab (C-SensLab) and its training initiative: Participants will learn about the C-SensLab, its mission, and its training initiative to empower young people, educators, and community members with accessible and affordable environmental sensing devices.

3. Build and use low-cost environmental sensing devices: Participants will learn how to build and use low-cost environmental sensing devices, such as air quality monitors, to collect and analyze data in their neighborhoods. They will also learn to use open-source data analysis tools to make sense of the data they collect.

4. Understand the impact of air pollution on human health and the environment: Participants will explore the ways in which air pollution can negatively impact human health and the environment, including its role in climate change. They will also learn how to use the data they collect to raise awareness about environmental health risks in their communities.

Audience

The C-SensLab Air Quality Monitoring Curriculum is highly versatile and adaptable to various audiences, including high school students, educators, and adults with limited science education exposure. The activities in each module can easily be scaled down or up to accommodate younger or more mature audiences, making the curriculum suitable for a wide range of learners. By offering the curriculum online, it can reach a broader audience and increase accessibility for more people to participate and learn. The modular design of the curriculum also allows for flexibility in its implementation, as each module can be used individually or sequentially to enhance courses, community-based programs, elective courses, after-school programs, or clubs.

How The Curriculum Works

The C-SensLab's air monitoring curriculum is designed as a workshop to encourage interaction between presenters and participants. The activities are designed to be hands-on, allowing participants to build, experiment with and use equipment themselves. The curriculum aims to teach science concepts and principles related to environmental science and monitoring through guided discovery, experimentation, and observation. The curriculum is accompanied by instructional resources, including reading materials, relevant websites, articles, and multimedia resources to facilitate learning.

The curricula activities are designed to help promote Socratic discussions and stimulate critical thinking that will help reinforce a problem-solving mindset. Problem-solving and troubleshooting are also essential components that the success of the equipment deployment and data collection depend on. During the workshop sessions, participants will be presented with different common scenarios that will help them recognize technical and non-technical situations that will require using logical and systems thinking. There will be ample opportunity to develop and practice these skills during the sessions.

This curriculum has been co-created and field tested by Community Sensor Lab interns, who include CUNY undergraduate students and community members from Red Hook Initiative. Part of our training requires interns to build documentation for our sensor technology and prepare lessons for new students or public programs. In this way, our curriculum and training materials are generated for the people and by the people of our local community.

Course Content

The C-SenseLab's air monitoring curriculum is organized into four modules that provide a comprehensive overview of the subject matter.

Module I: Environmental Data Literacy
> Objective: Impart foundational knowledge of environmental science and the importance of monitoring air quality in the participants' communities.

Module II: DIY Environmental Air Monitoring Tools
> Objective: Teache participants how to build and use their monitoring devices, providing hands-on experience with the equipment.

Module IV: Story Telling with Data
> Objective: Focus on data analysis and interpretation, emphasizing the importance of effectively communicating findings to the public.

Module V: Environmental Justice Case Studies
> Objective: Contextualizes the importance of air quality monitoring within broader social and policy-making frameworks.

Each module uses visually appealing slides, including presenter notes with concise instructions and tips. Written instructions and handouts for participants are also provided,

along with relevant articles, reports, and audiovisual materials that enrich the learning experience.

The flexibility of the C-SenseLab curriculum modules is a key feature, as users can choose to use the modules in various ways. The modules can be used sequentially in any order that suits the user's objectives and approach. Alternatively, each module can be used independently to complement an existing course, program, or curriculum. This adaptability allows users to customize their use of the curriculum to fit their specific needs and circumstances. The ease of implementation and customization makes this curriculum an accessible and valuable tool for educators, community leaders, and anyone interested in learning more about environmental monitoring and advocacy.

How to Approach Curriculum Components

The Environmental Air Quality Monitoring Curriculum from C-Sense Lab is organized into different units, each with an online outline and a corresponding file containing lecture slides, data-related activities, and case studies.

The curriculum can be used independently, sequentially, or in any order, depending on the facilitator's preference in introducing the topic. The DIY air monitor circuit building module contains easy-to-follow slides and short videos demonstrating how to assemble and use the equipment. The lecture slides are designed to help demystify the content and enhance understanding of the interdisciplinary science and engineering concepts.

The data analysis module teaches participants how to use data analysis and graphing tools to analyze and represent air quality data. In addition to analyzing and graphing data collected with their air monitors, they will be exposed to air quality data scientists use to study air quality phenomena. The data tools include step-by-step instructions on accessing and processing data, including statistical analysis, to render the data useful. The case studies module introduces the impact of air pollution on people and ecosystems.

The curriculum's teaching tools and related information are sequentially arranged in the slides' note section. To prevent issues with access and streaming, downloaded videos are included. Additionally, links to all pertinent images and downloaded documents are available in the note sections if required.