

Contributing to the Soil Science Lab Citizen Science Project



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Host Organization: Berkeley Lab

ETP Type: *Classroom*

Subject/Grade: 9th Grade Biology

Abstract

This two-week long mini-unit focuses on students completing an investigation and contributing their findings to Soil Science Lab, a citizen science project. Students will collect soil samples from around their school and community, learn how to use foldscopes, complete nematode isolation, upload their data to the Soil Science Lab and pictures to Foldscope, and analyze both their data and data from the Soil Science Lab community. Their summative task will be a science poster and presentation.

Focal Practices & Supporting Content

SEP:

Asking Questions
Planning and Carrying Out Investigations
Analyzing and Interpreting Data
Obtaining, Evaluating, and Communicating Information

CCC:

Patterns

CCSS

CCSS.ELA-LITERACY.RST.9-10.3 - Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

CCSS.ELA-LITERACY.SL.9-10.4 - Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

DCI:

LS2: Ecosystems - Interactions, energy and dynamics

- Interdependent relationships in ecosystems
- Ecosystem dynamics, functioning, and resilience

21st Century/Durable Skills and Applications

- Communication and Collaboration
- Flexibility and Adaptability

Measurable Objective(s)

- Explain what nematodes are and why they are an important part of ecosystems.
- Follow a scientific protocol successfully
- Use Foldscopes for data collection
- Upload and analyze data from the soil science lab citizen science project
- Create and present a science poster summarizing their findings.

Formative Assessment(s)

Day 1: Citizen science reading reflection questions (slide 5)
Day 2: Soil Science Lab nematodes and soil science reading reflection questions (slide 11)
Day 3: [Foldscope model practice sheet](#)
Day 4: Carry out nematode extraction
Day 5: [Upload data to soil science lab](#) and [class data form](#)

Summative Assessment(s)

Days 6-7: Science poster
Day 8: Final poster and presentation

Fellowship Description

The K-12 STEM Education and Outreach Program is part of the Government and Community Relations Office at Berkeley Lab. The high school educational programs offered include the Berkeley Lab Director's Apprenticeship Program (BLDAP), Experiences in Research (EinR), the Science Accelerating Girls' Engagement (SAGE) program, Science en Acción (SEA), and QCAMP, a week-long program for teachers. Each program has a different focus of activities for participants. The overarching goal for each of these programs is to provide meaningful learning experiences to their participants, and for students, to encourage pursuit of STEM majors and careers. The main program I was part of was BLDAP and I also supported SAGE. During SAGE camp, I worked as a SAGE guide and co-led professional growth workshops and supported field trips and tours for student participants.

The BLDAP program is a six-week paid internship for high school students. During this time, students learn how to code in Python, use 3D printers, conduct investigations in the wet lab using plants to understand how nitrogen impacts growth of grass plants, and learn how to isolate novel bacteriophages from environmental samples they collect. At the end of the program students complete a science poster and presentation where they highlight specific projects they completed and skills they built on from this experience.

I assisted in the wet lab with two different projects, EcoFAB and BRaVE Phage. I helped develop slides and a digital science notebook. Common skills I practiced in both were collaboration, leadership, organization, adaptability, and communication so programming went smoothly for participants. So far I have helped with the setting up of the new wet lab space, supported with orientation, met with researchers on both the EcoFAB team and BRaVE phage teams, and began planning student-facing documents for the BRaVE phage project since it is a new addition to the program this year.

Some careers related to this program included Research Scientists, Project Scientists, Staff Scientists, Instructional and Content Managers, Special Programs and Volunteer Manager, K-12 Programs Manager, Educational Program Administrator, and Student Assistants. Many different fields of expertise were needed to make sure programming ran smoothly for participants and volunteers.

Fellowship Connection to School/Classroom

I hope to use what I've learned at Berkeley Lab to support students in my 9th grade biology class with conducting their own investigations by creating a two-week long mini unit that will be completed at the beginning of the school year.

Students will practice working in collaborative groups to collect and analyze data, contribute their findings to a citizen science project, and complete a science poster and presentation. I hope that this unit supports students in building their confidence in science.

This unit will pull from learnings at Berkeley Lab such as collaboration, maintaining an organized and structured lab notebook, and sharing findings with others.

The mini unit will start with an introduction to the project. The next day students will go on a campus walk where they will collect soil samples at various locations they choose. Students will gather samples

in plastic bags, label their samples with the location (latitude and longitude), date, time, the current temperature and humidity that day, and add their samples to a class map of the campus. The teacher will store their samples until the nematode extraction.

The next day of the unit will focus on select readings that will explain what nematodes are and why they are important for research. Students will complete short reading reflection questions. Students will then get practice with foldscopes in class using prepared slides and demonstrate proper use by creating three models of their specimens to show they can use the field view, phone to take a picture, and projection view. Afterwards students will go collect samples to practice using the foldscope outside. We will save samples from outside and during the next class learn how to create wet mounts. The next day we will create slides to use in both a compound microscope and the foldscopes and compare strengths and drawbacks of both.

Students will then carry out the nematode extraction in class and identify soil type and pH for their sample. Since this will take at least 24 hours to complete after filtering soil, the next class will focus on another set of readings and review questions.

After the extraction is complete we will look at our samples under the foldscope and compound microscopes. Students will upload their images to the Soil Science Lab site using a teacher-created account or with their own created account. The teacher will download data from the Soil Science Lab into a google sheet and the class will analyze the data to look for patterns.

Once all of this is complete, students will learn how to create a science poster. The teacher will review how to create a question they wish to explore using the data, complete additional research for their question, create their posters, and complete a presentation of their work.

Instructional Plan

Contributing to Citizen Science - Nematodes and Foldscopes

WEEK 1	Intro Project	Campus Walk Soil Sample Collection	Foldscopes Practice Soil ID Day 1	Soil ID Day 2 Nematode Extraction Day 1
WEEK 2	Nematode Extraction Day 2 Citizen Science Data Upload	Poster Prep Day 1	Poster Prep Day 2 Peer feedback	Presentations

Day 1 (50 MINS)

Objective(s):

1. Understand how citizen science contributes to the scientific community
2. Sign up for a Soil Science Lab participant ID
3. Consider the work of a soil scientist

Materials Needed: [Slides](#) (1-6 of slide deck), National Geographic [citizen science reading](#), internet, chromebooks

Timing

Student/Teacher Activities:

3 Mins

Do Now

In the first page of their notebooks, students will answer the question "what do you think citizen science is?"

		Teacher will chart responses on the board then explain citizen science. Teacher will explain that citizen science is research conducted with participation from the general public to increase scientific knowledge. It is used in a wide variety of research areas such as ecology, biology, conservation, health and medical research, astronomy, media and communications, and information science.
20 Mins	Intro Project	Teacher will introduce students to the Soil Science Lab citizen science project. The teacher will tell students they will be working in groups of three to contribute data to the Soil Science Lab. Students will create an account to get a participant ID and be able to contribute findings later in the unit. - NOTE: Although only 1 group needs an ID, it may be helpful to have each student sign up and have one just in case a group member is absent.
25 Mins	Readings	Teacher will ask students to read and discuss the National Geographic article as a table group and answer reflection questions in their notebooks: 1. What role does collaboration play in citizen science, according to the article? How do scientists and community-based groups work together to advance scientific understanding? 2. Choose one specific citizen science project mentioned in the article (e.g., Project BudBurst, BioBlitz, NestWatch). Describe its goals, methods, and outcomes. How does this project contribute to scientific knowledge and community engagement? 3. Explain the significance of technology in facilitating citizen science projects. How have advancements like smartphones and online platforms transformed data collection and participation? 4. Imagine you are a participant in a citizen science project. How would you contribute effectively to the project's goals? What skills, knowledge, or resources would you need to maximize your impact as a citizen scientist?
5 Mins	Exit Ticket	Students will check their email for a message from Soil Science Lab. Teacher will ask students to record participant IDs in a Google sheet

Day 2 (50 MINS)

Objective(s):

1. Collect soil samples, location, weather conditions, humidity, date, time, and air pollution levels on campus walk.
2. Understand the connection between soil science and studying nematodes.

Materials Needed: [Slides](#) (7-12 of slide deck), Soil Science Lab [Nematode and Soil Science Reading](#), internet, chromebooks, Map of campus, plastic bags, Small trowel, Cell Phone (for location data), Pen / Pencil, Data Sheet, Science Notebooks, Glue or Tape, Thermometer, Soil Sensors (moisture and temperature), gloves

Timing	Activity
5 Mins	Do Now
	Students will get into groups of 3 and get materials needed for the campus walk and soil collection

30 Mins	Campus Walk	The teacher will lead students around the campus, stopping at certain areas to collect soil samples. Students will collect 1lb of soil, record latitude, longitude, weather conditions, humidity levels, date and time, and air pollution levels and write all information on the plastic bag with the collected soil sample. NOTE: Provide a copy of campus map to each group of students
10 Mins	Reading	Teacher will ask students to read and discuss the reading as a table group and answer reflection questions in their notebooks: 1. How do nematodes contribute to soil health and nutrient cycling? 2. What are the environmental factors that impact the distribution and abundance of nematodes in different ecosystems? 3. In what ways can nematodes be both beneficial and detrimental to agricultural systems? 4. How does the study of nematodes contribute to broader scientific understanding of biodiversity and ecosystem resilience?
5 Mins	Exit Ticket	Students will watch a video of a soil scientist's interview and answer questions in their notebook: 1. According to the interview, what does a soil scientist do? 2. Why is soil science important? Is this a job you might be interested in? Why or Why not?

Day 3 (90 MINS)

Objective(s): 1. Understand important parts, and correctly use, foldscopes 2. Create scientific drawings of specimens 3. Determine pH of soil		
Materials Needed: Slides (13-26 of slide deck), foldscopes, student sheet, color pencils, prepared microscope slides, soil samples, jar, pH test strips, Petri dish, distilled water, tap water, scale, rulers		
Timing	Activity	
5 Mins	Do Now	Students will answer in their notebooks: - Where do you think we will find nematodes? Create a hypothesis. - Possible sentence stem: I think we will find nematodes in (location) because... Teacher will have students share out and chart some examples on the board with the whole class.
10 Mins	Lecture	Teacher will show students the definition of soil and review six different types that can be selected when uploading data to the soil science lab.
20 Mins	Confirming Soil Type	Students will watch Understanding Soil Types and Soil Texture video. Students will then follow the instructions below to confirm their soil type. 1. Place soil into a jar until it is about two-thirds full 2. Add water to fill the jar 3. Close the jar and shake well

		- Wait 1 minute and draw a line at the top of the sand layer - Wait 1 hour and draw a line at the top of the silt layer - Wait 24 hours and draw a line at the top of the clay layer - Take a ruler and measure the distance between each mark in millimeters. - Record the distance between each mark in a data table. <table border="1"> <thead> <tr> <th>Components</th><th>Distance (mm)</th><th>Total (mm)</th></tr> </thead> <tbody> <tr> <td>Clay (from silt mark to final mark)</td><td></td><td rowspan="3">Add each component together</td></tr> <tr> <td>Silt (sand mark to second mark)</td><td></td></tr> <tr> <td>Sand (from bottom of jar to first mark)</td><td></td></tr> </tbody> </table> NOTE: Only complete steps 1-5 and complete steps 6-8 during the beginning of the next class. Because it will take 24 hours to wait for the clay layer, confirming soil type will have to happen during the next class. Students will be able to draw lines for the sand and clay layers during this class period then revisit and complete calculations during the next class.	Components	Distance (mm)	Total (mm)	Clay (from silt mark to final mark)		Add each component together	Silt (sand mark to second mark)		Sand (from bottom of jar to first mark)	
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10	Soil pH	Teacher will introduce pH to students. Students will follow the instructions from Soil Science Lab below to get their soil pH - Place 12.6g of soil in a clean small container or Petri dish - Pour in distilled water until moist - Agitate (mix) the soil and water to form a soil slurry - Insert a pH test strip into the mixture - Read and record your soil's pH in your science notebook										
10 Mins	Lecture / Demo	Teacher will introduce foldscopes , review parts and proper use, and provide a foldscope to each student so they can view a sample and practice each of the viewing modes.										
30 Mins	Intro Foldscopes	Teacher will give each student a copy of the foldscopes practice sheet. Students will practice using all three viewing modes and draw a detailed model of what they see. For the phone view section, students will take a picture of their specimen. The teacher will spot check all of the student's pictures and ask students to upload them to the class slides.										
5 Mins	Exit Ticket	Students will turn in their practice sheets.										

NOTE: Teacher should prepare the Petri dishes using the [Soil Science Lab protocol](#) for the next day's nematode extraction by following the instructions below:

- Boil 240 mL of distilled water in a beaker
- Dissolve 20g of gelatin and 20g of sugar into the boiling water. Remove from heat
- Once solution has cooled to the touch, pour the solution into a Petri dish until it is 2/3 of the way full
- Allow Petri dishes with agar to cool to room temperature and harden (around 4 hours)
- Store in the fridge until needed for nematode extraction.

Day 4 (50 MINS)

Objective(s):

1. Identify soil type
2. Conduct nematode extraction

Materials Needed: [Slides](#) (27-32 of slide deck), soil samples from lesson 2, [nematode extraction protocol](#), scale, prepared Petri dish with agar (or gelatin and sugar), jar or beaker, funnel or water bottle, tubing, paper towels, coffee filters, paper clips or binder clips, eye safety glasses or goggles, salt, distilled water, gloves

Timing	Activity											
5 Mins	Do Now	Teacher will ask students to carefully bring their jar of soil to their table to complete steps 6-8 from the soil typing protocol in day 3 (referenced below) 1. Place soil into a jar until it is about two-thirds full 2. Add water to fill the jar 3. Close the jar and shake well 4. Wait 1 minute and draw a line at the top of the sand layer 5. Wait 1 hour and draw a line at the top of the silt layer 6. Wait 24 hours and draw a line at the top of the clay layer 7. Take a ruler and measure the distance between each mark in millimeters. 8. Record the distance between each mark in a data table. <table border="1"> <thead> <tr> <th>Components</th><th>Distance (mm)</th><th>Total (mm)</th></tr> </thead> <tbody> <tr> <td>Clay (from silt mark to final mark)</td><td></td><td rowspan="3">Add each component together</td></tr> <tr> <td>Silt (sand mark to second mark)</td><td></td></tr> <tr> <td>Sand (from bottom of jar to first mark)</td><td></td></tr> </tbody> </table>	Components	Distance (mm)	Total (mm)	Clay (from silt mark to final mark)		Add each component together	Silt (sand mark to second mark)		Sand (from bottom of jar to first mark)	
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Sand (from bottom of jar to first mark)												
10 Mins	Soil Type	Teacher will show students how to use the texture triangle with the numbers they collected from the Do Now to get their final soil type. Students will record soil type in their notebooks.										
30 Mins	Nematode Isolation	Teacher will read the Soil Science Lab extraction protocol with the whole class then either demonstrate the procedure or play a quick video of the procedure first. Students will then follow the nematode extraction procedure below: 1. Create a funnel apparatus by fitting a rubber tube onto the stem of a funnel then clamp the end of the tube closed with either paperclips or binder clips 2. Mix 50 mg of salt with 100 mL of distilled water. 3. Pour salt water solution into the funnel, filling the rubber tubing to the neck of the funnel. 4. Line funnel with with a paper towel or coffee filter 5. Weigh out 85 g of soil and place soil into the lined funnel. 6. Cover with another paper towel or coffee filter and submerge the apparatus in distilled water. 7. Wait at least 24 hours										

		a. Over the next 24 hours, active nematodes will crawl through the sieve and soil to the end of the tubing.
5 Mins	Exit Ticket	Students will watch a video of a nematologist's interview and answer questions in their notebook: 1. What type of equipment does a nematologist use in their work? 2. How does their work help others? 3. Is this a job you might be interested in? Why or Why not?

Day 5 (50 MINS)

Objective(s): 1. Complete nematode isolation 2. Prepare microscope slides to review specimens under microscope 3. Take a picture of prepared specimens using phone view on foldscope 4. Upload data to Soil Science Lab		
Materials Needed: Slides (33-36 of slide deck), experiment setup from last lesson, chromebooks or laptops, internet, Soil Science Lab data submission form, gloves, eye safety, foldscope, microscope slides		
Timing	Activity	
5 Mins	Do Now	Teacher will ask students to set up for the final part of nematode extraction by getting their experiment set up from the last lesson, safety glasses and gloves, a chromebook, foldscope, blank microscopes slides.
25 Mins	Nematode Extraction Day 2	Students will get their experiments from the previous lesson and complete the extraction by opening the clamps to allow the nematodes to drip onto the prepared Petri dishes. Students will make observations then prepare slides for their foldscopes. Students will take pictures of their specimens using the phone view of the foldscopes.
15 Mins	Data Upload	Students will go to their emails and open up the email from Soil Science Lab with the link to upload data. Students will complete the google form.
5 Mins	Exit Ticket	Students upload class data using form . NOTE: This is the same data students will upload to Soil Science Lab but it was created so the teacher could have all student data in case there are issues accessing the Soil Science Lab data set. You cannot access the data set without uploading data first.

Day 6 (50 MINS)

Objective(s): 1. Review data from Soil Science Lab 2. Begin research on topic of interest from SSL data 3. Begin creating science poster	
Materials Needed: Slides (37-47 of slide deck), chromebooks or laptops, internet, Soil Science Lab data, science poster template , poster and presentation rubric	
Timing	Activity

5 Mins	Do Now	Teacher will play the Importance of Science Communication video. Students will answer the following questions in their notebook: 1. Why is it important to communicate your work? 2. What are some of the ways scientists communicate their work to others? Teacher will call on students to share out responses to the class. Teacher will write responses on the board.
20 Mins	Science Posters	Teacher will explain that a science poster is a way to communicate research and experimental findings through text and graphics to a small audience. It is a way to strengthen your public speaking skills. The teacher will review the science poster template, poster and presentation rubric. Today's focus will be on adding the title, materials, procedure, and results / data to the poster. Teacher will explain the required components of the poster: 1. Title 2. Introduction 3. Materials 4. Procedure 5. Results / Data 6. Discussion / Conclusion 7. Reflection Students will read the descriptions for each section required and review the poster template. Then they will work in groups for 15 minutes to draft the title (and authors), materials, and procedure sections of their poster. NOTE: Encourage students to assign each other a section to complete and review class materials to complete a draft of these sections.
20 Mins	Making Graphs	Students will visit Soil Science Lab and download the latest data set. NOTE: you cannot access the data set if you have not contributed data. It's important to make sure students have contributed to the project. The teacher should also upload data to have access. Students will create a poster with the data that focuses on soil quality and nematode presence. Students will practice making graphs using data and the google sheets graphing function.
5 Mins	Exit Ticket	Students will turn in their posters to get feedback from the teacher on the sections we completed today. Students will review an example science poster and reflect in their notebooks: - One or two Strengths of the poster - One or two Suggestions for improvement

Day 7 (90 MINS)

Objective(s):

1. Continue research from last class
2. Continue working on science poster
3. Give and receive peer feedback from at least one other group on science posters and presentations

Materials Needed: [Slides](#) (48-56 of slide deck), chromebooks or laptops, internet, Soil Science Lab data, [poster template](#), [poster and presentation rubric](#)

Timing	Activity	
5 Mins	Do Now	Teacher will return posters with feedback attached. Students will review feedback with their group, discuss, and reflect in their notebooks: 1. What feedback was helpful? How did you use it? 2. What questions do you have or follow-up would you like to get about that specific piece of feedback?
50 Mins	Poster prep and peer feedback	Teacher will ask students to get their draft posters and rubric. Teacher will review the introduction, results / data, discussion / conclusion, and reflection sections. Students will spend time working on their poster.
30 Mins	Peer Feedback	Students will get a copy of the poster grading rubric and trade posters with another group. Groups will read and give feedback on the poster by annotating the rubric, marking where students met standards of a section and writing feedback in the space provided. Students will give posters back to the original group with the annotated grading rubric. Students will read through and discuss feedback then take time to implement any changes.
5 Mins	Exit Ticket	Students will turn in their group poster and peer feedback from the poster rubric. Students will use a highlighter to mark where feedback was incorporated and/or where improvements were made to a section of the poster.

Day 8 (50 MINS)

Objective(s):

1. Present science poster to the class

Materials Needed: [Slides](#) (57-60 of slide deck), chromebooks or laptops, internet, poster rubric, [peer feedback form](#), [unit reflection form](#)

Timing	Activity	
5 Mins	Do Now	Grab chromebooks and open your presentation Open the peer feedback form. Each student will complete this for each presentation.
40 Mins	Presentations	Today is student presentation day. Presenters will present in front of the class. Students will use the peer feedback form to take notes and

		provide feedback to presenters.
5 Mins	Exit Ticket	Complete unit reflection form

Additional Supports

SEL

- Students will work in collaborative groups throughout this mini-unit

ELL

- Translation supports such as Google Translate will be available for students as needed

Materials

DAY 1 - Intro Project

[Slides](#) (1-6 of slide deck), National Geographic [citizen science reading](#), internet, chromebooks

Day 2 - Campus Walk / Soil Sample Collection

[Slides](#) (7-12 of slide deck), Soil Science Lab [Nematode and Soil Science Reading](#), internet, chromebooks, Map of campus, plastic bags, Small trowel, Cell Phone (for location data), Pen / Pencil, Data Sheet, Science Notebooks, Glue or Tape, Thermometer, Soil Sensors (moisture and temperature), gloves

Day 3 - Foldscope Practice

[Slides](#) (13-26 of slide deck), foldscopes, student sheet, color pencils, prepared microscope slides, soil samples, jar, pH test strips, Petri dish, distilled water, tap water, scale, rulers

Day 4 - Nematode Extraction Day 1

[Slides](#) (27-32 of slide deck), soil samples from lesson 2, [nematode extraction protocol](#), scale, prepared Petri dish with agar (or gelatin and sugar), jar or beaker, funnel or water bottle, tubing, paper towels, coffee filters, paper clips or binder clips, eye safety glasses or goggles, salt, distilled water, gloves

Day 5 - Nematode Extraction Day 2

[Slides](#) (33-36 of slide deck), experiment setup from last lesson, chromebooks or laptops, internet, Soil Science Lab data submission form, gloves, eye safety, foldscope, microscope slides

Day 6 - Poster Day 1

[Slides](#) (37-47 of slide deck), chromebooks or laptops, internet, Soil Science Lab data, science [poster template](#), [poster and presentation rubric](#)

Day 7 - Poster Day 2 / Peer Feedback

[Slides](#) (48-56 of slide deck), chromebooks or laptops, internet, Soil Science Lab data, [poster template](#), [poster and presentation rubric](#)

Day 8 - Presentations

[Slides](#) (57-60 of slide deck), chromebooks or laptops, internet, [poster and presentation rubric](#), [peer feedback form](#), [unit reflection form](#)

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Keywords

Citizen science, Foldscopes, Nematodes