GREAT LAKES LEARNING

LESSONS & ACTIVITIES BASED ON THE MONTHLY GREAT LAKES NOW PROGRAM

EPISODE 2303 | FADING STARS AND RIVER BUGS

CITIZEN SCIENCE IN THE GREAT LAKES

OVERVIEW

This lesson will explore the phenomenon of **light pollution** in the Great Lakes and some of the **citizen science** efforts going on around the region. Students will explore the impact that artificial lights have on night sky visibility for star gazing, learn about how everyday people can contribute to scientific research, and engage in citizen science projects in their community.

LESSON OBJECTIVES

- **Know** about the How Science works model that illustrates the process of science
- **Understand** the how various types of light bulbs contribute to light pollution and impact astronomy
- **Be able to** conduct citizen science projects to monitor weather and track bird populations

WHAT YOU'LL NEED

- Computer or mobile device with Internet access to view video and online resources
- Notebooks and pencils
- Chart paper
- Sticky notes
- Markers
- Lab supplies (see individual activities for a full list)
- Copies of the Student Handouts

INTRODUCTION

The stars don't shine as brightly as they used to, and if you live in a metropolitan area it's getting more difficult to even see the stars at night. That's because of the growing problem of light pollution. How did we get here and what's being done to preserve our night skies?

This is just one of several environmental issues that citizens just like you and me are trying to help solve through the efforts of everyday science research—called citizen science.

This lesson includes multiple activities, including lab activities, that can span the course of several sessions or be adapted to fit the needs of your group's meeting format.

Some prior knowledge* with which students should be familiar includes:

- how light travels
- basic astronomy vocabulary, e.g., galaxy, star
- habitats and populations
- weather systems
- energy and states of matter
- data analysis and graphing
- temperature, pressure, and precipitation

the scientific method

Follow this QR Code or hyperlink to the Episode Landing Page!

Check out our full collection of lessons for more activities related to topics like these.

****The sequence of these activities is flexible, and can be rearranged to fit your teaching needs.***

NGSS CONNECTIONS

Phenomenon: Light Pollution

- MS-LS2-5
- HS-ESS3-4
- HS-ETS1-2
- HS-PS4-2
- MS-ESS2-5
- MS-LS2-4
- HS-LS2-7
- SEPs 1-8

During the course of the lesson, students will progress through the following sequence** of activities:

- Class discussion to elicit and activate prior knowledge about **science**
- Reviewing how science works
- Teacher notes on light pollution
- Watch segments from *Great Lakes Now*
- Class discussions to debrief the videos
- Read about **citizen science** and **dark sky parks**
- Conduct citizen science projects to monitor weather and track bird populations
- Do an experiment to model and measure the light pollution from various light bulbs
- Design a citizen science project to help address an issue in your community

The lesson progresses through three major sections: **launch, activities, and closure.** After the launch of the lesson, you are ready to begin the lesson activities. Once finished with the activities, students will synthesize their learning in the closure. You can select the activities that are best suited for your learners and teaching goals, and then sequence them in a way that makes sense within your learning progression and the scaffolds of the lesson.

If you use this lesson or any of its activities with your learners, we'd love to hear about it!

Contact us with any feedback or questions at:
GreatLakesNow@DPTV.org

TEACHER BACKGROUND INFORMATION

by Gary G. Abud, Jr., Great Lakes Now Contributor

**This information can be presented by the teacher as notes to students at the teacher's discretion.*

True or false: the stars only come out at night? Besides the fact that the sun is itself a star, the stars we refer to as stars are always in the sky, even during the day, but because the brightness of the sun outshines other stars from earth we are unable to see the entire starfield during the daytime. The same thing can even happen at night when the moon is shining brightly in a fuller phase. But beyond the light from the sun and moon, artificial lights—those from homes, businesses, and street lights—can also interfere with our ability to see the constellations.

Star watching requires dark conditions such as can be seen in the night sky over a very rural area. That's because, when compared with viewing the stars near a city, remote locations offer less light pollution—and thus darker environments—making stargazing easier.

Light pollution is when artificial light, e.g., light from non-natural sources, interferes with the natural darkness of the night sky causing it to appear unnaturally brighter. This can be caused by outdoor lighting that is too bright or that shines in the wrong direction, such as street lights or floodlights. The closer you are to artificial light sources the more it can interfere with your ability to see the stars.

Beyond the inconvenience to astronomy, light pollution can have negative effects on the environment, such as disrupting the natural sleep cycles of animals, interfering with their ability to migrate or find food, and impacting their breeding patterns. Light pollution can also affect humans by disrupting our own circadian rhythms and sleep patterns, and contributing to some health problems.

The effects of light pollution can even be seen from space, as satellite images of the dark side of the earth reveal patterns of light resembling the veins in marble.

Some individuals and groups, such as the International Dark Sky Association (IDA), have been mapping out the locations around the world with the darkest skies. Based on the amount of light pollution in an area—or rather, the lack thereof—the IDSA will award a designation of an international dark sky park. This is a place certified for its reliability in having the necessary darkness in order to have great stargazing. The Great Lakes is home to one such designated area Headlands International Dark Sky Park in Mackinaw City, MI. To maintain that special park, the community of the nearby area has to commit to protecting the natural darkness with practices the limit light pollution.

While we all would love to have the ability to see constellations, meteor showers, and space station fly-bys more clearly, not everyone has access to a dark sky park. And with an increased global population, more and more rural areas are being developed into urban and suburban cities, resulting in more light pollution.

But this doesn't mean the end of star watching. There are ways to reduce light pollution, such as choosing bulbs that are less luminous, using outdoor lighting that is shielded and directed downward, turning off lights when they are not needed, and using motion sensors to turn lights on and off automatically.

Observing the night sky without light pollution is important for astronomers and amateur stargazers, who want to see the beauty of the stars and planets without interference from artificial light sources, but because light pollution is a growing problem in many areas, individuals and communities will need to take steps to reduce the footprint of artificial light to alleviate the impact it can have on light pollution and preserve the natural beauty of the night sky.

Now, the next time you take a nighttime walk to stargaze, notice the sources of light pollution in your area and how they impact your ability to see the stars.

LESSON LAUNCH

A. Warm Up

The warm up is intended to be structured as teacher-facilitated, whole-group student discussion activities. It helps students to begin thinking about the topic at the center of the lesson.

1. Ask students to list out on a piece of paper five things that come to mind when thinking of **science**.
2. Have students pair up with a partner to share their five ideas with each other. If any ideas appear on both lists, have students circle those.
3. Then, engage students in a whole-group discussion to ask them to share any ideas that were circled.
4. Generate a list of the circled ideas.
5. Ask for volunteers to share any ideas that were not circled that they think are really important to include in this topic.
6. Generate a separate list of those ideas.
7. At the end of making the two lists, have students copy down one single list of all the circled ideas and important ideas in their notebooks or on their paper.
8. Ask students individually to rank the ideas in the list from most to least relevant.
9. Ask for some students to share which term should be most relevant and why they think that is. Engage the whole group in discussion to arrive at consensus about the most relevant idea related to **science** that they already know about or that came to mind during this exercise.

B. Bridge to Learning

After the warm-up activity has concluded, help students prepare for the learning that is about to come by having them:

1. Work with a partner to list out the steps of the scientific method
2. Share some ideas with the whole class to arrive at consensus of what it includes
3. Explore the **How Science Works** model from University of California Berkeley (included in the student handouts)
4. Compare and contrast the traditional scientific method with the How Science Works model

C. Close Reading a Video

Ask students whether one has to be a scientist in order to do science. Elicit a few responses and discuss the ideas with them. Then, inform students that they are going to explore something called **citizen science**. Ask for and discuss a few responses to define what this term might mean. Let students know they are going to watch a video of a student doing citizen science in India. Introduce Sahithi Pingali, a student who was featured in the Peabody-Award Winning documentary *Inventing Tomorrow*. There is **a 15min version** from PBS WORLD of her story and **a 5min version** on PBS LearningMedia (resource 4 of 5 on the page) as well. Show the video to students. Have them discuss with a partner what parts of the How Science Works model they saw Sahiti engage in during the video clip. Elicit a few ideas and facilitate a discussion about it, circling them on a How Science Works model to show everyone. Finally, ask students what they think citizen science might mean after the video.

D. Background Information Notes

Explain that this video shows something very important about citizen science—namely that it can be done by any citizen and is a collective effort to provide scientific data from the community. Then provide **Teacher Background Information**.

ACTIVITY 1: WATCH A GREAT LAKES NOW SEGMENT

This activity is a video discussion of a *Great Lakes Now* episode segment.

First, inform students that they will be watching a *Great Lakes Now* segment discussing light pollution and star watching. During the video they need to jot down four things they took away from the video using the **4 Notes Summary Protocol**.

Then, if students are not already familiar, introduce them to the 4 Notes Summary Protocol, which they will use after they finish watching the video, where they write down one of each of the following notes:

- **Oooh!** (something that was interesting)
- **Aaah!** (something that was an ah-ha moment)
- **Hmmm…** (something that left them wanting to know more)
- **Huh?** (a question they have afterward)

Next, have students watch the segment from episode 2303 of *Great Lakes Now* called **The Globe at Night**.

Last, have students complete their individual 4 Notes Summary and then discuss those in groups of 3-4 students.

Teaching Tip: Use the Student Handouts to help students organize their thinking in writing around each of the lesson protocols.

Post-Video Discussion

After the groups have had time to go over their 4 Notes Summaries, invite a handful of students to share out some of their notes, eliciting at least 1-2 of each of the 4 Notes and listing those somewhere for the whole group to see.

Ask students to turn back and talk with their groups to make connections between the *Great Lakes Now* video and what they remember from the warm-up activities.

How is what we saw in the video related to what we discussed earlier during the lesson launch activities?

After giving the groups some time to talk, bring the whole group back together for a shareout and discussion of ideas.

In this culminating discussion, the goal is to help students make connections between the video segment and what they discussed during the launch activities earlier in the lesson about what they knew about **science.**

Once the discussion finishes, have each student write a "**Sum It Up**" statement in their notebooks. This is a single sentence that captures the big idea of what was just learned.

Have 2-3 students share out their **Sum It Up** statements before concluding this activity.

ACTIVITY 2: READ ABOUT DARK SKY PARKS

Observing the night sky without light pollution can be a wonderful experience that allows us to appreciate the beauty of the universe. But increasing use of artificial light results in the brightening of the night sky and prevents the ability for us to star gaze comfortably. That's why some organizations are seeking to find the world's darkest locations for night sky viewing and preserve those spaces from light pollution. They're called Dark Sky Parks and they are special places, indeed.

In this activity, students will use a **Think Pair Square Protocol** for discussing what they will read about this very topic.

First, have students partner up and distribute the article **Great Lakes, Dark Skies** by Mary Stewart Adams from *Great Lakes Now*. Allow time for students to individually read the article, and have them jot down three things they took away from the article using the **Rose Thorn Bud Protocol**—in their notebook or using the handout.

Then, give students time after reading to discuss the article that they read with their partner. Have students share their rose, thorn, and bud with each other, including how those points connect to each other. The pair should come up with a statement to summarize all of their article takeaways.

Next, have two student pairs join up, standing near each other to form the four corners of a square, to discuss the article and what they talked about in their pairs. Encourage them to come to a consensus about which point they found most important or interesting in the article.

Last, have each group craft a summary statement of the most important point from their discussion and ask for a volunteer in each group to share that key point with the whole group. As student groups share their most important point, record their ideas on the board and have students copy the list of student ideas down into their notebooks. Once the shareout is complete, ask students to return to their groups and discuss one last question based on the article:

How might we best reduce light pollution in order to ensure that we continue to have dark skies in our communities?

You can keep this as a class discussion based on the article itself or, after giving the groups some time to discuss this question, invite them to research and share their findings from some of the ways listed at the end of the article to affect positive change with regard to light pollution.

Teaching Tip:
If the reading level of the article is going to be tough for some students to read individually, have partners or small groups read the article together aloud while each follows along.

ACTIVITY 3: MEASURING LIGHT POLLUTION

The purpose of this experiment is for students to model the effects of different types of light bulbs on the night sky to measure the impact of artificial light pollution.

Materials:

- A dark room (or large a cardboard box to make a dark space)
- Light bulbs of different types (incandescent, fluorescent, LED)
- A light meter or a smartphone app that measures light intensity
- A star chart that shows the positions of stars in the sky (printed with dark background and stars shown in white)

First, inform students that they will be working with a group to model light pollution and measure its effects on a small scale. They will be creating a model night sky and testing the light pollution generated by different types of bulbs using a meter or an app on a mobile device. Once they understand the task, make the materials available to them. Depending on the context in which you are teaching this lesson and doing this activity, you could either:

1. cover all windows in the room and minimize as much artificial light as possible, then give each group a designated area of the room where they can put their star chart on the wall and view it through a slit in a sheet of cardboard or construction paper
2. Set up the large box with a small opening for looking in and through one side to view the star chart while attaching the star chart on the other side of the inside of the box and placing the lamps nearby or in the box so it will shine on the star chart

Teaching Tip: Test this activity out beforehand to see which version will be most workabale for your students.

Then, once their setup is complete. Have them follow the procedure to measure the amount of light from each bulb and observe how it impacts viewing of the stars on the star chart. A sample procedure you can use is:

1. Set up a dark room or a cardboard box with a small opening for observing the night sky.
2. Place each light bulb one at a time in a lamp or socket.
3. Use the light meter or smartphone app to measure the brightness of the light bulb in lumens (if possible).
4. Turn off all other lights in the room, and observe the night sky through the opening.
5. Using the star chart, record the number of visible stars with each lamp on.
6. Make sure to give a little time between the testing of each light bulb.

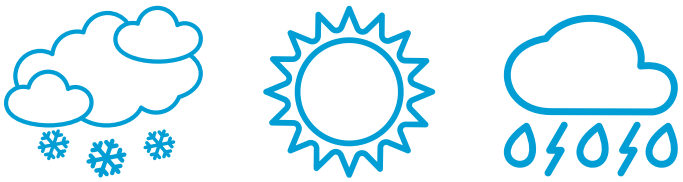
Next, on chart paper or large dry erase boards, have students create a chart or graph to compare the brightness of each type of light bulb using the measurement from the light meter or app. Have them create another chart or graph to compare the number of visible stars for each type of light bulb.

Last, have students share their charts and graphs during a debrief of the lab in a poster presentation format by selecting students to summarize their findings. Engage students in a discussion to analyze the results and draw conclusions about how different types of light bulbs affect the brightness of the night sky, produce the most light pollution, and which type of light bulb is the least harmful to the environment?

Extend* the discussion by asking them to consider what happened when several groups had their light bulbs all turned on at the same time, and also what difference it would have made if the lights had shields on them to focus some of the light in a certain direction and block it from going in all directions.

*For an additional extension opportunity, consider having students participate in **the NSF Globe at Night project** in your community.

ACTIVITY 4: WEATHER MONITORING



The purpose of this activity is for students to engage in citizen science to track weather patterns in their local area and compare them to meteorological forecasts.

Materials: *note: it isn't necessary to use all of these tools, as some of these measurements can be looked up online; instead, use what is relevant and available in your learning context*

- Thermometer
- Barometer
- Rain gauge
- Wind vane
- Anemometer
- Notepads or a weather log sheet (paper or digital)
- Pencils or pens
- Access to **Globe.gov** (optional)

First, inform students that they will be working with their groups to monitor* the weather near their home and at school over the course of several days and weeks by collecting and recording weather data in their local environments. Elicit student ideas about how accurate they think the weather forecasts we get from the news and Internet typically are. Explain to them that weather forecasting is an important science and service to the community that uses a lot of scientific data and computer-generated calculations to make predictions about upcoming weather based on past patterns—even using up-to-the-minute data. What they will be doing is collecting several pieces of data to use for weather monitoring, but to a lesser extent than meteorologists use.

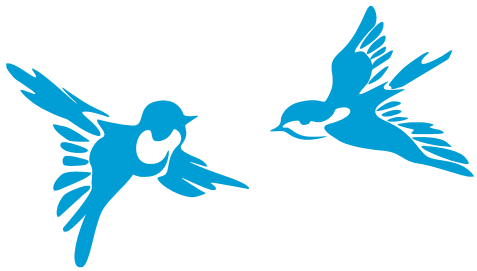
Note: you can provide training and resources for students to learn about monitoring weather patterns and collecting data at **Globe.gov.*

Then, provide students with the materials and instruments you want them to have. Determine the length of time during which everyone will collect weather data (e.g., 7 days, 2 weeks, 1 month, etc.) and make sure that the weather logs will capture enough days and all the fields that students can measure data for. Assign an accessible location to be the measurement spot for each day (e.g., a site on school grounds, backyard at home, a local park) where students can safely monitor the weather conditions.

Next, have students set up their weather monitoring instruments in the designated location. Provide instructions on how to use each instrument and encourage students to take measurements at the same time each day. If doing the data collection during class time, give students a set amount of time to collect and record weather data using their instruments and notepads or weather log sheets. Encourage them to note important details, such as temperature, barometric pressure, rainfall, wind speed, and wind direction. Alternatively, they can take some measurements directly with their instruments and look up others (such as barometric pressure) online to include in their notes.

Last, once the data collection period is complete, have students summarize their weather data in some way using a chart, graph, or other visual tool. Use this data to compare weather patterns across different days between groups and to identify any trends or patterns in weather over time. Have them look up and compare their weather data with data collected from nearby weather stations or online weather websites and to identify any differences or similarities. Engage the students in a discussion of what their findings have in common and what differences there are. Help them to explain what might be different between their data. Help them to consider the importance of citizen science and how students' weather data can help scientists better understand and predict weather patterns.

ACTIVITY 5: THE BIRD COUNT CHALLENGE



The purpose of this activity is for students to engage students in bird watching and citizen science by encouraging them to identify and record the birds they observe in their local environments and communities.

Materials:

- Bird identification guide or app
- Binoculars
- Notepads or bird count sheets
- Pencils or pens
- Access to the **Cornell Lab of Ornithology's eBird website** (optional)

First, ask students to complete the following sentence out loud and all at once: "during the winter birds fly..." Ask them to consider how we know that birds fly south for the winter? Explain to them that not only have we learned that birds often fly south in the U.S. during the winter, but also that one of the ways that scientists have learned this is by mapping the types and quantities of different birds in various areas over time and tracking the patterns. This leads to the ability to predict and explain migration patterns of birds and for us to monitor what is going on with different bird species year round.

Next, inform them that as part of this activity, they are going to monitor the bird populations in their environments and communities through the bird watching challenge. Emphasize the important role that citizen science can play in bird monitoring for conservation and scientific research. Explain that the overall process of this activity will have students watching for, identifying, counting, and documenting the number of each type of bird in their watch area. Have them partner/group up and provide them with the materials that they will need to conduct the bird count challenge.

Then, assign locations for the bird watching activity, such as a spot at school, students' homes, a local park, or other natural area in the community. Encourage students to choose a location that is accessible and safe for them to explore the birds with their partners. Give students a set amount of time to observe and record the birds they see in the designated area. Encourage them to use binoculars to get a closer look at the birds and to note and log important details, such as size, color, and behavior. They can complete the bird count challenge on a single occasion or multiple times over a period of days/weeks. Remind them to use the bird identification guide or app to help identify any birds that were not immediately recognizable. Have students tally up the number of birds they observed and record this information on their notepads, apps, or bird count sheets with their groups.

Last, after the observation period is complete, reconvene as a group and have all students share their data to collectively summarize the birds they observed and recorded. You could create a shared class spreadsheet, make a class histogram on chart paper or a large whiteboard, or find another way to summarize the data. Make time to analyze the data as a class once it is summarized. Have groups compare their findings to those of other students, and discuss the similarities and differences between everyone's results. Ask them to consider how this data might compare at different times of the year?

As an extension of the activity, you can consider repeating the data collection during a different season of the year. You could also have students enter their bird observations into **eBird.org**, a citizen science platform from Cornell University where they can contribute their data to ongoing research and bird monitoring efforts. If you choose to extend this activity, be sure to follow up by discussing the importance of citizen science and how students' bird observations can help scientists better understand and protect bird populations.

ACTIVITY 6: WATCH A GREAT LAKES NOW SEGMENT

This activity is a video discussion of a *Great Lakes Now* episode segment.

First, inform students that they will be watching a *Great Lakes Now* segment discussing citizen science projects around the Great Lakes. During the video they need to jot down four things they took away from the video using the **4 Notes Summary Protocol**.

Then, if students are not already familiar, introduce them to the 4 Notes Summary Protocol, which they will use after they finish watching the video, where they write down one of each of the following notes:

- **Oooh!** (something that was interesting)
- **Aaah!** (something that was an ah-ha moment)
- **Hmmm…** (something that left them wanting to know more)
- **Huh?** (a question they have afterward)

Next, have students watch the segment from episode 2303 of *Great Lakes Now* called **The Catch**.

Last, have students complete their individual 4 Notes Summary and then discuss those in groups of 3-4 students.

Teaching Tip: Use the Student Handouts to help students organize their thinking in writing around each of the lesson protocols.

Post-Video Discussion

After the groups have had time to go over their 4 Notes Summaries, invite a handful of students to share out some of their notes, eliciting at least 1-2 of each of the 4 Notes and listing those somewhere for the whole group to see.

Ask students to turn back and talk with their groups to make connections between the *Great Lakes Now* video and what they remember from the warm-up activities.

How is what we saw in the video related to what we discussed earlier during the lesson launch activities?

After giving the groups some time to talk, bring the whole group back together for a shareout and discussion of ideas.

In this culminating discussion, the goal is to help students make connections between the video segment and what they discussed during the launch activities earlier in the lesson about what they knew about **citizen science.**

Once the discussion finishes, have each student write a "**Sum It Up**" statement in their notebooks. This is a single sentence that captures the big idea of what was just learned.

Have 2-3 students share out their **Sum It Up** statements before concluding this activity.

ACTIVITY 7: READ ABOUT CITIZEN SCIENCE

It's often the case that when when we think of people doing science, we often envision professionals in long white coats looking through microscopes in a laboratory. But science can be conducted by everyday residents of communities, like us, as well—that's citizen science. Understanding the role that it plays in scientific research, as well as the similarities and differences between it and professional science is an important part of the fuller picture. That's why in this activity, students will use a **Think Pair Square Protocol** for discussing what they will read about this very topic.

First, have students partner up and distribute the article (available in the student handouts section of the lesson) **Why Does Citizen Science Matter?** by Gary Abud, Jr. from *Great Lakes Now*. Allow time for students to individually read the article, and have them jot down three things they took away from the article using the **Rose Thorn Bud Protocol**—in their notebook or using the handout.

Then, give students time after reading to discuss the article that they read with their partner. Have students share their rose, thorn, and bud with each other, including how those points connect to each other. The pair should come up with a statement to summarize all of their article takeaways.

Next, have two student pairs join up, standing near each other to form the four corners of a square, to discuss the article and what they talked about in their pairs. Encourage them to come to a consensus about which point they found most important or interesting in the article.

Last, have each group craft a summary statement of the most important point from their discussion and ask for a volunteer in each group to share that key point with the whole group. As student groups share their most important point, record their ideas on the board and have students copy the list of student ideas down into their notebooks. Once the shareout is complete, ask students to return to their groups and discuss one last question based on the article:

How might citizen science play a role in our community to solve local problems or learn more about our regional environment?

Allow time for students to discuss their responses to this question with their partners before engaging the entire group in a discussion about their ideas.

As an extension of this discussion, you can move next to **Activity 8 and Activity 9** in the lesson.

Teaching Tip:
If the reading level of the article is going to be tough for some students to read individually, have partners or small groups read the article together aloud while each follows along.

ACTIVITY 8: WATCH A GREAT LAKES NOW SEGMENT

This activity is a video discussion of a *Great Lakes Now* episode segment.

First, inform students that they will be watching a *Great Lakes Now* segment discussing a citizen science effort to monitor an indicator species in southeast Michigan waters. During the video they need to jot down four things they took away from the video using the **4 Notes Summary Protocol**.

Then, if students are not already familiar, introduce them to the 4 Notes Summary Protocol, which they will use after they finish watching the video, where they write down one of each of the following notes:

- **Oooh!** (something that was interesting)
- **Aaah!** (something that was an ah-ha moment)
- **Hmmm…** (something that left them wanting to know more)
- **Huh?** (a question they have afterward)

Next, have students watch the segment from episode 2303 of *Great Lakes Now* called **Stonefly Survey**.

Last, have students complete their individual 4 Notes Summary and then discuss those in groups of 3-4 students.

Teaching Tip: Use the Student Handouts to help students organize their thinking in writing around each of the lesson protocols.

Post-Video Discussion

After the groups have had time to go over their 4 Notes Summaries, invite a handful of students to share out some of their notes, eliciting at least 1-2 of each of the 4 Notes and listing those somewhere for the whole group to see.

Ask students to turn back and talk with their groups to make connections between the *Great Lakes Now* video and what they remember from the warm-up activities.

How is what we saw in the video related to what we discussed earlier during the lesson launch activities?

After giving the groups some time to talk, bring the whole group back together for a shareout and discussion of ideas.

In this culminating discussion, the goal is to help students make connections between the video segment and what they discussed during the launch activities earlier in the lesson about what they knew about **citizen science.**

Once the discussion finishes, have each student write a "**Sum It Up**" statement in their notebooks. This is a single sentence that captures the big idea of what was just learned.

Have 2-3 students share out their **Sum It Up** statements before concluding this activity.

ACTIVITY 9: CHOOSE YOUR OWN CITIZEN SCIENCE ADVENTURE

In this activity, students will get to make decisions and select their own citizen science experiments to get involved with all while learning about the scientific process and contributing to the advancement of science in their communities. Teachers can curate certain projects for students to select or leave this more open ended for them.

First have students form groups of 3-4 and visit **Scistarter.org** to get started reviewing possible projects to do. Some possibilities to consider might include:

- Stream Selfie - identify locations and status of streams in your area
- iNaturalist - monitor biodiversity
- Mosquito Habitat Mapper - identify mosquito types by location
- Silent Earth - find the quietest places on the planet to map sound pollution
- EarthEcho - monitor water quality

Many of the SciStarter projects merely require an app and mobile device; however, some do require special tools for taking measurements and collecting data. That's why SciStarter has partnered with local libraries to make toolkits available for the projects that require specialized instruments for collecting citizen science data. On their website you can find libraries near you that have kits available to check out and do projects.

Regardless of what they choose, it's important to remember that their citizen science project is meaningful to their community and them.

Then, once they select a project to take part in, have students research what's involved in the project and to develop a plan for how they will participate in it. They should determine how, when, and where group members will take part in the citizen science research.

Next, have the groups come up with a hypothesis for what they expect will be the outcome in their project for their local area. For example, if they were to choose a project to document the changing distribution of wintering Trumpeter Swans in their community, they should make a prediction about what they think they will find in their research area (e.g., lots of swans, only a few, uniform distribution, more/less swans near water, etc.)

Last, determine a timeframe for completing the SciStarter citizen science projects with the group and have each group make a plan for how they will create a poster or infographic to visually summarize and share the findings and outcomes of their project.

After the completion of the projects, allow time for students to prepare their presentations and create a poster presentation or gallery walk opportunity for students to share and learn about the research their peers did.

LESSON CLOSURE

After the conclusion of all the activities, help students to make connections* between everything they did in the lesson and what they learned overall.

A. Free Recall

Group students in pairs or triads (e.g., in groups of 2-3 partners) and distribute the **Free Recall Protocol handout**, Alternatively, you can have students do this in their notebooks. Set a 3-min timer and have students generate a list of everything they can remember learning about in this lesson related to the central topic of the lesson. This doesn't have to be in depth, just whatever each group can call to mind. Have them draw lines between any terms that relate to one another. After the timer finishes, give groups a chance to volunteer to share aloud 2-3 things from their free recall lists and any of the connections that they made with those. Jot down any ideas that come up multiple times during the shareout for the whole group to see.

B. Lesson Synthesis

Give students individual thinking and writing time in their notebooks to synthesize their learning, by jotting down their own reflections using the **Word, Phrase, Sentence Protocol.**

In the Word-Phrase-Sentence Protocol, students write:

- A **word** that they thought was most important from the lesson
- A **phrase** that they would like to remember
- A **sentence** that sums up what they learned in the lesson

C. Cool Down

After the individual synthesis is complete, students should share their synthesis with a partner.

After sharing their syntheses, have students complete a **3, 2, 1 Review** for the lesson with their partner, recording in their notebooks or, optionally, on exit ticket slips to submit, each of the following:

- **3 things** that they liked or learned
- **2 ideas** that make more sense now
- **1 question** that they were left with

Invite several students to share aloud what they wrote in either the synthesis or 3, 2, 1 Review.

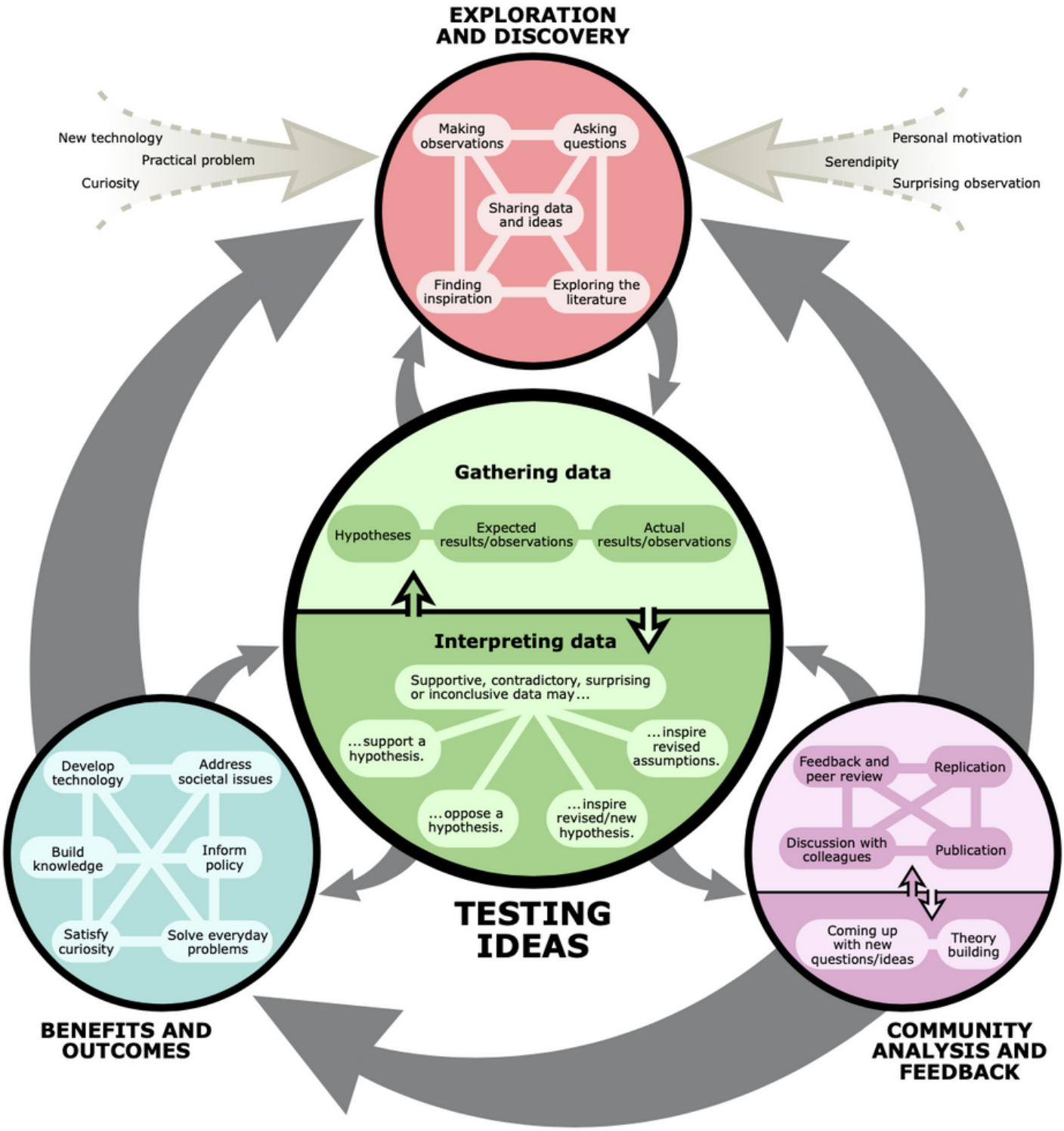
Lastly, ask one student volunteer to summarize what has been heard from the students as a final summary of student learning.

**Optionally here, the teacher can revisit the learning objectives and make connections more explicit for students.*

Teaching Tip: Use the Student Handouts to help students organize their thinking in writing around each of the lesson protocols.

NAME: _____

How Science Works



ARTICLE: WHY DOES CITIZEN SCIENCE MATTER?

by Gary G. Abud, Jr., Great Lakes Now Education Contributor

Citizen science is when everyday people help scientists with their research. It is still a type of scientific research, but rather than being done in a lab only by professionals it involves regular people, or citizen scientists, in collecting and analyzing data. In contrast, professional science typically refers to scientific research that is conducted by professional scientists who have received specialized training in their field.

While citizen science involves non-professional scientists, it is still considered a valid and important form of scientific research. Citizen scientists are sometimes even trained by scientists or provided with specific protocols to follow, and their data is often carefully reviewed and analyzed by professional scientists.

Citizen science is a great way for everyone to help scientists learn more about the world we live in, and for the citizens to explore and discover new things. It is important and helpful to the scientific community because it allows scientists to collect much more data than they could on their own. By involving citizens in their research, scientists can get access to data from all over the world, and in places that they might not be able to visit themselves.

This kind of data can be very valuable, especially when studying things like the environment, animal behavior, or changes in the climate. For example, if scientists want to study the migration patterns of birds, they might not be able to track all the birds on their own. But with the help of citizen scientists who observe and report bird sightings, they can get a much better understanding of how birds move across different regions. Because scientists can't be everywhere at once, that's where citizen scientists come in—they can help by observing the things around them and recording what they see.

For example, if you like going for walks in the park, you might notice that there are lots of different kinds of birds. You could take pictures or make a list of all the different birds you see, and share that information with scientists. They can use your observations to learn more about what kinds of birds live in different places and how they behave.

One key difference between citizen science and traditional science is the level of training and expertise required to conduct the research. Professional scientists are typically highly trained in their field, with advanced degrees and specialized knowledge, while citizen scientists may not have the same level of formal training. However, citizen scientists can still make important contributions to scientific research without the same training.

Another difference is the scale of the research. Professional scientists often conduct large-scale studies with significant resources, while citizen science projects may be smaller and more localized. However, citizen science can still be a powerful tool for collecting data over large geographic areas or long periods of time, especially when multiple citizen scientists are involved.

Citizen science also helps to engage the public with science and research, which can encourage more people to get involved and learn about science. By involving more people in scientific research, we can create a more informed and educated society, which can help us make better decisions about how we care for our planet and the animals that live on it.

Overall, despite being distinct from traditional science, citizen science is still considered valid, helpful, and important to the scientific community because it allows scientists to collect more data, do unique research, engage the public, and make better more-informed decisions about our world.

NAME: _____

A Word, Phrase, Sentence Protocol

What is a **word** that you thought was most important from this lesson?

What is a **phrase** that you would like to remember from this lesson?

What is a **sentence** that sums up what you learned in this lesson?

3, 2, 1 Review Protocol

What are **3 things that you liked or learned** from this lesson's activities?

-
-
-

What are **2 ideas that make more sense** now to you?

-
-

What is **1 question that you were left with** after this lesson?

-

NAME: _____

Free Recall Protocol

With 1-2 partners, generate a list of everything you can remember learning about in this lesson related to the central topic of the lesson. Draw lines between any terms that relate to one another.

NAME: _____

4 Notes Summary Protocol

OOOH!

Something that was interesting to you

AAAH!

Something that became clearer; an "ah-ha" moment

HMMM...

Something that left you wanting to learn more

HUH?

Something you questioned or wondered

Sum It Up Statement:

Summarize your group discussion about your 4 Notes Summaries below:

NAME: _____

Think Pair Square Protocol

THINK

Write down your own individual ideas

PAIR

Summarize what you and your partner discussed

SQUARE

Summarize what your group discussed

NAME: _____

Rose, Thorn, Bud Protocol

ROSE

Something that "blossomed" for you in your learning

THORN

Something that challenged your thinking or was difficult to understand

BUD

Something that's new and growing in your mind — a "budding" idea