



Module 4

Grade Level: High School

Teaching Time:

The length of this module is left to the discretion of the teacher. Since the module is learner-centered, student research can take part in the classroom, and/or as an out-of-class assignment; therefore, the time given for the student to complete their research project could be condensed into a number of weeks, or spread across the semester with defined due-dates for the various research project components.

Materials:

- Colored markers
- Flip chart paper on which a number of students have room to write
- Resources and reference from Modules 1-3, as needed.

Teacher Note:

See Resources section for more detailed list of readings, Web links, and other activity resources, that are provided for this Module.



Module 4: Environmental Research and Stewardship Action

Summary

Module 4, *Environmental Research and Stewardship Action*, is the culmination of the first three modules of this Unit. Research skills developed throughout the Unit will be applied by students to investigate an environmental issue of their choosing. Additional skills including, developing survey instruments to gather social data, recognizing types of environmental action, and developing action plans are presented. Students present their findings to their peers, families, and the community, and are encouraged to carry out their action plans.

Background

In **Module 1, *A Historical Perspective of Oyster-Related Environmental Issues – The Oyster Wars of Chesapeake Bay***, students analyzed articles, multimedia, and other resources to (1) identify environmental events, problems, and issues; and (2) determine stakeholders' beliefs and values associated with oyster-related issues. By teaching them how to investigate all sides of an issue, students were given an in-depth picture of why complex environmental issues can be difficult to resolve.

In **Module 2, *Investigating Sustainable Resource Management Using the Fish Banks Simulation***, students participated in a role playing computer simulation modeling the fishing industry. The simulation represented a snapshot of how a common use resource area available to all individuals can be adversely affected when the collective impacts of all users are added together (refer to *The Tragedy of the Commons*, Hardin, 1968). Not all economic or ecological variables were addressed in the model, but it provided a simulated experience demonstrating the complexity and overlap of ecological and human systems.

Depending on the simulation method that was used (either the online version or the game kit), the model may have reflected fisheries in coastal New England or in the world's oceans. We adapted the Debriefing to locally relevant fish species in the Chesapeake Bay by providing additional resources to the debriefing slide presentation. Chesapeake Bay fisheries data connected the real world scenarios of declining oyster populations and other economically important species to the FishBanks simulation.

In **Module 3, *Evaluating Habitat Requirements for the Eastern Oyster***, students evaluated the biotic and abiotic requirements necessary for oysters to thrive and reproduce. This included reading a scientific paper describing essential water quality parameters, and using maps of a Chesapeake Bay tributary where areas were delineated for the following oyster habitat characteristics:

- Salinity (bottom and surface)
- Dissolved oxygen (bottom and surface)
- Water depth
- Structural habitat (soft or hard bottom)
- Live oyster density
- Current natural oyster bars, historic oyster bars, and current oyster sanctuary boundaries

From their research, students determined the best sites for placing oysters, just as scientists would use this data to inform management. Further, students also analyzed the Harris Creek public hearing transcripts about proposed sanctuaries to identify the beliefs and values of the stakeholders, and their stand on the issue.

In **Module 4, *Environmental Research and Stewardship Action***, students will choose an environmental issue they wish to investigate. They will have reviewed many resources thus far, including scientific papers, historical accounts, newspaper articles, internet resources, media, and public hearing transcripts related to oysters in Chesapeake Bay. Using these types of secondary resources, students will begin to research background information about an environmental topic that interests them.

After completing sufficient background research, students will choose an environmental issue they would like to study, and develop research questions surrounding the chosen issue. Using their existing background knowledge, students will develop data instruments that collect

information about aspects of both science and society's knowledge and opinions about the issue.

Students will also learn about types of action that can be employed to resolve the environmental issue they have investigated, make recommendations based on the data they have collected, and develop an action plan.

Their final project includes a report, and presentation, and if students so choose, they may carry out the action plan that they created. Remember, this is [student directed](#) – *it is their choice as to whether they want to take action.*

KEY WORDS

Bias – a one-sided viewpoint; lacking a neutral viewpoint; prejudice in favor of or against one thing, person, or group compared with another.

Conclusion – in science, an expression or statement of the end result; the final result as shown by the data; the outcome or observation.

Inference – a possible explanation of the data; an implication, assumption, or judgment made from data (or from conclusions); the explanation for the observation.

Hypothesis – a proposed explanation for a phenomenon.

Interview – a method of verbal communication to acquire specific information from someone knowledgeable about a specific topic. The data collected may include information about a person's personal knowledge, experiences, or attitudes.

Opinionnaire – a questionnaire about a particular topic, designed to evoke viewpoints and “measure” opinions, beliefs, or attitudes of human beings about that topic.*

Physical survey – an investigation used to acquire detailed information about something. This could include the study of existing environmental conditions of an area (e.g., the biodiversity of plants in a select area, or the levels of dissolved oxygen in a specific body of water at the same specific time and place each day). It could also include collecting information to determine the exact number of things that exist or occur in a given area (e.g., the number of people who car pool to work, or the number of classrooms that recycle paper at your school).

Population – the total group of people who are associated with what you are investigating.

Questionnaire – a written research instrument that includes a series of questions about a particular subject designed to gather specific factual information from respondents.*

Random sampling – a subset of a statistical (human) population in which all viewpoints have an equal chance of being represented.

Recommendation – a sample made up of people that the researcher can easily contact.

Sample – the smaller number of individuals, or subset, selected using a defined procedure to represent the overall population.

Sample of convenience – a sample or subset of a population made up of people that are easy and convenient for the researcher to contact, such as all of the students in a classroom.

Systematic sampling – a way of sampling using a system or procedure where individuals do not have an equal chance of being selected.

**Opinionnaires* and *Questionnaires* can be combined into one survey instrument, gathering information about what people know, as well as their opinions and attitudes about a topic.

Vocabulary Sources

Business Dictionary, <http://www.businessdictionary.com>

Explorable.com, <https://explorable.com/simple-random-sampling>

Hungerford, H.R., Volk, T.L., Ramsey, John M., Litherland, Ralph A., & Peyton, R. Ben. (2003). *Investigating and Evaluating Environmental Issues and Actions: Skill Development Program*. Stipes Publishing, L.L.C., Champaign, IL.

NOAA National Marine Sanctuaries, <http://sanctuaries.noaa.gov/education/evaluation/glossary.html>

Research Connections, <http://www.researchconnections.org/childcare/research-glossary>

Science Dictionary, <https://www.thesciencedictionary.com>

Shuswap Watershed Project Teacher's Handbook
http://shuswapwatershed.ca/pdf/Education_Handbook.pdf

Learning Objectives

- Students will identify and investigate a current environmental issue.
- Students will evaluate the environmental events, problems, and issues, and identify the knowledge, beliefs, and values of stakeholders involved with the issue;
- Students will develop research questions and design research instruments to collect data.
- Students will collect and analyze data, and develop charts, graphs, concept maps, etc. to communicate their findings.
- Students will write a report and present their research to peers, school administrators, parents, and/or the community.
- Students will develop solutions, create an action plan, and carry out an action plan to mediate or solve the environmental issue they researched.

Guiding Questions

- How do we thoroughly and effectively evaluate environmental issues when there is conflict regarding how to solve an environmental problem?
- How do we evaluate possible solutions to resolve or mediate environmental problems?
- What of environmental action exist, and which ones are most appropriate for individual environmental problems?

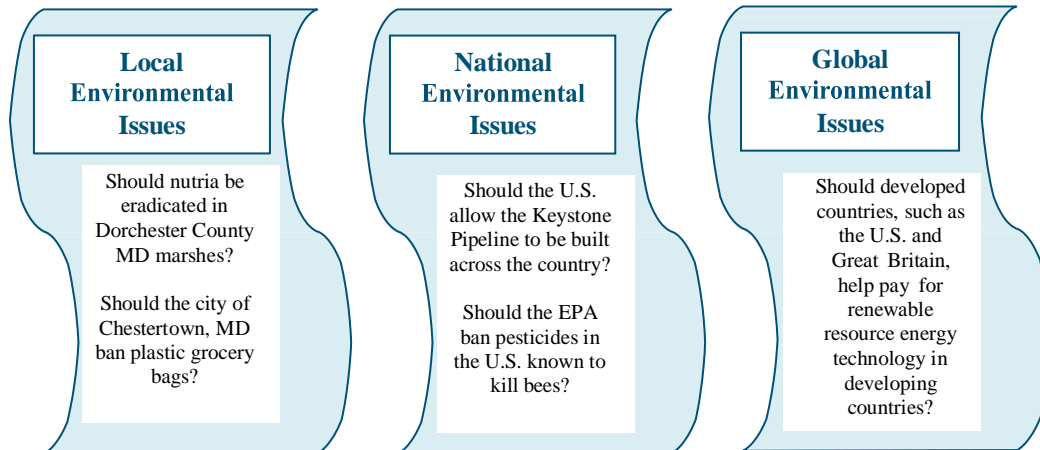
PROCEDURE

ACTIVITY I: Identifying Current Environmental Issues

ENGAGEMENT

Students will identify current environmental issues on a local, national, and global scale.

1. Ask your students to identify and read about current local, national, and global environmental issues in the news. This will expose them to other environmental issues, not just oysters in Chesapeake Bay. The assignment can be accomplished in class, or as a homework assignment. Sources of information can come from online websites, newspapers, or other media resources. They should identify one issue for each geographic scale.
2. As a class, ask students to share what they discovered:
 - Provide paper (flip chart) labeled for local, national, or global issues.
 - Give each student a marker, and ask them to write on the paper under the proper heading the issues that they found.



- Ask them if they can identify similarities or differences among the different locations. If they have brought in printed materials (copy of an article from a newspaper or internet resource), they may attach it to the wall under one of the geographic categories.
- Choose a few of the issues, and ask students to briefly identify the stakeholders and their associated values.
- Were there any reasonable recommendations made in the articles that were agreeable to the stakeholders, and was action taken to resolve the issue?
- Give students time throughout the week, or other specific time frame to collect information about local, national, and global issues. They may continue to bring in

articles to share. Tell students that they should begin thinking about local environmental topics that they are interested in, because they will be doing their own issue investigation.

ACTIVITY II: Choosing an Environmental Issue to Investigate

EXPLORATION

Students will choose an environmental issue to investigate, in-depth, on a topic of interest. Students may work individually, with a partner, or as a small group.

Teacher Note: If a student is not interested in oysters, but is rather in some other locally relevant environmental topic, allow them to research the topic of their choice. This should be a student-driven research project.

1. Students will identify a topic that they are personally interested in and would like to learn more about.
2. Using both primary scientific resources and secondary sources of information, students will perform background research on their topic, and identify an environmental issue that they would like to investigate related to the topic. They will submit the issue they wish to investigate to their teacher for approval.

Instruct your students that secondary resources should be evaluated for reliability.

Primary scientific sources, include peer reviewed journal articles, and reports from resource agencies, such as NOAA, MD Department of Natural Resources, or the U.S. Fish and Wildlife Service, Maryland Sea Grant, Chesapeake Bay Program, among others.

Teacher Note: See *A Research Guide for Students and Teachers*, Developing an Effective Search Strategy, pp. 9-11,

http://www.esf.edu/outreach/k12/documents/pagesfromresearchguide_nsfkg122.pdf

3. From their background research, and applying the skills they learned in previous Modules, the students will:
 - Identify the event and problem(s) associated with the environmental topic they have chosen; then choose an issue associated with problems to research. See example in Appendix A – Teacher Pages.

ASSESSMENT: Students develop a concept map that identifies events, problems, and issues around their topic of interest, and possible research questions they would like to answer.

ACTIVITY III: Identifying Stakeholders, Beliefs, and Values

EXPLANATION

Again, students should analyze resources to:

- Determine the stakeholders involved in the issue.
- Identify the beliefs and values of the stakeholders, and the stand they take on the issue using research papers, news articles, or other multimedia sources, and feedback from experts that they may have contacted.

ASSESSMENT: Students complete a *Players, Beliefs, and Values Chart* for at least one issue related to their topic using an article or other media resource. (A copy of the chart can be found in Appendix D of Module 1).

ACTIVITY IV: Developing Research Questions and Data Collection Instruments

EXPLORATION

Students will develop research questions, and design research instruments to collect data about the issue they are investigating.

1. Develop research questions using the *Rules for Writing Research Questions for Environmental Issue Investigations and Associated Variables* in Appendix C from Module 1. The type of issue students investigate will guide the design of their research instrument, whether they are collecting physical observable data related to the environment, or social data targeting stakeholder knowledge, beliefs, and values.
2. Consider both the environmental and social contexts of the issue when developing questions. Remind your students that environmental issues involve humans. Evaluating issues includes collecting information about social systems, as well as environmental systems (See *Variables* in Module 1 – Appendix C), and is key to thoroughly analyzing environmental issues!

ASSESSMENT: Students will develop at least three research questions they would like answered regarding the issue they have chosen to investigate, and submit these questions to their teacher for approval.

Developing Data Collection Instruments

- Physical Field Survey – used to collect observable data in a specific area (e.g., water quality, habitat delineation, weather data, etc.)
- Questionnaire – Used to collect information about what people know, what they do.
- Opinionnaire – used to collect information about what people think. This may include information about opinions, beliefs, and attitudes about a specific topic.
- Combination instrument – Combination Questionnaire-Opinionnaire
- Interview questions – the person being interviewed should be knowledgeable about the topic, and include stakeholders who hold differing positions about the environmental issue that the student is researching.

(See Hungerford, et al, 2003, pp 97-112)

Other Collection Instrument Resources:

- *A Research Guide for Students and Teachers*, Sampling Design, pp. 19-26; How to Design a Questionnaire, pp. 27-32
http://www.esf.edu/outreach/k12/documents/pagesfromresearchguide_nsfkgk12-2.pdf
- *Shuswap Watershed Project Teacher's Handbook*, (February 2011), Version 2.1.
http://shuswapwatershed.ca/pdf/Education_Handbook.pdf

Resources Related to *Bias*:

Examples of students' biased questions can be found here:

<http://www.calvin.edu/~rpruim/courses/libarts-stats/100/overheads/biased.shtml>

This video reviews biased questions:

http://www.icoachmath.com/math_dictionary/biased_question.html

Additional Bias and Survey Instrument resources can be found in the *References and Resources* section of this Module.

Teacher Note: It is very important that the teacher review the students' data instrument before sharing them with the public to make certain that their statements or questions are not **biased**. (Perhaps students from different research groups could perform a peer review of data instruments as well). It is possible to alienate survey participants resulting in them refusing to answer the questions. Remember, you will be asking a sample population questions to:

- Determine what people know (or think they know) about a problem or issue.
- Determine public opinion about the problem or issue.

Know your audience and be able to identify your own personal biases!

ACTIVITY V: Collecting and Analyzing the Data

EXPLORATION/ EXPLANATION

1. Students will collect data using the research instruments they designed in [Activity IV](#). This process could take any number of forms – field work, opinionnaires, questionnaires, and interviews. Remember to collect data on both environmental and social systems, if appropriate.
 2. Organize and interpret data, developing graphs or other visualization. Develop conclusions and inferences for each research question.
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ACTIVITY VI: Developing Action Plans

ELABORATION

Students will develop solutions, create an action plan, and carry out an action plan to mediate or solve the environmental issue they researched.

Actions could include:

- **Persuasion** – convincing others that a certain action is desirable (e.g., letter writing, public service announcements, editorials, etc.)
- **Consumer action** – economic pressure aimed at changing the behaviors of business or industry (e.g., refusing to purchase items because of packaging, the method of harvesting, or treatment of workers; or only purchasing items that are labeled “energy efficient,” GMO-free, etc.)
- **Political action** – persuasion aimed at elected officials or governmental agencies (e.g., picketing, rallies, signing a petition)
- **Ecomanagement** –physical actions focused on improving the status of an issue or problem (e.g., planting trees for erosion control, building bird nest boxes, or home or energy water conservation projects)
- **Legal action** – action aimed at law enforcement or legal restraint (e.g., voting, campaigning, lobbying)

Vocabulary Sources

Investigating and Evaluating Environmental Issues and Actions, Hungerford and Volk, See pages 159 – 195 in Hungerford & Volk, 2003.

Shuswap Watershed Project Teacher’s Handbook, (February 2011), Version 2.1, p. 23.
http://shuswapwatershed.ca/pdf/Education_Handbook.pdf

Types and Benefits of Environmental Action

<u>Type of Environmental Action</u>	<u>Ease of Evaluating Benefits to the Environment</u>
Persuasion: educating or lobbying other members of the public.	Benefits may never be demonstrable, and/or may not exist. The possibility exists that this persuasion may not in fact change anyone's behavior.
Consumerism: either changing one's own consumer habits or encouraging others to do so.	Several measurement instruments can be used to identify changes in consumerism, and resources documenting the relationship between consumer habits and environmental impact are readily available*
Political Action: action that is aimed at influencing a decision-maker.	Decision-makers may never respond to pressure – or a pro-environmental decision they make may be due to other factors. Interviews of decision-makers can be helpful in determining this.
Ecomanagement: action to restore, remediate, or improve a natural area.	This is easily documented and measured using a "before and after" scenario. Funders who emphasize easy accountability, such as EcoAction, place high emphasis on activities of this sort.
Legal Action: action taken through legal avenues.	Action of this sort can be easily documented, through such things as judicial decisions.

Types and Benefits of Environmental Action

From *Shuswap Watershed Project Teacher's Handbook*, (February 2011), Version 2.1, p. 23.

http://shuswapwatershed.ca/pdf/Education_Handbook.pdf

Action Projects

- Types and Benefits of Environmental Action, pp. 22-23
- Criteria for Action Projects in Environmental Education, pp. 23-24

Criteria for Action Projects can be found on pp 24-25. *Quick References for Environmental Action*

A Teacher's Guide to Community Environmental Action

<http://www.abcee.org/cms/wp-content/uploads/2010/10/Teacher-Action-Guide.pdf>

Guidelines for Developing an Action Plan

Eco-Schools (Great Britain)

<http://www.eco-schools.org.uk/gettingstarted/actionplan>

National Wildlife Foundation – Steps for Developing an Action Plan, Step 3 - Eco-Action

<https://www.nwf.org/Eco-Schools-USA/Become-an-Eco-School/Steps/Eco-Action-Plan.aspx>

Green Schools Alliance Action Plan

<http://www.greenschoolsalliance.org/students/congress/sc3-commitment>

A Research Guide for Students and Teachers, p. 6

http://www.esf.edu/outreach/k12/documents/pagesfromresearchguide_nsfgk12-2.pdf

Examples of Student Projects

A Research Guide for Students and Teachers, p. 7-8

http://www.esf.edu/outreach/k12/documents/pagesfromresearchguide_nsfgk12-2.pdf

TYPES OF ENVIRONMENTAL ACTION

Students should work in small groups. Consider the following environmental topics related to exotic invasive species in the Chesapeake Bay watershed. Choose one species, read through the resource(s) listed below.

Answer the following questions:

1. When did the species arrive here?
2. How did it get here?
3. What are its negative characteristics that make it invasive?
4. What type of environmental action has been taken, if any, to address the issue?
5. Using the remaining list of environmental actions, recommend an action for each category, if applicable. (e.g., If only *Ecomanagement* strategies have been implemented for a species, how might *Persuasion*, *Consumerism*, *Political Action*, or *Legal Action* strategies apply?)

Maryland Invasive and Exotic Species

<http://dnr2.maryland.gov/Invasives/Pages/default.aspx>

Mute Swans

http://dnr2.maryland.gov/wildlife/Pages/plants_wildlife/Invasives/inv_MuteSwan.aspx

Northern Snakehead

<http://dnr2.maryland.gov/fisheries/Pages/snakehead.aspx>

http://dnr2.maryland.gov/fisheries/Documents/Write-up_NSH.pdf

Blue and Flathead Catfish

http://dnr2.maryland.gov/fisheries/Documents/Invasive_Catfish_%20Fact_Sheet.pdf

Chinese Mitten Crabs

<http://dnr2.maryland.gov/Invasives/Documents/mittencrab09.pdf>

Purple Loosestrife

http://www.dnr.maryland.gov/wildlife/Plants_Wildlife/PurpleLoosestrife/index.asp

Didymo

http://dnr2.maryland.gov/Invasives/Documents/Didymo_EPA_Fact_Sheet.pdf

Water Chestnut

http://www.dnr.maryland.gov/bay/sav/water_chestnut.asp

Wavyleaf Basketgrass

http://www.dnr.maryland.gov/wildlife/Plants_Wildlife/WLBG/index.asp

ACTIVITY VI: Final Report and Presentation

EVALUATION

Students will write a report and present their research to peers, school administrators, parents, and/or the community.

Report and Presentation Outlines – Teachers can modify this any way they want. The written report and presentation should include the following:

- Title
- Background information
- Identify the Event, Problem, Issue – You may *Develop a Concept Map with Event(s), Problem(s), and Issue(s)* showing cause and effect.
- Research Questions
- Identify the Stakeholders. **Note:** Remember, do not make assumptions about what a group knows or believes. Individuals within that stakeholder group may hold different beliefs altogether from another group member.
- Develop *conclusions and inferences* for each data set
- Include the Survey Instrument(s) that you used to collect data
- Solutions/Recommendations
- Action Plan
- References
- Acknowledgements

ACTIVITY VII: Conversation Mapping and the Eastern Oyster

EXTENSION

Background

Students have reviewed a lot of background material to learn about the Eastern oyster in Chesapeake Bay. Using the research and evaluation skills they have gained from the first three Modules, students will create a *Conversation Map* that provides a voice for them to make comments, express thoughts and ideas, ask questions, and voice opinions regarding a particular “trigger.”

Conversation mapping is an efficient way of collecting a large amount of data from a diverse group of experts and/or stakeholders in a short period of time. It is one of the core activities of the Systems Thinking tool-set. Philip Wallis – Blog – Conversation Mapping (See link below)

The trigger could be *Oysters in the Chesapeake Bay*, or you could be more specific with *Oyster Sanctuaries in Harris Creek*. Feel free to use any trigger that will get your students involved in the conversation. If there is another environmental issue that your class is interested in, you may choose to use that issue for the *Conversation Trigger*.

Teacher Note: Below are links to some very good resources that provide the steps for developing a Conversation Map. Watch the YouTube video and refer to the other websites to get a feel for the activity before giving your students the assignment:

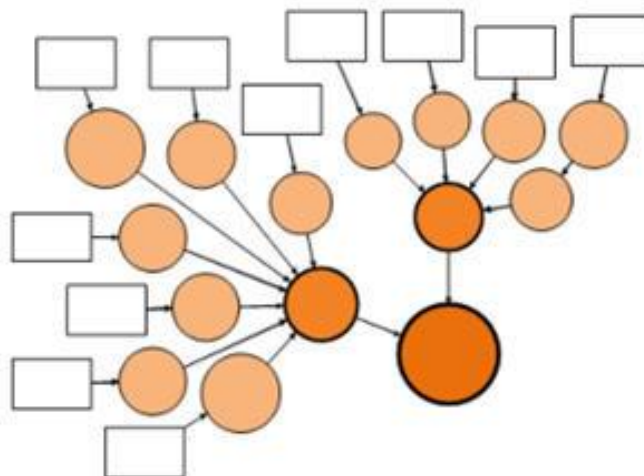
- https://www.youtube.com/watch?v=2npgMBm_HiU
- <http://old.cognitive-edge.com/wp-content/uploads/2005/06/29-Conversation-Mapping-BMcK-0605.pdf>
- Philip Wallis – Blog – Conversation Mapping
<https://philipwallis.wordpress.com/2012/02/14/conversation-mapping/>

1. Introducing the Technique

You will need to introduce conversation mapping to your students by showing them how the conversation map progresses from a central trigger topic to a range of conversational strands, as shown.

During this exercise there is **NO TALKING – WRITING Only!**

The map may look something like this:



2. Developing the Conversation

Divide the students into groups of approximately 10 – 15 each. Groups should begin by writing down the ‘conversation trigger’ in a circle in the middle of the paper. Conversations should start branching off from the trigger question. You can either use the same conversation trigger for each table, or assign different triggers to each table to maximize responses.

Ask students to build a concept map related to the sanctuaries issue in Harris Creek (or another issue of their choosing), and begin developing a conversation by adding their thoughts associated with the issue. Thoughts, ideas, opinions, questions, and reasons why students are concerned about the topic should be written and circled. If a student thinks of a comment, question, etc., about the comment another student made, they should draw a line, write their comment, and circle or draw a box around it, and so on, until they have run out of things to say.

Allow students to work 20 minutes on their Conversation Map, switch to review what the other group has written, and then allow them to continue writing on the other group’s Conversation Map.

3. Using a Concept Mapping Tool to Outline the Conversation

From the Conversation Map, transcribe the information using a mapping tool, such as *Insight Maker*, that provides an outline of the conversation.

Teacher Note: A number of Concept Mapping Tools can be found at NspiredD² <https://itlatnd.wordpress.com/2011/05/11/ten-popular-concept-mapping-tools/>

Provide each student with a copy of the *Map* and the *Outline*. This can be either a hard copy, or if students have computers, they can add more information as the activity continues.

4. Identifying emergent themes

Once the conversation has ended, and the conversation has been mapped by a tool of your choosing, ask your students to identify “emergent themes” that show up as ideas appearing in more than one part of the conversation(s), and that connect conversational strands together. Emergent themes could include:

- Opportunities
- Needs
- Threats
- Strengths
- Weaknesses

Sources for this activity ask you to label the emerging themes using one color post-it for *issues* and another for *opportunities*. It is best to write these concisely with a marker or pen.

Here is an example of an actual Conversation Map:



Source: <https://philipwallis.wordpress.com/2012/02/14/conversation-mapping/>

5. Ask your students the following questions:

- Identify the key issues that people/community are most concerned about. Solutions may appear based on these themes.
- Ask students to identify the solutions that come up in the emergent themes.
- Consider the beliefs and values of others as you evaluate the responses that are shared. The beliefs and values of those involved with the issue, reveal many different ideas formulated about the topic (*trigger*).
- Ask students to label who they think the various statements in the conversation map could represent.
- Who are the stakeholders? Some of this information may have come from prior knowledge gained during the earlier Modules in this Unit. Perhaps you could have the students role-play during this exercise using some of the belief statements used from earlier lessons.
- Identify the value descriptors for each comment.
- Provide each student with the Conversation Map and the Outline with whatever mapping software you used.
- Ask students to discuss how this process could be used to identify stakeholders, beliefs, and values.

EDUCATION STANDARDS

Next Generation Science Standards		How is Standard Addressed
NGSS Core Disciplinary Idea(s)	<p>DCIs may or may not be identified at this level, depending on what the student chooses to investigate. Possible DCIs include:</p> <p>HS-LS2.C: Ecosystem Dynamics, Functioning, and Resilience If a biological or physical disturbance to an ecosystem occurs, including one induced by human activity, the ecosystem may return to its more or less original state, or become a very different ecosystem, depending on the complex set of interactions within the ecosystem.</p>	<p>How Standard is Addressed</p> <p>HS-LS2.C: Depending on the type of environmental issue that students evaluate, they often research the effects of human activity on ecosystem functioning.</p>
	<p>HS-LS4.D: Biodiversity and Humans Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. (secondary to HS-LS2-7), (HS-LS4-6) ETS.1 Developing Possible Solutions</p>	<p>HS-LS4.D: Students may evaluate human effects on biodiversity as it pertains to a local environmental issue – if appropriate.</p>

<p>NGSS Science/Engineering Practice(s)</p>	<p>Engaging in Argument from Evidence Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.</p> <ul style="list-style-type: none"> - Compare, integrate, and evaluate sources of information presented in different media formats, as well as in words in order to address a scientific question or solve a problem. - Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source. 	<p>Engaging in Argument from Evidence</p> <p>Students collect data about an environmental issue with which they are interested, and must evaluate the following:</p> <ul style="list-style-type: none"> • Secondary sources of information; they should be able to recognize bias in a source. • Primary sources of information, including the data they have collected from their research <p>Students will develop research questions, collect data, and use both primary data and secondary data to defend an argument by making recommendations to solve an environmental problem.</p>
<p>NGSS Cross-Cutting Concept(s)</p>	<p>Cause and Effect</p> <p>Students suggest cause and effect relationships to explain and predict behaviors in complex natural and designed systems.</p>	<p>Cause and Effect</p> <p>Students consider how possible solutions to the issue they are researching could be implemented to address the environmental solution.</p>

<p>Ties to Common Core</p>	<p>ELA/Literacy</p> <ul style="list-style-type: none"> • Research to Build and Present Knowledge. Common Core 9-10 and 11-12) Writing/ History and Social Studies • Integration of Knowledge and Ideas. Common Core (9-10 and 11-12) Reading/ History and Social Studies <p>RST.11-12.7: Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-LS2-7)</p> <p>MP.2: Reason abstractly and quantitatively. MP.4: Model with Mathematics.</p>	<p>RST.11-12.7: Students will investigate a local environmental issue, write a report and present their findings to their peers, school, and the local community.</p> <p>MP.2 & MP.4: Students analyze data to make a claim supported by evidence.</p>
<p>Ties to MD Environmental Literacy Standards</p>	<p>Standard 1.0: Environmental Issues Topic A: Environmental Issue Investigation Indicator 1: Identify an environmental issue.</p> <ul style="list-style-type: none"> • The student will recognize that real problems have more than one solution and decisions to accept one solution over another are made on the basis of many issues. SCI CLG 1.1.1 • The student will investigate a biological (or environmental) issue and be able to defend their position. SCI CLG 3.6.2 • Identify an environmental issue and formulate related research questions. SCI CLG 6.4.1 <p>Indicator 2. Develop and write research questions related to an environmental issue.</p> <ul style="list-style-type: none"> • Identify an environmental issue and formulate related research questions. SCI CLG 6.4.1 <p>Indicator 3. Given a specific issue, communicate the issue, the stakeholders involved, and the stakeholders’ beliefs and values.</p>	<p>Topic A, Environmental Issue Investigation Indicators 1-5: By evaluating all sides of an issue, based on stakeholders’ beliefs and values, students may find that there is more than one acceptable solution to the problem. They develop research questions, design and conduct the research, analyze and interpret data, and develop conclusions from their research.</p>

<p><i>Ties to MD Environmental Literacy Standards</i></p>	<p>Indicator 4. Design and conduct the research.</p> <ul style="list-style-type: none"> • The student will select appropriate instruments and materials to conduct an investigation. SCI CLG 1.2.5 • The student will identify appropriate methods for conducting an investigation (independent and dependent variables, proper controls, repeat trials, appropriate sample size, etc.). SCI CLG 1.2.6 • Design and conduct the research. SCI CLG 6.4.2 <p>Indicator 5. Use data and references to interpret findings to form conclusions.</p> <ul style="list-style-type: none"> • The student will recognize data that are biased. SCI CLG 1.1.4 • The student will organize data appropriately using techniques such as tables, graphs, and webs. SCI CLG 1.4.1 • The student will analyze data to make predictions, decisions, or draw conclusions. SCI CLG 1.4.2 • Interpret the findings to draw conclusions and make recommendations to help resolve the issue. SCI CLG 6.4.3 <p>Topic B: Action Component</p> <p>Indicator 1. Use recommendation(s) to develop and implement an environmental action plan.</p> <ul style="list-style-type: none"> • Apply the conclusions to develop and implement an action project. SCI CLG 6.4.4 • Text Types and Purposes. Common Core (9-10 and 11-12) Writing/History and Social Studies <p>Indicator 2. Communicate, evaluate and justify personal views on environmental issues and alternate ways to address them.</p> <ul style="list-style-type: none"> • The student will recognize that real problems have more than one solution and decisions to accept one solution over another are made on the basis of many issues. 	<p>Topic B: Action Component</p> <p>Indicator 1. Based on research conclusions, students develop recommendations and create an action plan.</p> <p>Indicator 2. Students justify their argument on how they stand on the issue they investigated, and the recommendations to solve the problem. They must also evaluate whether their proposed action is reasonable: Can they complete the action, and will it improve</p>
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	<p>SCI CLG 1.1.1</p> <ul style="list-style-type: none"> • The student will communicate conclusions derived through a synthesis of ideas. <p>SCI CLG 1.5.9</p> <ul style="list-style-type: none"> • Analyze the effectiveness of the action project in terms of achieving the desired outcomes. SCI CLG 6.4.5 • Text Types and Purposes. Common Core (9-10 and 11-12) Writing/History and Social Studies 	<p>or resolve the problem?</p>
	<p>Standard 7: Environment & Society The student will analyze how the interactions of experience, learning, and culture influence social decisions and social change.</p>	<p>Standard 7: Environment & Society To thoroughly investigate an environmental issue, students evaluate ALL sides of the issue, which includes analysis of stakeholders’ beliefs and values.</p>
<p><i>Ties to MD State STEM Standards of Practice (Draft)</i></p>	<p>5. Engage in Logical Reasoning A. Engage in critical thinking.</p>	<p>Engage in critical thinking. Students evaluate scientific data, make conclusions and inferences, make recommendations, and revise recommendations based on new information.</p>
<p><i>Ties to C3 Framework for Social Studies</i></p>	<p>Dimension 3: Evaluating Sources and Gathering Evidence</p> <p>Dimension 4: Communicating Conclusions and Taking Informed Action</p>	<p>Dimension 3: Students collect data from primary and secondary sources. Primary sources may include social or physical survey data.</p> <p>Dimension 4: Students communicate their research findings, including critiquing their peers’ projects. From their research they suggest recommendations for solving the environmental problems, develop an action plan, and choose whether they will take action.</p>

MODULE REFERENCES

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<https://philipwallis.wordpress.com/2012/02/14/conversation-mapping/>

OTHER RESOURCES

Survey Instruments

Survey Questions 101: Do you make any of these 7 question writing mistakes?
<http://www.qualtrics.com/blog/writing-survey-questions/>

Common Sense Tips for Creating Surveys That Work <http://www.qualtrics.com/blog/creating-surveys/>

Examples of Bad Questions & Suggestions of How to Fix Them!
<http://people.wku.edu/holli.drummond/first%20page/classes/strategies%20of%20social%20research/example%20of%20bad%20survey%20questions.pdf>

Catalog of Biases in Questionnaires (Health related, but rules could apply to any questionnaire)
<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1323316/>

Creating Good Interview and Survey Questions

<https://owl.english.purdue.edu/owl/resource/559/06/>

Common Survey Question Mistakes That'll Ruin Your Data

<https://www.surveymonkey.com/blog/2015/02/11/5-common-survey-mistakes-ruin-your-data/>

Opinionnaire

<https://reischlenglish.files.wordpress.com/2012/10/opinionnaire.pdf>

Measuring Attitudes Using the Likert Scale

<http://www.simplypsychology.org/likert-scale.html>

The Likert Scale Explained

<https://www.surveymonkey.com/mp/likert-scale/>

Likert Scale – Changing Minds

http://changingminds.org/explanations/research/measurement/likert_scale.htm

What are Likert-Type Scale Responses, When to Use Them, and Examples

<https://www.surveylegend.com/likert-type-scale-responses-examples-with-examples/>

Types of Surveys <http://www.socialresearchmethods.net/kb/survtype.php>

Surveying Attitudes: Questionnaires vs. Opinionnaires

[http://jayalden.com/docs/Surveying Attitudes.pdf](http://jayalden.com/docs/Surveying_Attitudes.pdf)

*Survey Monkey – Environmental Issues Survey Template

<https://www.surveymonkey.com/mp/environmental-issues-survey-template/>

Survey Monkey – Diet and Exercise Survey Template <https://www.surveymonkey.com/mp/diet-exercise-survey-template/>