Modeling and Macroinvertebrates

(10 class sessions)

Authors

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SUBJECT/GRADE LEVEL

Subject Area: Science/Math

Grade Level: Middle School

Materials

- Water samples and/or water sample worksheet
- Microscopes (if using actual water samples)
- Computers for research
- Optional items available for model design including
  - Plastic, paint or aluminum trays
  - Aluminum foil or wax paper
  - Plastic materials (tablecloths to be cut)
  - Styrofoam or cardboard
  - Tape
  - Paper
  - Sand, soil, rocks, plant material
  - Light source (lamp) (to test for shade on model)
  - Spray bottle (to test for erosion)
  - Water
- Student worksheets

STANDARDS

Next Generation Science Standards

- MS-LS2-4
- MS-LS2-5
- MS-ETS_1-1.
- MS-ETS1-2
- MS-ETS1-3
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Mathematics Standards | Common Core State Standards

- CCSS.MATH.CONTENT.7.RP.A1 Analyze proportional relationships and use them to solve real-world and mathematical problems
- CCSS.MATH.CONTENT.7.RP.A3 Use proportional relationships to solve multistep ratio and percent problems.
- CCSS.MATH.CONTENT.7.NS.A1 Apply and extend previous understandings of operations with fractions, decimals and percents.
- CCSS.MATH.CONTENT.7.EE.B3 Solve real-life and mathematical problems using numerical and algebraic expressions and equations.

English Language Arts Standards | Common Core State

- CCSS.ELA-LITERACY.RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.
- CCSS.ELA-LITERACY.RI.6.10 By the end of the year, read and comprehend literary nonfiction in the grades 6-8 text complexity band proficiently, with scaffolding as needed at the high end of the range.

LESSON OBJECTIVE(S)

Students will be able to

Determine the health of a stream by analyzing macroinvertebrates.

Design a model to demonstrate a healthy watershed.

CAREER CONNECTION(S)

Mentor Background: **Dr. Audrey Harrison** is a Research Entomologist in the Aquatic Ecology and Invasive Species Branch within the Environmental Laboratory at ERDC. Audrey's work as an entomologist includes both terrestrial and aquatic insect assemblages. Current research focus areas include large river macroinvertebrate community dynamics, restoration of large woody debris habitat, insect/fish food web interactions, stream entomology, and pollinator surveys on DoD installations. Audrey serves as a course instructor for WRAP Stream Restoration for Regulators and PROSPECTS #280 Ecosystem Restoration. Audrey's educational background includes a Bachelor of Science - Biology, Mississippi College, Clinton, MS. 2009. Concentration: Aquatic Entomology; Master of Science - Entomology, Clemson University, Clemson, SC, 2012. Thesis: *The Diets of Larval and Juvenile Pallid Sturgeon (Scaphirhynchus spp.) in the Lower Mississippi River*; Doctor of Philosophy – Biology, University of Mississippi, Oxford, MS. Dissertation: *Effects of Hydrological Connectivity on the Benthos of a Large River (Lower Mississippi River, USA).*

Samantha Wiest is a research environmental engineer with ERDC's Environmental Laboratory. She recently obtained her Engineer Intern (EI) license, graduated from Oregon State University with a BS in Ecological Engineering, and is hoping to earn a Master's degree in a related field. In her years at ERDC, she has worked on projects related to developing a riparian model for impact and benefit assessment, storm water management, and developing hydraulic models for habitat research. She wants to continue her focus on work related to ecosystem restoration, water resources, and sustainability.

STEM Careers: Entomologist, Environmental Scientist, Environmental Engineering

ENGAGEMENT

Brief Description: In this portion of the lesson, students will work in small groups to use a dichotomous key to identify the macroinvertebrates in a given sample.

Procedures:
Time frame: One 40-minute class periods

Background: Aquatic macroinvertebrates are aquatic organisms that lack backbones and are large enough to see without magnification. Macroinvertebrates are classified using a dichotomous key. The samples used in this lesson are extrapolated from a survey done by the US Army Corp of Engineers on Luxapalila Creek in 2020.

Teacher and student actions:
The lesson will begin with the teacher showing students a picture of a macroinvertebrate. The teacher will ask the students to individually make a list of the things they notice about the creature and the things they wonder about the creature. After five minutes, the teacher will ask for volunteers to share their list with the rest of the class. The teacher will show a picture of a second macroinvertebrate beside the first picture and ask the students to note the differences between the two organisms. Once the students have had a chance to share, the teacher will explain that the pictures are of macroinvertebrates, and that a dichotomous key can be used to identify the type of macroinvertebrate. The teacher will walk the class through using the dichotomous key to identify the first macroinvertebrate. The teacher will then place the students into small groups and give them a sample of images to identify. Students can identify the samples using this online interactive dichotomous key - Macroinvertebrate Identification Key (macroinvertebrates.org) or this presentation. If students are running short on time or having difficulty with the dichotomous key, they can use this Macroinvertebrate Identification for Beginners. The student groups should identify each of the macroinvertebrates in their sample. If they finish early, they can work on identifying the items from another sample.

Formative assessment: Students can be formatively assessed on their discussion responses. Groups can be assessed based on the accurate identification of the macroinvertebrates in their sample.

Possible adaptations: Groups of students can be given visual representations of water samples or can take a trip to a local watershed area to collect samples to observe. Students may work individually or in groups for this portion of the lesson. Students may be assigned macroinvertebrates that are easier or more difficult to identify based on the needs of the students.

EXPLORATION

Brief Description: In this portion of the lesson, students will learn about why macroinvertebrates are used to determine stream health.

Procedures:
Time frame: One 40-minute class period

Background: Aquatic macroinvertebrates are aquatic organisms that lack backbones and are large enough to see without magnification. Macroinvertebrates can serve as bioindicators of the health of aquatic environments. Additional information about aquatic macroinvertebrates is linked in the resources section.

Teacher and student actions: The teacher will begin the lesson by asking students to brainstorm their thoughts about the connection between macroinvertebrates and the water. Students will also complete this math worksheet to further explore the Mississippi watershed area. After completing the worksheet, students will share their responses, and the teacher will explain that macroinvertebrates can tell us more about the water quality of an area. The teacher will show this video about why macroinvertebrates are used to determine stream health. As students watch the video they should be writing down information. After the video, ask students to write one question and one observation they have about the information in the video. Working in a small group, the students will share their observations and questions with their small group. The students will also read the information on this page - Macroinvertebrates - Kenilworth Park & Aquatic Gardens (U.S. National Park Service) (nps.gov) and jot down their two key takeaways. They will then make predictions about the type of water quality their sample was from. They will identify evidence for their predictions. They won't develop a firm idea yet as the next lesson will have them use their sample to calculate water health.

Formative assessment: Students can be formatively assessed based on their observations/questions and small group discussion. Students can assess the completion of the predictions of the quality of their water sample. Students can also be assessed on their completed math worksheets.

Possible adaptations: Students could work individually instead of with small groups. If time is a concern, students could watch the video or read the article rather than doing both.

EXPLANATION

Brief Description: Based on their findings from the previous lesson, students will explain the type of environment their sample of macroinvertebrates came from. Students will examine environmental characteristics such as temperature, plant availability, water flow, and erosion.

Procedures:
Time frame: One 40-minute class period

Background: Different types of macroinvertebrates are found in different levels of water quality. Water quality levels are impacted by a variety of factors including temperature, pollution, erosion, water flow and plant cover.

Teacher and student actions: The teacher will ask the students to recap the information they have learned so far about macroinvertebrates. Students should note that they have identified different types of macroinvertebrates using a dichotomous key and that they have learned how macroinvertebrates can be indicators of water quality. The teacher will explain that the groups will revisit their water quality predictions from the previous portion of the lesson and determine the water quality levels for their samples of macroinvertebrates. The teacher will review the biomonitoring data form with the students and explain how it is used. The students will then work in their small groups to complete the Biomonitoring data worksheet based on the macroinvertebrates they identified in the engage section of the lesson. Students will then revisit the prediction they made in the exploration section of the lesson and explain the accuracy of their predictions.

Formative assessment: Student groups can be formatively assessed based on the completion of their biomonitoring data form and the explanation of the accuracy of their predictions.

Possible adaptations: Students could work on the activity individually rather than in groups and then compare responses for the samples. If groups finish their biomonitoring data page early, they could complete a biomonitoring data page for a different sample. Students could begin to think about the possible reasoning behind the quality of water of their sample or draw a sketch of the area where the sample may have come from.

ELABORATE

Brief Description: In this portion of the lesson students will be introduced to the real world challenge of restoring an area of the Mississippi after the creation of a visitor center. Students will follow a process of design, test, and retest, to create an environment where their sample of macroinvertebrates could survive.

Procedures:
Time frame: Six 40-minute class periods

Background: Water quality is impacted by a variety of factors. When buildings are created and the environment is changed, steps can be taken to restore an area.

Teacher and student actions:
Part 1: The teacher will review the information that students have covered so far in the unit. The teacher will then introduce the prompt that students will be tasked with engineering a way to ensure that the macroinvertebrates present in their sample are able to live in the environment after the development of a learning center. This information is on page 1 of the student document.

Part 2: The students will start by individually drawing a design for the restoration of the assigned area. The students will then share their ideas with the members of their group. After each group member has shared, the group will develop a consensus model and budget for their design (pages 2 and 3 of the student document). Students will participate in a gallery walk (page 6 of the student document) of the models to provide feedback on the other designs.

Part 3: The students will work in groups to build their design.

Part 4: The students will work in groups to test their design based on the project criteria. The teacher will ask the class to brainstorm ways that they can test their model. Examples can include, using a spray bottle to mimic rain and erosion, tilting the model to test erosion, using a lamp to measure shade levels over the water, etc. The data collection sheet is page 4 of the student document.

Part 5: The students will work in groups to redesign their project based on the data from their tests by completing pages 3 and 5 of the student document.

Part 6: The students will work in groups to test their second design and complete a reflection page. Student pages for all parts of the Elaborate section.

Formative assessment: Students will be formatively assessed on the completion of the gallery walk and design pages.

Possible adaptations: If time is a limiting factor, students could do one round of building and testing. Similarly, students could design the prototype and then explain why it would/wouldn't work without testing it.

EVALUATION

Brief Description: In this part of the lesson students will create video reflections of what they learned.

Procedures:
Time frame: One 40-minute class period

Background: Having students report out on their learning can provide them with authentic ways to demonstrate their understanding of a concept.

Teacher and student actions: The teacher will ask student volunteers to remind the class of the steps that have been taken so far in the project. The teacher will explain that the final part of the lesson is for students to demonstrate their understanding of the concepts learned. The students will create a model to display for the community and will feature the model in a video reflection about what they learned.

Formative assessment: Students can complete a brainstorming page before they complete their video. Rubric can be used to assess their video.

Possible adaptations: Students could work in their groups or individually for this summative project. Students could create a comic or poster of their design instead of creating a video.

REFERENCES

- Provide links to resources that you used in the creation of this unit.

Water Quality Impacts on Aquatic Macroinvertebrates | USU - Includes tolerance levels and list of items that macroinvertebrates need to survive

macroinvertebrate useful for explaining types of macroinvertebrates.

What can macroinvertebrates tell us about water quality? – AWWareness (auburn.edu)

https://docs.google.com/presentation/d/10VkgB_xhGX41xXnlaKXk9ntzKzxRNJvg/edit?usp=sharing&ouid=110141026072728959178&rtpof=true&sd=true

https://www.nps.gov/keaq/learn/nature/macroinvertebrates.htm

https://greatriverpassage.org/wp-content/uploads/2023/08/FINAL-Mississippi-River-Learning-Center-Report.pdf