Mathematical Modeling: Eat Like a Bird

Peter Brandt

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For more information about this lesson and Designing for Technology Integration seminars contact TERC: alan_feldman@terc.edu.

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The Knowledge Loom is a free, web-based professional development resource for educators maintained by The Education Alliance at Brown University.

For more information about The Knowledge Loom, contact The Education Alliance: loom@lab.brown.edu

NEIR*TEC *DTI Instructional Design Template

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Peter Brandt
peter_brandt@terc.edu

Overview

Unit Focus

Math/science-investigating animal behavior using mathematical models

Grade/Professional Development Level

grades 4-12, math/science

Duration of Unit/Professional Development Experience

90 minutes

Learners and Contexts

Description of Learners

Learners are teachers K-12 (any subject), leaders of professional development, technology integration specialists, or administrators.
The content of this lesson was developed with middle school students in mind, and this professional development version of the lesson has been tested with educators K-12.
Prior knowledge:
(Science) Participants have some experience with the scientific method, enjoy hand-on science experiments, and are generally familiar with seagulls and their feeding habits.
(Math) Participants have some experience with data collection and analysis as well as basic graphing and graphic analysis.
(Technology) Participants have some experience with basic computer skills including Internet skills.

Context Analysis

The lesson should be conducted in a room with access to the Internet and enough computers for each group of four. Laptops are ideal; a computer lab with workspace adjacent to computers would also work well.

Goals and Standards

Essential Question

Content (mathematics and science):
How can we explain patterns in the behavior of animals?
How can technology resources support mathematics and science inquiry?

Goals

Science:

- Participants will apply the scientific method to investigate a natural phenomena.
- Participants will conduct an experiment and accurately record data from that experiment.
- Participants will interpret data and make substantive conjectures.
- Participants will be able to connect understandings gained from simulated phenomena to real phenomena.

Math:

- Participants will accurately interpret data presented in new and unfamiliar graphical forms.
- Participants will use data analysis and graphing to gain insight into a natural phenomena.
- Participants will understand the story represented by the data (e.g., "diminishing returns") and identify key elements of the pattern like inflection point and limits.

Alignment with standards/frameworks

Math

NCTM Standard -Data Analysis

- Students will develop and evaluate inferences and predictions that are based on data.
- Students will discuss and understand the correspondence between data sets and their graphical representation.

NCTM Standard -Connections

- Students will recognize and apply mathematics in contexts outside of mathematics.

NCTM Standard -Representations

- Students will use representations to model and interpret physical, social, and mathematical phenomena.

Science

NSTA -Life Science Standard

- Students should develop understanding of
  --regulation and behavior
  --diversity and adaptations of organisms

Increasing access for all learners

This unit her will meet the needs of a variety of learners by representing information through video images, audio, text, and graphs. By working in groups, participants who are less skilled in using one kind of information can be assisted by participants who are more skilled with that mode of learning.

The experiment is an active and engaging way to introduce both the scientific and mathematical concepts. Although the general concepts are abstract, the unit makes these concepts accessible

Performance Objectives

Participants will develop at least three conjectures, based on the data provided, concerning the feeding behavior of the crows. Each will provide a plausible advantage (or disadvantage) of a given behavior.
Participants will engage in a class discussion about the feeding behaviors during which multiple statements about energy expended vs. energy gained (food) will be made.
Groups will effectively conduct the experiment organizing their efforts in a way that leads to accurate recording of their data.
Groups will be able to state specific advantages and disadvantages to each drop height and make relevant connection to the natural phenomena.
Participants will analyze the pattern of the graphed data and link it to their experience during the experiment and use the shape of the graph and informal calculations to justify an optimal drop height.
Participants will recognize the pattern of the graphed data as representative of their experience during the experiment and identify parts of the graph that represent element of the phenomena (like steep slope to start shows how quickly the height effected the drop number at first and the shallow to end show how after a certain height there was little gain).
Based on their experience with this activity, participants will be able to craft an observable conjecture and conduct a field observation.

Instructional Activities and Assessments

Introduction/Pre-Instruction

Ask the students to share their knowledge of the feeding habits of seagulls.

Inform students that today they will be participants on a "Virtual Field Trip" to observe one feeding habit of the Northwestern Crow

Introduction/Pre-Instruction Assessment

Assess the participants' previous knowledge and ability to identify significant details in feeding habits. This assessment will take place through careful listening (a) during the group discussion, (b) through interaction with groups and individual students as they watch the video, and (c) through one-to-one interactions.

Instructional Activities

Activity 1
After the opening discussion students explore the "Whelk-Come To Mathematics" lesson on the NCTM Illuminations web-site (http://illuminations.nctm.org/imath/912/Whelk/index.html) While they explore this page, they watch the one minute video that shows the feeding behavior of these birds. Participants identify the key details of this feeding behavior, make conjectures about the advantages and disadvantages of each of the characteristics, and generate additional questions they have about the feeding behavior. This activity ends with a discussion of what participants have learned and the conjectures they have developed that explain the crow's behavior.

Activity 2
Participants conduct the experiment as described in the "Whelk-Come To Mathematics" lesson on the NCTM Illuminations web-site (http://illuminations.nctm.org/imath/912/Whelk/whelk2.html). The webpage allows for students to enter the data they collect. After they conduct the experiment, they complete a set of questions, “Reflect on the Experiment” (available on the website), with their group.

Activity 3
Participants review their reflections on the experiment in small groups and then the class considers the graph of the aggregated class data as they discuss the phenomena. Participants identify elements in the data and graph that illustrate key elements of their experience and the phenomena. They then use the additional questions they identified during Activity 1 to draft a proposal for an observational study which they might conduct during a field trip to the shore.

Assessment

Activity 1
Assess participants' understanding through careful attention to the group discussion and discussions among small groups during the activity, and through the review of conjecture sheets.

Activity 2
Observe each group to be certain that they understand the procedures for the experiment. Assess participants' understanding through careful attention to the group discussion and discussions among small groups during the experiment. Pose questions to each group to assess their understandings and prod them into making connections to the natural phenomena and to the math and science concepts.

Activity 3
Assess participants' understanding through careful attention to the group discussion.

Assessible end product/activity

End product/activity assessment

Implementation and Reflection

The Big Picture

This lesson is often presented as part of TERC's institutes, as one of several GMOTT (Good Models of Teaching with Technology) exemplars. This unit highlights the excellent resources that are available on the web -in this case, a one-minute video of the feeding behavior of the Northwestern Crow, a simplified spreadsheet and grapher, and careful instructions for teachers.

This unit was adapted by Peter Brandt (TERC), based on the unit posted by on the NCTM site. The version presented here follows the NCTM version closely --Pete teaches the unit with some significant variations. This written version was initially drafted by Pete and finished by Alan Feldman.

Implementation Timetable

Implementation Reflection: Goals

Implementation Reflection: Performance Objectives