

Title: Ecology, Field Studies and the Scientific Method

Introduction

Students often hold the misconception that science takes place in a laboratory being done by old men wearing glasses in white lab aprons and that the only way that experimentation can take place is in within the confines of the lab. In this article students examine the activities of an ecology researcher as he tries to unravel the complex relationships along tallgrass prairie of Minnesota. The article would provide an excellent introduction to an existing lesson on ecology field techniques, such as quadrat sampling, transect sampling or mark recapture activities.

Learning Outcomes:

1. Students will gain insight into the nature of science and the processes involved in the methods of science.
2. Students will develop critical thinking skills necessary to question and to explore answers to questions posed by science.
3. Students will develop communication skills necessary to understand scientific writing.

Curriculum Alignment:

National Standards addressed by this lesson include content standards for grades 9-12 for the Life Sciences. Fundamental concepts include the abilities necessary to do scientific inquiry and the interdependence of organisms.

North Carolina Standards

Biology

5.01 Investigate and analyze the interrelationships among organisms, populations, communities, and ecosystems.

- Techniques of field ecology.
- Abiotic and biotic factors.

1.01 Identify biological questions and problems that can be answered through scientific investigations.

1.02 Design and conduct scientific investigations to answer biological questions.

- Create testable hypotheses
- Identify variables.
- Use a control or comparison group when appropriate.
- Select and use appropriate measurement tools.
- Collect and record data.
- Organize data into charts and graphs.
- Analyze and interpret data.
- Communicate findings.

English III

2.01 Research and analyze ideas, events, and/or movements related to United States culture by:

- locating facts and details for purposeful elaboration.
- organizing information to create a structure for purpose, audience, and context.
- excluding extraneous information.
- providing accurate documentation.

6.01 Demonstrate an understanding of the conventions of language by:

- decoding vocabulary using knowledge of Anglo-Saxon, Greek, and Latin bases and affixes.
- using vocabulary strategies such as context clues, resources, and structural analysis (roots, prefixes, etc.) to determine meaning of words and phrases.
- analyzing the power of standard usage over nonstandard usage in formal settings such as job interviews, academic environment, or public speaking events.

6.02 Discern and correct errors in speaking and writing at a level appropriate to eleventh grade by:

- reviewing and refining purposeful use of varying sentence types with correct punctuation.
- reviewing and refining correct pronoun usage, antecedents, and case.
- refining subject/verb agreement and choice of tense.
- extending effective use of phrases and clauses.
- discussing parts of speech as they relate to writing.
- editing for correct spelling and mechanics.

Classroom Time Required:

One 90 minute class period for reading and discussion. If time permits the instructor may wish to have students design a field study of their own or as a class activity this could include multiple days depending on the study.

Materials Needed:

Copy of New York Times articles "Ecologist Measures Nature's Mosaic, One Plot at a Time" which can be accessed at:

<http://www.nytimes.com/1998/10/06/science/scientist-work-g-david-tilman-ecologist-measures-nature-s-mosaic-one-plot-time.html?scp=1&sq=Ecologist+Measures+Nature&st=nyt>

Frayer Circles

Technology Resources:

Computer with internet access

Pre-Activities/ Activities: Students should have been introduced to the science of ecology. Unfamiliar vocabulary should be addressed using the Frayer charts provided, further information on using the Frayer charts can be found on the resources page. The instructor should review common sampling techniques in field ecology using internet or textbook resources. Three of the most common techniques along with a brief description are found in a table at the end of this lesson. The instructor should preview the rubric provided to in order to assist students in being successful and to correctly deliver the information students may need in order to design their own field study.

- **Engage:** Engage students with a review of the scientific process and the associated vocabulary; also introduce the meaning of abiotic/biotic and any new terms from the article. This may also be a good time to have students think about careers in the life sciences.
- **Explore:** Students should read the article making note of the types of experiments mentioned in the article. By the end of the article students should begin to realize that Dr Tillman’s research revolves around the interaction of living organisms and the abiotic factors that affect them. Ask students to develop a list of questions that could be answered by the methods used by Dr. Tillman.
- **Explain:** The process of science and how field studies are important to the scientific process and how the design of field studies doesn’t always fit the traditionally taught “scientific method” taught in the school curriculum. Introduce students to the three most common examples of field studies (see chart below). Direct students to revisit the questions posed earlier and to decide which if any of the methods discussed could be used to answer these questions. Be sure to include in your discussion the importance of maintain a control for comparison and how only one variable should be manipulated at a time. Also address the collection of data and how it can be represented using charts and diagrams.
- **Elaborate:** Allow the students to design a field study that could be done on or nearby to campus. Allow them to discuss their plans within small groups. Try and set a tone for critiquing each others experimental plans while being supportive to one another. Your goal is to develop the best plan.
- **Evaluate:** Use the scoring rubric provided to assess the student designed field study. The rubric is designed to allow scoring for those who wish to follow the field study. This may not be possible for some so you may need to adjust the rubric according to your specific needs or to what extent students are able to progress on the project.

Assessment:

Students would be assessed based upon the elements of experimental design such as clear statement of hypothesis, identification and control of variables, application of experimental type to question under study.

Modifications: Students could design experiments in cooperative groups or this could be done as a class activity. The teacher may want to work toward having the class design a particular experiment or study and then give the students sample data to analyze if individual circumstances prevent the class from actually performing the activity.

Alternative Assessments:

Supplemental Information: see chart below on types of field studies.

Critical Vocabulary These are the terms with which students seem to have the most difficulty, since the English standard course of study emphasized etymology of word this information is provided where it could be found.

biotic - From the Latin *bioticus* derived from the Greek *biotikos* "pertaining to life" from *bios* "life". The living components of an ecosystem.

control – The part of an experiment used as a baseline for comparison.

mosaic – From the Latin *musaicum* "mosaic work, work of the Muses," A picture or decoration made of small, usually colored pieces of inlaid stone, glass, etc.

abiotic - see *Biotic* above for etymology, the prefix *a-* denotes "not". The non-living factors within an ecosystem such as water, sunlight and temperature.

ecologist - From the Greek. *oikos* "house, dwelling place, habitation" + *-logia* "study of". A scientist who studies the interactions among organism and their environment.

proliferate - From the Latin *proles* "offspring". To produce many offspring.

hypothesis -From the Greek. *hypothesis* "base, basis of an argument, supposition," lit. "a placing under," from *hypo-* "under+ *thesis* "a placing, proposition" . A statement of the outcome of a scientific investigation.

biodiversity – From the Greek. *bio* "life" + *diversus* "turned different ways,". Diversity among the living things in an area.

oscillation – From the Latin *oscillare* "to swing,". In the context of the article the meaning is to move from one condition to the other.

variable – From the Latin. *variabilis* "changeable," from *variare* "to change". The part of an investigation that is manipulated by the scientist.

ebullient – From the Latin. *ebullire* "to spout out, burst out," from *ex-* "out" + *bullire* "to bubble". Overflowing with enthusiasm

Comments

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Common Methods of Field Studies

Transect Sampling

Description A tape or rope marks the line. The species occurring along the line or within a given parameter (example 5 cm) are recorded.

Useful for determining changes in community composition along an environmental gradient such as a slope or change in moisture or humidity.

Considerations include time constraints. Works best for plants and easily captured animals such as some arthropods. Causes minimal disturbance to the environment. Low abundant species may be missed.

Quadrat Sampling

Description Sampling units or quadrats which may range from one to several meters are placed randomly or in a grid pattern on the sample areas. The occurrence of a organisms in the squares is noted.

Useful for determining community composition and features of population abundance: species density, frequency of occurrence and percentage cover.

Considerations May be time consuming to do well. Works best for plants and easily caught animals. Quadrat size must be appropriate to the organisms being surveyed. Rapidly moving or cryptic organisms may need to be trapped. Can be disturbing to ecosystem if animals or plants are removed.

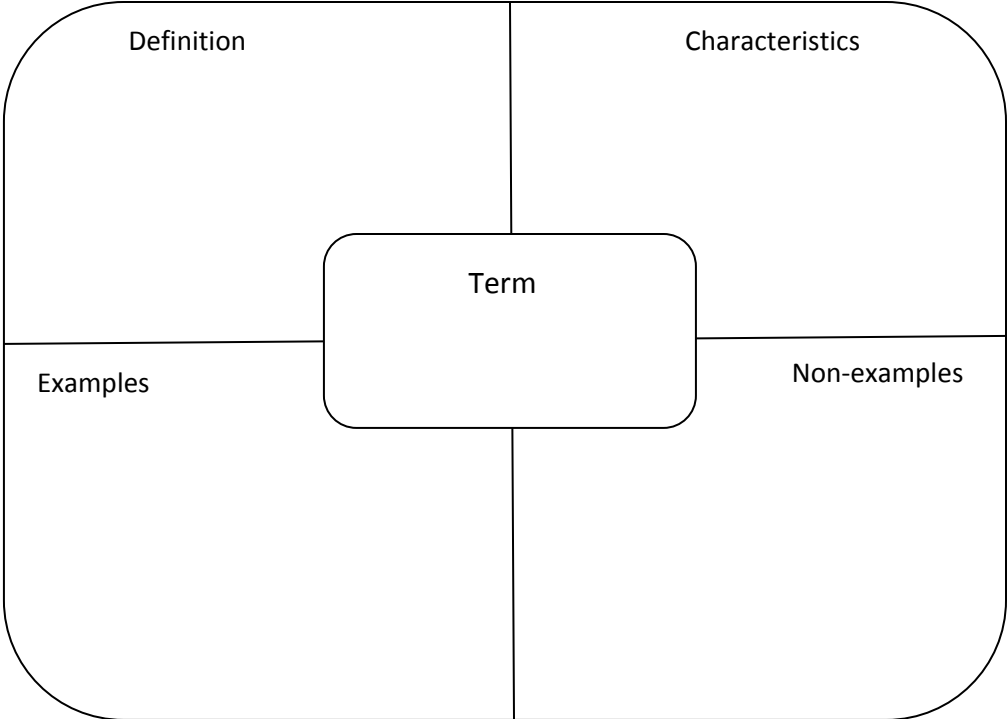
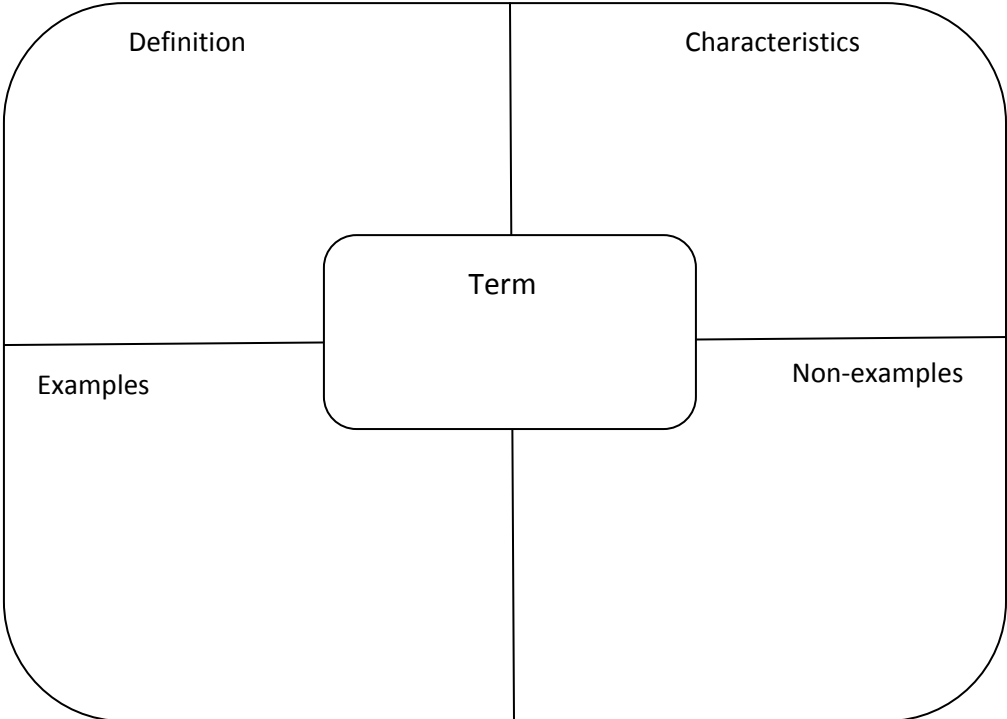
Mark & Recapture (capture-recapture)

Description Animals are captured marked then released. After a suitable time period, the population is resampled. The number of marked animals recaptured in a second sample is recorded as proportion of the total.

Useful for determining total population density for highly mobile species in a certain area such as beetles or butterflies.

Considerations can be time consuming. Not suitable for immobile species. Populations should have a finite boundary. Periods between samplings must allow for redistributions of marked animals. Markings should present little disturbance and should not affect behavior.

Frayer Vocabulary Circles



Barton, Mary Lee & Deborah L.Jordon. Teaching Reading in Science 2nd edition. Aurora: MCREL, 2001.

Ecology Field Study Rubric			
Criteria	Poor (1 pt)	Fair (3 pts)	Good (5 pts)
Reason behind study	No reason is given for the study.	A reason is given for the study, but the reason seems to have no benefit for the student.	A reason is given for the study that will benefit the student.
Questions or Process of Measurement	No questions are included, and no measurement collection is addressed.	The questions are biased, or the process of collecting measurements is vague.	Nonbiased questions are included, or a process is described in detail about how the accuracy of measurements will be maintained
Population	No population is identified.	A population is identified, but it is not what the sample will measure.	Intended population is accurately identified.
Sample Collection	No process is included about how the sample will be collected.	A process is included about how the sample will be collected, but the process is vague.	A detailed process is included about how the sample will be collected.
Sample Data	Sample data is not neatly displayed and does not represent the intended population.	Sample data is not neatly displayed, but it represents the intended population, or the sample data is neatly displayed but does not represent the intended population.	Sample data is easily understood and neatly displayed in a table or chart. The sample represents the intended population.
Summary of Data	No summary of the type of data is included.	A summary of the type of data collected is included but only its type or level of measurement is accurate.	A summary of the type of data collected includes accurately whether the data is qualitative or quantitative and its level of measurement.
Experiment vs. Observational Study	Student does not accurately identify whether the study is observational or experimental.	Student identifies accurately whether the study is observational or experimental, but only includes one reason for the decision.	Student identifies accurately whether the study is observational or experimental, citing at least 2 reasons for choosing the label.
Assessment of Data	No discussion is given about how the sample data will be assessed.	One to three sentences are included about how the sample data will be assessed.	A paragraph of at least 4 sentences is included about how the sample data will be assessed.