Conference Strand: Research Symposium & NAAEE Conference Poster Session

Implications of Field Science Inquiry for K-12 EE

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ABSTRACT

A panel of experts was convened in Washington State in 2004 to create an investigation template to help K-12 teachers conceptualize and assess *field studies* by students, in an initial attempt to introduce more authentic forms of inquiry into the standards and into the lives of students. This panel included scientists, learning sciences specialists, assessment specialists, master teachers, and members of the Office of the Superintendent of Instruction. The template was intended to articulate new visions of inquiry and direct the development of field investigation items on the state science assessments. This paper outlines descriptive, comparative and correlative methods of field studies, and compares the study designs. The key differences relate to the identification of variables, data collection, the analysis of data, and the ways in which the data are represented. These forms of investigation are more representative of the types of science being done in the field today and they provide rigorous and engaging inquiry experiences for young learners.

BACKGROUND

Natural resource scientists and educators are working to ensure that science education in schools includes the science of studying natural environments. One barrier to implementing conservation education is that some school systems and/or state standards do not recognize field studies as legitimate science inquiry. They recognize only those investigations that utilize cause-effect relationships and hypothesis testing. In other words, they recognize only those investigations where all conditions can be controlled and manipulated in an experimental setup.

Current state and national standards in science encourage instruction that focuses on problem-solving and inquiry— activities which characterize the pursuits of scientists (see AAAS, 1993; NRC, 1996, 2000; NSTA, 1995). Analyses of practice in scientific communities have shown that there is no universal method and that science inquiry can take a variety of forms (Alters, 1997; Knorr-Cetina, 1999; McGinn & Roth, 1999). Procedurally, some scientists do formulate and then test hypotheses; other scientists, however, construct their hypotheses only after data analysis, and still other scientists, such as field biologists, astronomers, or anatomists, conduct descriptive research in which hypotheses may not be explicitly tested (Latour, 1999;1987).

The majority of research in natural resources does not fit the experimental design/controlled experiment model.

- In biological sciences the systems being studied are complex, and variables often interact in probabilistic ways.
- Most studies must be done in the natural environment, because the simple act of “reproducing” natural phenomena in the laboratory may distort how those phenomena occur.
- Most scientists in the field do not actively manipulate variables and maintain “control” and “experimental” groups.

- Field studies often do not assume that there is a causal relationship between variables. The relationship may be one of correlation, but not necessarily causation.

There is currently no national consensus on the framework for science inquiry in the field and how it relates to experimental design. This is another barrier to teachers' understanding and implementing field investigations. It also creates a barrier for students' ability to transfer their knowledge of inquiry from the classroom into the natural environment and vice versa.

FIELD INVESTIGATION MODEL

The goal of natural resource scientists and educators represented by the Association of Fish and Wildlife Agencies is to introduce more authentic forms of inquiry about natural resources into state science standards and into the lives of students. The Association is partnering with other national natural resource education organizations, scientists, teachers and others to establish a model of three types of field investigation scientific inquiry that will help accomplish this goal.

The three types identified include descriptive, comparative and correlative. The differences relate to the framing of the investigative question, identification of variables, ways in which the data is represented, and the form of the conclusions (Windschitl, Ryken, Tudor, Dvornich, Koehler 2007).

These three types of field investigation have many advantages:

- They are more representative of the types of science being done today. Not only do they represent the science of natural resources; they also represent astronomy, genetics, oceanography, meteorology and other subjects.

- They are more engaging for young learners.

Descriptive Design

Descriptive field investigations involve describing parts of a natural system.

- Example 1: Second graders recorded and graphed food preferences for local lizards, their habitat niches, and body characteristics such as length, weight and color. Students explored descriptive questions such as "What do lizards eat?" and "Where are the lizards most common?" To find out what short-horned lizards did over the winter, they did a literature search but found little data. To further explore they built an enclosure in the schoolyard in an attempt to mimic conditions in the field. The students' work provided new descriptive insights into how the lizards behave during the change of seasons.
- Example 2: High school students wanted to answer the descriptive question, "Where do cougars go when their habitat gives way to a new housing development?" Students worked with a state fish and wildlife agency biologist and participated in capturing the cougars, marking them with ear tags and collecting physical data that includes length, neck girth, chest girth, length and condition of canine teeth and weight. They collected blood and tissue samples for disease analysis and DNA profiling. Students helped radio-track the animals from the air and the ground. They plotted coordinates of cougar locations on computer-generated maps of the study area and used computer programs to calculate the space each cougar occupies annually and during each season. The location information allowed scientists to study the home range of the animal throughout the year.

Comparative Design

Comparative field investigations are the most similar to controlled investigations because data is collected on different groups, under different conditions, at different times or at different locations to make a comparison.

- Example 1: Fourth graders interested in learning about home range and seasonal daily movements of the lizard gathered information from local area farmers about lizard sightings and then identified and marked these locations on maps. This first part is considered descriptive inquiry, but the students followed up with a comparative study by asking the question “Is there a difference in lizard movement in different seasons?” Here the comparison is movement at different times of the year. To do their comparison they radio collared lizards and collected data comparing the amount of movement the lizards undertook during each of the four seasons.
- Example 2: High school students decided to investigate the question, “What is the effect of forest type on deer and elk populations?” They set up study zones within different forest types and measured stand characteristics such as slope, tree numbers and canopy cover. Wintertime deer and elk track data was collected and then used to compare between forest types.

Correlative Design

Correlative field investigations involve measuring or observing two variables and searching for a pattern.

- Example 1: Students from the same elementary school are following up with a correlative study by investigating two questions, “What is the relationship between temperature and lizard abundance?" and "What is the relationship between rainfall and lizard abundance?" They're using tools such as geographic information systems (GIS) and spreadsheets and collecting data on temperature and rainfall. Once several years of data are collected, students will begin to make predictions about lizard abundance based on rain and temperature data.

- Example 2: The students studying the deer and elk populations are introduced to simple statistical procedures so that they can investigate correlations between the numbers of animal tracks present and characteristics (canopy cover, number of trees/acre, slope, etc.) of each forest site.

The table below outlines the differences and similarities among the designs of descriptive, comparative and correlative field investigations and relates these to the essential features of inquiry.

<table>
<tr><th colspan="4">Three Types of Field Investigations</th></tr>
<tr><td>Essential Questions</td><td colspan="3">What defines my environment?
What is a healthy environment?
What is humans’ relationship to the environment?
How can our community sustain our environment?
What is my role in the preservation and use of environmental resources?</td></tr>
<tr><td></td><td>Descriptive</td><td>Comparative</td><td>Correlative</td></tr>
<tr><td>Formulate Investigative Question</td><td>How many?
How frequently?
When Happen?</td><td>Is there a difference between groups, conditions, times, or locations?</td><td>Is there a relationship between two variables?</td></tr>
<tr><td>Identify Setting within a System</td><td colspan="3">Identify geographic scale of investigation (e.g., riparian corridor or Cedar River Watershed)
Identify time frame of the investigation (e.g., season, hour, day, month, year)</td></tr>
<tr><td>Identify Variables of Interest</td><td>Choose measurable or observable variables</td><td>Choose a measured variable in at least two different (manipulated variable) locations, times, organisms, or populations</td><td>Choose two variables to be measured together and tested for a relationship</td></tr>
<tr><td rowspan="2">Collect and Organize Data</td><td colspan="3">Multiple measurements over time or location in order to improve system representation (model)
Individual measurement is repeated if necessary to improve data accuracy
Record and organize data into table(s) or other forms</td></tr>
<tr><td></td><td colspan="2">Describe how sampling, measurement, observations were consistent for the two or more locations, times or organisms (controls) and was random and representative of the site.</td></tr>
<tr><td rowspan="2">Analyze Data</td><td colspan="3">Means, medians, ranges, percentages, calculated when appropriate
Organize results in graphic and/or written forms and maps using statistics where appropriate</td></tr>
<tr><td colspan="2">Typical representations of the data to build a descriptive and comparative models
Charts
Line Plots
Bar Graphs
Maps</td><td>Typical representations of the data to demonstrate correlations upon which models are developed
Scatter plots
r-values</td></tr>
<tr><td rowspan="2">Use Evidence to Support a Conclusion</td><td colspan="3">Answer the investigative question
Use data to support an explanation.
Limit conclusion to the specific study site.
Compare data to standards.</td></tr>
<tr><td>Does the data summary answer the investigation question?</td><td colspan="2">Does the evidence support the hypothesis?</td></tr>
<tr><td>Discussion</td><td colspan="3">Discuss how results help answer the system's question and add to our understanding of the model/system.
Compare data to other similar systems/models.
What factors might have impacted my research?
How do my findings relate to the essential questions?
What are my new questions? What action should be taken? Why?</td></tr>
</table>

CONCLUSIONS

This field investigation model is an initial attempt to introduce more authentic forms of inquiry into the standards and into the lives of students. The effort is long overdue. Not only are these forms of investigation more representative of the types of science being done today, they are more engaging for young learners. Natural resource scientists and educators hope that this initiative can be opened up to critique, refinement, and elaboration by others dedicated to a similar vision of advancing the way we think about school science.

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