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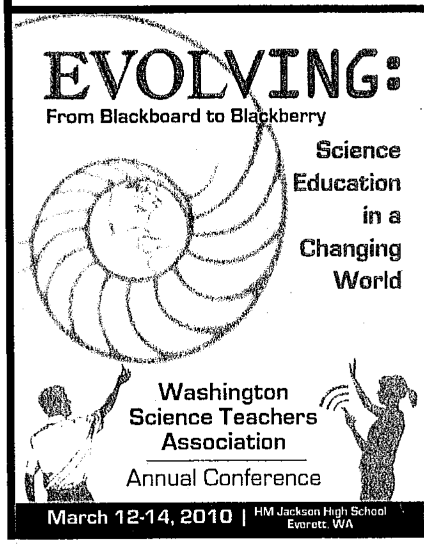
Reflections from the 2010 Spring Conference



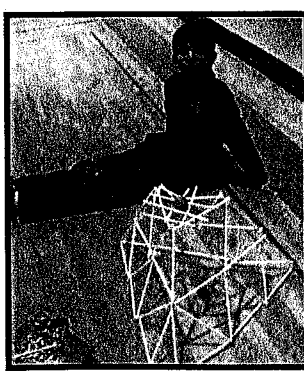
WASHINGTON SCIENCE TEACHERS ASSOCIATION
WSTA

Science Education: A Sustainable Future for All

Mark your calendar March 18-20, 2011

EEAW

Port Townsend at Fort Worden State Park and Conference Center



Results from the Eastside 41st WSTA Annual

Engineering Contest

A Model for Field Investigation in the Science Classroom

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Science education has long focused on one model of scientific inquiry: students test a hypothesis by conducting an experiment in which variables are carefully controlled, often under laboratory conditions. Usually, the hypothesis predicts cause-effect relationships. Yet this model does not represent the way research is conducted in many disciplines, including field-based biological sciences, astronomy, and geology. In these sciences, field investigation is the primary means of gathering data. To ensure that field investigation methods are taught in schools and recognized by state standards, a three-part model for field investigation was developed by a panel of science education professors, scientists, teachers, and practitioners convened by the Pacific Education Institute.

Field investigation addresses a range of research issues: Disciplines such as biology, for example, examine complex systems, and variables often interact in probabilistic ways. Most studies must be done in the natural environment, because complex environmental conditions cannot be reproduced in the lab. In the field, scientists usually cannot manipulate variables and maintain "control" and "experimental" groups, and they rarely assume a causal relationship between variables. Rather, scientists observe naturally occurring phenomena and look for descriptive, comparative, or correlative trends and relationships. The three approaches to conducting field observations—descriptive, comparative, and correlative—form the basis for the field investigation model:

Descriptive

These investigations involve describing parts of a natural system. For example, Waterville second graders studying short-horned lizards recorded and graphed food preferences, habitat, and body characteristics such as length, weight and color. The students explored descriptive questions, such as "What do lizards eat?" and "Where are the lizards most common?" They also built an enclosure in the schoolyard to mimic conditions in the field. Their work provided new descriptive insights into how the lizards behave during the change of seasons.

Comparative

These investigations are similar to controlled investigations. They may involve collecting and comparing data for different groups, organisms, locations, or times. For example, fourth graders studying the home range and daily movements of the short-horned lizard gathered information about lizard sightings from local farmers and then identified and marked these locations on maps. While the first part is considered descriptive inquiry, the students followed up with a comparative study, asking "Is there a difference in lizard movement in different seasons?" To make this comparison, they radio collared lizards, collected data on their movements during each of the four seasons, compared the results, and then drew conclusions.

Correlative

These investigations involve measuring or observing two variables and searching for a pattern. For example, students from Waterville are investigating two questions, "What is the relationship between temperature and lizard abundance?" and "What is the relationship between rainfall and lizard abundance?" Using tools such as geographic information systems (GIS), they collect data on temperature and rainfall. Once several years of data are collected, students will make predictions about lizard abundance. While it may be difficult to demonstrate a cause-effect relationship using such data, it is impossible to answer the questions using controlled laboratory experiments.

Field Investigation in Washington State Classrooms

Standards for Teachers

The field investigation model aligns well with the new standards for the preparation of teachers and provides teachers and teacher candidates with opportunities to meet the new standards through a sound, evidence-based approach.

Teacher preparation programs in Washington adhere to five state approval standards. Standard V, recently revised by the Professional Educator Standards Board, applies to all teachers in all grade levels and subject areas. It requires candidates to provide tangible evidence that they have acquired the prescribed knowledge and skills, emphasizes the integration of content across disciplines, and directly addresses scientific reasoning and environmentally sustainable practices (5.1.C and 5.3.D <http://www.pesb.wa.gov/documents/StandardV.pdf>).

The North American Association for Environmental Education recently developed national standards for the National Council for Accreditation of Teacher Education (NCATE). Addressing initial preparation of K-12 environmental educators, the standards require teachers to "demonstrate an understanding of various methods of inquiry, select inquiry methods that are appropriate for different kinds of environmental conditions, and engage in active learning through environmental inquiry" (Standard 2.1, "The EE standards submitted to NCATE," <http://www.naaee.org/programs-and-initiatives/ncate-ee-program-standards/>).

Standards for Students

Teachers adept at the three types of field investigation can use them to help students observe, ask questions, design inquiries, and collect, organize, and interpret data in order to develop concepts and relationships. These are all key components of the second Essential Academic Learning Requirement in Science (EALR 2) for Washington State learners: "The student knows and applies the skills, processes, and nature of scientific inquiry" (P. 8, <http://www.k12.wa.us/ CurriculumInstruct/science/pubdocs/ScienceEALR-GLE.pdf>). The associated Grade Level Expectations in Science include a description of field investigation (P. 62, Appendix E,); the degree to which students will be asked to apply field investigation methodology will depend on grade level. Goal 1 of the Environmental Education Guidelines for Washington Schools (2000) also states, "The student will develop knowledge about the components of the environment and understand their interactions within natural systems" (P. ix, <http://www.k12.wa.us/CurriculumInstruct/ EnvironmentSustainability/pubdocs/EEGuidelines2000.pdf>). The field investigation model thus gives educators a framework for meeting current standards in science and environmental education.

Moreover, students better understand the process of inquiry when they adapt the skills obtained from controlled investigations in the classroom to comparative field investigations in the natural world. Both types of investigation require a prediction or hypothesis. Students' procedures must describe what is changed (manipulated variable), what is kept the same (controlled variable), what is measured or observed (responding variable), how measurements are taken, and how multiple trials will be taken. Students must answer the investigative question, provide supporting data, and explain the connection of data to the question. Thus, comparative field investigations help students develop the knowledge and skills necessary to do inquiry, and this in turn contributes to their performance on the Science Washington Assessment of Student Learning (the state standardized exam).

Bringing the three-part model for field investigation into science classrooms allows teachers and students to broaden their understanding of scientific inquiry by introducing them to the methods of scientists whose investigations of the natural world cannot be conducted in the laboratory. It also provides excellent opportunities for experience-based learning. The value of this approach is now reflected in state and national standards for teacher candidates and students.

<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>Use Evidence to Support a Conclusion</td><td colspan="3">1. Answer the investigative question.
2. Use data to support an explanation.
3. Limit conclusion to the specific study site.
4. Compare data to standards.</td></tr>
</table>

Three Types of Field Investigations (continued)			
	Descriptive	**Comparative**	**Correlative**
Use Evidence to Support a Conclusion (continued)	Does the **data summary** answer the investigation question?	Does the **evidence support the hypothesis**?	
Discussion	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?		

This regular feature is presented by Washington TOTOS (Teachers of Teachers of Science)

The **audience** for the TOTOS articles are:

- university faculty members who teach elementary and secondary pre-service teachers to teach science,
- science educators who provide in-service training to teachers, and
- classroom teachers.

Guidelines for publication may be obtained from Dr. Martha J. Kurtz, Science Education Department, 400 E. University Way, Ellensburg, WA 98926-7540. Mail proposed TOTOS articles to Dr. Kurtz or e-mail them to: kurtzm@cwu.edu.

Guidelines for Submitting a Teacher of Teachers of Science (TOTOS) Articles

Martha J. Kurtz, Central Washington University

WSTA members thank TOTOS members for sharing their research with the state's professional science educational community through a regular section of the journal. To simplify the process for submitting articles, TOTOS members should follow these guidelines (see TOTOS article in this journal titled "A Model for Field Investigation in the Science Classroom"). The TOTOS articles in each journal will look somewhat alike so the members recognize them.

The **audience** for the TOTOS articles are:

- university faculty members who teach elementary and secondary pre-service teachers to teach science,
- science educators who provide in-service training to teachers, and
- classroom teachers.

Guidelines

1. Send potential articles for the TOTOS feature to **Martha J. Kurtz**, not to the WSTA journal editor
   Written: Science Education Department, 400 E University Way, Ellensburg, WA 98926-7540
   E-mail. Questions? kurtzm@cwu.edu or 509-963-1422.
2. Send articles at least **two weeks** before the deadline. The journal is published four times a year.
   The submission deadlines are: February 1, April 1, August 1, and October 1.
3. The WSTA editor will format the article so please do not spend much time with format. However, please organize the article with desired emphasis. Use the TOTOS article in this journal as a sample.
4. The WSTA journal is produced in Word formatted with 0.8 inch side margins in Times Roman font 11 with limited use of underlines and bold type.
5. Graphics, photographs, and tables are encouraged and should be included electronically.
6. Include the author's name, affiliation, and picture when appropriate.
7. Articles can be any length; the WSTA journal editor may shorten it if necessary.