SchoolYard Science:
A Learning Model for K-12 Life Sciences

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Overview

- Describe the development of cases
- Discuss the results of a study in one participating middle school classroom
- Outline how case development aligns with district teaching and learning goals
  - State Science Standards
  - District Scope & Sequence
- Describe the development and results of a district-wide professional development partnership
Benefits of Cases

• Cases provide instructional materials to support student inquiry
• Development of cases provides context for professional development
Research Projects Initiated By Schools As Part of SchoolYard Science (SYS)

- Life history and natural history of native and non-native organisms
- Succession and the impact of invasive organisms in schoolyard habitats
- Biological diversity of restored wetland habitats
- Development of a woodland management plan for school forest habitat
- Seasonal comparison of aquatic invertebrates in a small river
- Phenology of a vernal pond
- Comparison of 2 urban sediment detention ponds*
- Modeling nutrient dynamics in aquatic microcosms*

*Specific classroom study on student learning (Science Scope In Press Fall 2005)
Motivating Students to Ask Questions and to Guide Their Investigations: An Active Learning Exercise

- What is an Invasive Organism?
- How are Invasive Organisms different from Native/Natural Organisms?
- Why do you think that people are interested in invasive organisms?
- In your group identify and list 5-10 characteristics or traits of an invasive organism.
- How are these traits similar and different to native or natural organisms?
Connecting Student Research and Curriculum

- Student investigations are modeled after long-term ecological research (LTER) and conducted at/or near the school yard
- Data rich learning environments developed to link student inquiry with what's already known
- Cases are designed to be integrated into a curriculum to create student inquiry projects
SYS Case Example

- Life History and Natural History of Invasive Organisms
  - Characteristics of invasive plants
  - Comparison of native and non-native plants in SYS habitats
  - Developing an invasive plant management plan for SYS habitats
Ways of Thinking About Data

- Databases that provide background on plants and animals
- Databases that provide additional resources
- Databases that may be queried
- Real-time remote sensing data
Invasive Organism Case

- Connects to curriculum about organisms in 6th grade and populations 7th grade
- Provides additional background to motivate students’ questions related to a relevant issue
Motivating Student Questions: A 6th Grade Classroom Study

- Questions initially grounded in observations
- Productive questions lead to scientific inquiry
- Classroom discussion makes explicit links between questions and evidence
- Collaborative research project on model-based reasoning with Lucas, Broderick, Lehrer, and Schauble
Initial Questions From Students After Observations At Ponds

- How much blood can a leech suck in an hour?
- Are there more fish in our pond?
- Where does the water come from?
- What happens to the animals in the winter?
- How does the water in the pond get polluted?
- Is the animal life in pond 2 more diverse than pond 1?
‘What Makes A Good Question?’
Initial Criteria Developed By Students

• Easy to answer

• Meaningful / valuable

• Genuine

• Researchable

• Can not be answered yes or no
'Connecting Questions-Evidence-Arguments'
Revised Criteria Developed By Students

- Simple and understandable
- Investigator has an expected outcome
- Methods are clear from the wording
- Connected to other questions
- Revision of initial question
- Genuine: don’t already know the answer
- Research is doable given tools, knowledge, and supplies
- Sensible/meaningful; adds knowledge
Synthesis of Classroom Observations and Interviews

- Initial arguments based on personal beliefs
- Initial arguments based on single undocumented observations
- Classroom discourse and teaching shifted arguments to evidence
- Evidence includes documented observations, research of others, & empirical results
- Repeatability of results
Changing Students’ Beliefs About Evidence

Because I said so
Because someone told me so
Because an authority said so
Because I observed and documented
Because I conducted an experiment
Because I communicated my findings clearly
Because I created a model based on research
Because I only included evidence specific to my model

Summaries of classroom discussion and interviews with students to reflect changes in views of evidence over the course of the school year
Model-Based Reasoning

- Models were descriptive or predictive and different types were representational, narrative, mathematical, or physical
- Students created models that gave evidence of their understanding of complex systems and phenomena
- Classroom discussions were used to develop criteria for what makes a good model
Conclusions From Classroom Study

- Student research questions were more sophisticated when classroom design included discourse among students and also with content experts (e.g. ecologists, botanists, etc.)

- Student research was more sophisticated and iterative when it was imbedded throughout the year rather than in isolated units of instruction

- Students developed and revised models based on their research findings and used these to create arguments
Program Development & District Partnerships

• **Outline how case development aligns with district teaching and learning goals**
  - State Science Standards
  - District Scope & Sequence

• **Describe the development and results of a district-wide professional development program**
SYS Model

- District-wide (all 11 middle schools in MMSD, targets all 5,600 middle school students)
- Summer and academic year professional development and classroom support
- Teams of teachers and curriculum coordinators (school-based learning coordinator) participate from each school (some school teams also have an undergrad education student)
- UW graduate students and faculty/staff mentors provide science content and research protocol expertise
- Teams create cases to support teacher professional development and student inquiry
  - Cases are data-rich learning environments related to questions about the life and environmental sciences
  - Cases extend from content to the schoolyard habitat
Velma Hamilton MS SYS project
MMSD curriculum

• MMSD K-8 schools have adopted* the recommended curricula
  - 30/30 Elementary Schools have adopted **FOSS
  - 11/11 Middle Schools have adopted FOSS
    • 11/11 Middle Schools are participating in SYS

* - adoption does not necessarily equal implementation in all classrooms

** - Full Options Science Systems
## SYS History

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<td><strong>2000</strong> 5 schools, 20 life science teachers (6th grade), 500 students (est.)</td>
<td>2000 Summer and schoolyear professional development support, 100 teachers (est.)</td>
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<td><strong>2001</strong> 10 schools, 35 life science teachers (6th grade), 1,000 students (est.)</td>
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<td><strong>2002</strong> Joint Summer Institute on FOSS <em>Diversity of Life</em>, joint schoolyear inservices (45 teachers, all 6th grade)</td>
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<td><strong>2003-04</strong> Currently all 11 schools, multiple grades, 75 teachers, 2,000 students (est.)</td>
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Summary of SYS model and partnership

Attributes:

• Needs science experts for support
• Creates cross-district dialogue about science curriculum
• Develops Collaboration/partnership of higher education and local school districts
• Elicits teacher input into professional development needs
• Activities align with district curriculum and state and district standards
• Emphasis on student learning
Partnerships & Funding

- NSF-Long-term Ecological Research LTER School Yard Supplement (Steve Carpenter)
- NSF Graduate Teaching Fellows GK-12 (Terry Millar)
- Eisenhower Professional Development Program and Elementary and Secondary Education Act (Robert Bohanan & Kevin Niemi)
- Madison Metropolitan School District
- University of Wisconsin-Madison
- University of Wisconsin System
- Center for Biology Education
- North Temperate Lakes LTER
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- Rich Lehrer, Professor Peabody College Vanderbilt
- Leona Schauble, Professor Peabody College Vanderbilt
- SYS Teachers
- Graduate Teaching Fellows