Welcome to
Issue-Oriented Science: Engage, Motivate, Educate
Presented by SEPUP
Lawrence Hall of Science
UC Berkeley

Presenters

The Science Education for Public Understanding Program (SEPUP)

- Dr. Barbara Nagle, SEPUP Director
- John Howarth, SEPUP Associate Director
- Laura Lenz, SEPUP Instructional Materials Developer

Introductions

On an index card write . . .

- Your name
- The subject(s) you teach/specialize in
- Any experience you have with issue-oriented science instruction
- What you would like to gain from this session
Ideas About Issue-Oriented Science

Think about the following statement:

*Incorporating issues into science instruction occurs at the expense of understanding science content.*

Stand by the sign that most closely reflects your position regarding the statement.

If others have chosen the same sign share with them the reasons for your response.

Appoint a spokesperson who is willing to report out the thinking of your group.

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Overview of the PDI

**Morning Session**

9:00 – 9:20  Introductions and overview
9:20 – 10:30  What is issue-oriented science?
              “Reclaiming the Metal”: an issue-oriented activity
10:30 – 10:45  Break
10:45 – 11:45  Issue-oriented science design elements
11:45 – 12:15  Why use issue-oriented science?
12:15 - 1:15  Lunch

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**Afternoon Session**

1:15 - 2:15  What makes a good issue & ways of incorporating issues?
2:15 – 3:00  Issue-oriented assessment
3:00 – 3:15  Break
3:15 – 4:30  Developing your own IOS instructional materials
4:30 – 5:00  Next steps and evaluation
What is Issue-Oriented Science?

“Reclaiming the Metal”: An Issue-Oriented Science (IOS) Activity

From the unit, “The Chemistry of Materials,” from SEPUP’s middle school physical science course, Issues and Physical Science

“Reclaiming the Metal” Activity Context

• “Reclaiming the Metal” falls in the middle of a series of lessons on the chemistry of materials

• In this activity, students investigate the reaction rate of a series of chemical reactions with a copper compound and use the information to answer the question, “How should we handle copper waste?”
**IOS Activity: Reclaiming the Metal**

**Challenge**
- Which metal is best at reclaiming copper from the used copper chloride solution?

**Investigate**
- Compare the reactions of copper waste with three different metals — zinc, iron, and aluminum.

**Procedure**
- Appropriate safety precautions
- Place copper waste in waste containers
- Instead of forceps, use a spoon

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**Evaluating the Results of the Investigation**

- Answer Analysis Question 3 using the “ET writing frame”

Note: Analysis Question 3 is an ET Assessment. We will return to this in the afternoon session.

- Informal meeting of the minds: Compare your evidence and conclusions with those of two other people. Record the ways your evidence and conclusions are similar and different.

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**“Reclaiming the Metal”**

- What were students learning in this activity?
- What was the issue?
- How was the issue incorporated in the activity?
What are the major goals of Issue-Oriented Science?

Goals of issue-oriented science

- To engage all students in the process of learning science
- To encourage and prepare students to use scientific evidence to make decisions
- To help educate tomorrow's citizens about the application of science to everyday life
- To develop scientifically literate citizens
Reflection on IOS Activity

In your bluebook respond to the following.

In what ways do you think an IOS classroom might be different from a traditional (non-inquiry, non-IOS) classroom?

Characteristics of the IOS Classroom

- Use of strategies that support inquiry
  - Teacher as facilitator
  - Group and class discussions
  - Research
  - Role-playing
  - Scaffolding and differentiated instruction
  - Process skills used in context
  - Questions to guide discussions
- Coherent flow of both content and issue
- The issue drives the lessons and is not an add-on
Facilitating group discussion

- Discussion Web
- Intra-act discussion
- Think-pair-share
- Four corners discussion
- Carousel activities

Developing an IOS Activity

During the rest of the morning begin to think about
- Choosing a science content area
- Selecting an issue

You will use this information during the afternoon when you begin to develop an activity or sequence of activities.

Understanding by Design

- Begin with the end in mind
  - What will students know, understand, and be able to do as a result of the unit or lesson(s)?
  - What evidence will show what students know, understand, and are able to do?
  - How best will students learn the material?
Developing IOS Instructional Materials

1. Select a content area.
   - Articulate learning targets
   - Include content and process targets

2. Select a relevant issue.
   - Evaluate the issue (afternoon session)
   - Articulate learning targets for the issue

3. Consider what prior knowledge will be required.

4. Consider the flow of concepts and issues if designing several activities or a unit.

5. If designing a unit or sequence of activities, develop an outline that includes the content, type and length of activity, and assessment opportunities. Look for balance.

6. Design and test the individual learning experiences, paying attention to the resources available. Use a variety of questions to drive the activities.

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Why use issue-oriented science?

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Why use issue-oriented science?

- Integrates sciences and integrates science with other subjects, portraying a realistic view of how science contributes to solving problems and of the role of science in careers.
- Makes real-world connections and shows students how science is useful in daily life.
- More authentic science, for ALL students.
- It helps students in learning science.
- It helps improve attitudes of students towards science.

Policy

- National Science Education Standards (NRC, 1996)
  - Standard F: Science in Personal and Societal Perspectives
- Benchmarks for Science Literacy. (AAAS, 1993)
  - For example:
    - Standard 1c: The Scientific Enterprise
    - Standard 3: Technology and Science
    - Standard 7: Human Society
    - Standard 8: The Designed World
- NSTA Position Statements

NSTA Position Statement: Beyond 2000—Teachers of Science Speak Out

Scientific literacy entails being able to read with understanding articles about science in the popular press and to engage in social conversation about the validity of the conclusions. Scientific literacy implies that a person can identify scientific issues underlying national and local decisions and express positions that are scientifically and technologically informed. A literate citizen should be able to evaluate the quality of scientific information on the basis of its source and the methods used to generate it. Scientific literacy also implies the capacity to pose and evaluate arguments based on evidence and to apply conclusions from such arguments appropriately. (NRC, 1996, page 22)

NSTA Position Statement: Science/Technology/Society: A New Effort for Providing Appropriate Science for All

NSTA views STS as the teaching and learning of science in the context of human experience. It represents an appropriate science education context for all learners. The emerging research is clear in illustrating that learning science in an STS context results in students with more sophisticated concept mastery and ability to use process skills. All students improve in terms of creativity skills, attitude toward science, use of science concepts and processes in their daily living and in responsible personal decision-making.

http://www.nsta.org/about/positions/sts.aspx

Student Outcomes: Learning in IEY
Wilson and Sloane (2000)

<table>
<thead>
<tr>
<th>Unit</th>
<th>N</th>
<th>Total Score Per Test Mean % Correct</th>
<th>Total Score Post Test Mean % Correct</th>
<th>Total Score Gate Mean % Correct</th>
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<tr>
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<td>45</td>
<td>64</td>
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<td>Shaping the Land</td>
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<td>67</td>
<td>31</td>
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<td>71</td>
<td>25</td>
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<tr>
<td>Weather and Atmosphere</td>
<td>76</td>
<td>52</td>
<td>78</td>
<td>18</td>
</tr>
<tr>
<td>The Earth in Space</td>
<td>138</td>
<td>34</td>
<td>75</td>
<td>34</td>
</tr>
<tr>
<td>Space Exploration</td>
<td>123</td>
<td>46</td>
<td>69</td>
<td>23</td>
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## Effect Size by Unit

<table>
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<th>Unit</th>
<th>Effect Size</th>
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<tr>
<td>Shaping the Land</td>
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<tr>
<td>Rocks and Minerals</td>
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<td>Plate Tectonics</td>
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<td>Weather and Atmosphere</td>
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<tr>
<td>The Earth in Space</td>
<td>0.80</td>
</tr>
<tr>
<td>Space Exploration</td>
<td>0.69</td>
</tr>
</tbody>
</table>

Cohen’s d large effect size is over 0.80, moderate effect size is over 0.5

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## SGI Biology

![Figure 2. SGI Biology Pre-Post Effect Sizes](image)

Small effect size $d = 0.147$; medium effect size $d = 0.330$; large effect size $d = 0.474$ (Cliff, 1993; Romano et al, 2006).

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## SGI Physics

![Figure 3. SGI Physics Pre-Post Effect Sizes](image)
Student Outcomes: Learning and decision to continue in science courses

  Gains in student achievement on standardized tests as a result of a two-year integrated science sequence in Los Angeles Unified School District. In many of the participating schools, the integrated science sequence was based on two SEPUP courses: Issues, Evidence and You and Science and Sustainability. Gains were also observed in students’ grades and decision to continue in science courses.

Student Outcomes: Learning and Attitudes Toward Science

  Students in a year-long program based on S&S showed improvements in reasoning about science and technology
  Students’ attitudes toward science improved significantly during the program described above.

Reflection

- What questions arose this morning?

Write your questions on an index card and we will do our best to answer them this afternoon.
Lunch
Franklin 11 -13
We start promptly at 1:15

Incorporating issues into science activities

Practice enhancing science activities with issues

Two activities
- Natural selection
- Energy transfer

Choose one of the non-issue oriented activities to complete with a partner.
Enhancing activities with issues

After you complete the activity,
1. Generate a list of the concepts and skills the lesson teaches
2. Brainstorm a list of issues related to the concepts and skills you identified in step 1.
3. Brainstorm ways to include these issues in the activity.
4. Be prepared to share your ideas with the group.

Enhancing activities with issues, continued

5. Look at the related SEPUP activity.
6. Determine how the issue is embedded in the activity.
7. Determine how the learning outcomes changed.

Incandescent Light Bulbs

Should incandescent light bulbs be illegal?

California state legislator Lloyd Levine proposed the "How Many Legislators does it take to Change a Light Bulb Act" in California.

The 2007 energy bill (U.S) sets new efficiency standards by 2012. Currently only CFs meet the standards.

Why? Are there trade-offs?
Types of Issues

Issues can range from personal to societal.

Societal issues can be focused at the community and/or global level.

Examples of personal issues

- Would you choose to buy a mined or manufactured diamond?
- Would you take this new medicine?
- Would you choose to drink bottled water or tap water?
- Which car would you buy if your primary concern was safety in a crash?

Examples of societal issues

- What space missions should be funded from a limited budget?
- What is the most effective way to reduce heart disease?
- How should society encourage energy efficiency?
What makes a good issue?

Criteria for Evaluating Issues

The strongest issues:
- Require knowledge and understanding of important scientific concepts and processes
- Require an application of relevant scientific evidence
- Relate to scientific concepts and processes appropriate to grade level and subject matter
- Engage diverse groups of students
- Are complex enough to foster discussion and debate (Is there more than one solution or response?) OR clearly illustrate how science can inform a decision.

Let's return to your suggested issues and review them.
Other considerations

- You might also include issues that:
  - Are in the news
  - Are especially relevant to the age group
  - Illuminate the difference between the evidence that science can provide and the social aspects of the decision

Is the issue engaging to diverse groups of students?

- Consider your audience
- Factors affecting this are:
  - Geographic location
  - Socioeconomic background
  - Urban, rural, vs. suburban
  - Gender
- When you use issues:
  - Make local connections
  - Include a variety of personal and societal issues
  - Engage students in an issue with a scenario that helps them identify with others

Some questions relate to many issues

- How strong is the evidence in support of this position or decision?
- Is "it" safe enough?
  - How can it be made safer?
- How can we balance human needs and environmental protection?
- What is the best way to use limited resources?
Some ways to incorporate issues

- Lab or activity
  - e.g. Tasting or testing different water samples
- Analyzing data
- Reading and discussion
  - Stories about events that have happened
- Role plays/skits
  - Scripted, typical conversations
  - Different roles with different perspectives
- Debates
- Position statements

Introduce an issue with a scenario

Introduce an issue with a cartoon
Introduce an issue with news articles or headlines

Assessing Issue-Oriented Science

What are you assessing?
- In science
- In inquiry-oriented science
- In issue-oriented science
SEPUP Scoring Rubrics

- **Content**
  - Understanding Concepts

- **Process**
  - Organizing Data
  - Designing Investigations
  - Analyzing Data

- **Making Evidence-Based Decisions**
  - Recognizing Evidence
  - Evidence and Trade-offs

- **Communication**
  - Organizing Scientific Ideas (SI)
  - Communication Skills (CS)

- **Group Interaction**

Score Student Work

- Use the ET Scoring Rubric to score the work of Students A, B, and D

Assessing IOS

- Use the Evidence and Trade-offs (ET) rubric to revise your answer to Analysis Question 3 from this morning’s activity on copper waste.
- What was this experience like?
- Was this a good assessment question?
  - Explain
Scoring Guide: Evidence and Trade-offs

<table>
<thead>
<tr>
<th>Level 4</th>
<th>Student accomplishes Level 3 and goes beyond in some significant way.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 3</td>
<td>Student compares options using accurate and complete evidence and takes a position supported by the evidence. Student describes trade-offs of his/her decision.</td>
</tr>
<tr>
<td>Level 2</td>
<td>Student discusses one or more options using accurate or relevant evidence and takes a position supported by the evidence BUT reasoning is incomplete and/or part of the evidence is missing.</td>
</tr>
<tr>
<td>Level 1</td>
<td>Student takes a position BUT provides reasons that are subjective, inaccurate, or nonscientific.</td>
</tr>
<tr>
<td>Level 0</td>
<td>Student’s response is missing or irrelevant.</td>
</tr>
</tbody>
</table>

What are the challenges to this kind of assessment?

Scoring reliability

- Moderation
- Set specific criteria, related to the scoring guide, for each assessment
Assess One Variable at a Time

- Unidimensionality: A single score represents a single dimension or trait that has been assessed

Lack of Unidimensionality

<table>
<thead>
<tr>
<th></th>
<th>Dimension A</th>
<th>Dimension B</th>
<th>Total Score</th>
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<tr>
<td>Student 1</td>
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<td>Student 2</td>
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<td>12</td>
</tr>
<tr>
<td>Student 3</td>
<td>6</td>
<td>6</td>
<td>12</td>
</tr>
</tbody>
</table>


Writing good ET questions

- Open-ended: more than one possible correct answer
- Try writing a Level 3 answer (or several answers) yourself
- Discuss with other teachers
- Try out with a class
  - Look for a range of answers
  - Be sure at least some students are able to write a Level 3 answer
Final Thoughts on Assessment

- Share rubrics with students
- Provide multiple opportunities for students to become familiar with the rubrics
- Have students practice writing answers
- Provide specific feedback on performance
- Consider self- and peer-scoring
- Use what you learn from assessments to adjust instruction

Developing your own IOS

Using the templates, work alone or with others to outline an issue-oriented activity (or sequence of activities) in a content area

Quick write

For the IOS learning experience you worked on today, what will you do next?

Write down one to two things that you will complete in order to further the development of the IOS learning experience.
Conclusion

- Rigor of issue-oriented science depends on selection of appropriate issues
- Issue-oriented science engages a broad spectrum of students
- When using issues, think carefully about how to present them and how to structure the curriculum to encourage use of scientific evidence, processes, and concepts in discussions and decisions about issues.

Incorporating issues into science instruction occurs at the expense of understanding science content.

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This Power point presentation and all handouts will be posted on the SEPUP website the week after the meeting at http://www.sepuplhs.org/news.html

(Click on 'SEPUP Workshop Materials Available for Download')