NAEP Assessments of Science
Content Knowledge in Practice

Hands-On and Interactive Computer Tasks

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<th>2012 Framework for the K-12 Science Education Standards</th>
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Obtaining, evaluating, and communicating information
NAEP Components

• Multiple-choice items
• Short constructed response items
• Extended (long) constructed-response items
• Hands-on tasks
• Interactive computer tasks (ICTs)
NAEP Technology and Engineering Literacy (TEL) Assessment Framework
NAEP Hands-on Task (HOT)
Grade 12 – Maintaining Water Systems
NAEP Interactive Computer Task (ICT)
Grade 4 – Mystery Plants

Part 1

How much sunlight does Plant A need to grow best?

- Do Experiment
- View Data Table
- Draw Conclusions

Lots of Sunlight

Some Sunlight

A Little Sunlight
Interactive Computer Task
Example
## Advantages of ICTs

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<th>Category</th>
<th>Examples</th>
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| Studying phenomena that cannot be easily observed | • Observe plants grow  
• Observe microscopic organisms                                      |
| Working safely in lab-like simulations             | • Examining how heat relates to flow rates of liquids                     |
| Studying situations that require repetition       | • Finding heat capacity of metals                                        |
| Searching resources                                | • Use online documents to learn about previous studies on phytoplankton  |
Types of ICTs

3 Types of ICTs

- Information search and Analysis
- Empirical investigations
- Simulations
Mystery Plants – Grade 4

Science Content

- Physical Science
  - Matter
  - Energy
  - Motion
- Life Science
  - Structure and Functions of Living Systems
- Earth & Space Sciences
  - Earth in Space and Time
  - Earth Structures
  - Earth Systems

Science Practices

1. Identifying Science Principles
   - recognize
   - recall
   - relate
   - measure
   - describe
   - represent
2. Using Science Principles
   - explain
   - predict
   - solve problems
   - reason
   - interpret
   - analyze
3. Using Scientific Inquiry
   - answer a question under investigation to extend knowledge and evaluate evidence
4. Using Technological Design
   - make design decisions to solve real-world problems

- Empirical investigation of plant growth designed as an interactive computer simulation
- Students perform repetitious testing and observations of real biological phenomena in a simulated setting
- Key advantages of computer simulations
  - Time can be sped up for observing plant growth
  - Abstract ideas can be made tangible and accessible
  - Simplified, real-world setting allows for focusing on construct relevant elements of the question, which reduces unnecessary cognitive actions

- Presented as a Predict-Observe-Explain problem set
Mystery Plants Grade 4

Experiment 1

What are the best sunlight conditions for growth of Plant A (sun-loving plant)?
Experiment 1: Sun-loving plant

Predict

Use prior knowledge to predict the levels of sunlight plants need.
Prediction question assesses students’ ability to make predictions by reasoning with scientific facts, concepts, and principles
Experiment 1: Sun-loving plant

Observe

Investigate and make observations about how varying sunlight amounts affect the growth of Plant A.
Observation task assesses students’ ability to know how and why science proceeds as it does by using empirical testing
Experiment 1: Sun-loving plant

Explain

Select the correct conclusion and provide an explanation using data observed.
Explanation questions assess students’ ability to explain how the natural world works
How the Assessment Is Administered
Administering the Assessment

• Administered by NAEP field staff
• Field staff bring in all necessary equipment (test booklets, hands-on tasks, laptops, ear buds, etc.)
• Staff are responsible for all pre-assessment and assessment day activities
• Students are assessed in classrooms or as a group in a school cafeteria or other large room
## Assessment Design

**Interactive Computer Tasks**
- Two 20-minute tasks
- One 40-minute task

**Sample**
- Grades 4, 8, and 12
- 2,000 students per grade
Scoring Tasks and Reporting Scores
Scoring Tasks

• Scored similarly to all other NAEP assessments
  – Scorers evaluated constructed-response items according to scoring rubrics
  – Multiple-choice answers were machine-scored

• Collected student actions in extended ICTs
  – Examined how well students used computer-based tools to conduct scientific investigations
Reporting Scores

• Percent correct
  – Performance was summarized at the item level by using the average percentage correct

• Student percent correct score
  – Performance was summarized across test items using a student percent correct score

• Process analyses
  – Grouped students into various categories according to their response patterns to a pre-specified item sequence
Examination of Percent Correct Patterns

Key Discoveries

1. Students were **successful** on parts of investigations that involved limited sets of data and making straightforward observations of that data.

2. Students were **challenged** by parts of investigations that contained more variables to manipulate or involved strategic decision making to collect appropriate data.

3. Students could select **correct** conclusions from an investigation, but scored **lower** when asked to explain their results.
Reporting on Process

• Practices, as defined by the science framework, have not been reported on separately in the NAEP assessments

• Analysis of science HOTs and ICTs focuses on processes and captures solution paths for tasks
  – The 2009 examples show specific areas of strength and weakness in student success across a task
Only 23% of all fourth-graders displayed complex prior knowledge, did the experiment correctly, and were able to give complete explanations. (Follow the leftmost series of green disks.)
Practical Issues, Challenges, and Innovations
Development Timeline

• Assessment development is a multi-year process

- Fall 2006: Begin pilot development
- Spring 2008: Administer pilot and score response
- Winter 2008: Perform task try-outs and stakeholder reviews
- Summer 2008: Perform analyses and select items for operational assessment
- Winter-Fall 2009: Administer assessment, score responses, and analyze data
- Spring 2010 - 2011: Analyze content for reporting and produce reports
Task Development

• **Challenge**: Costly to design and build

• **Solutions**: Early steps ensure accurate measure
  – Staged approach to development:
    – Student feedback in tryouts
    – Performance on pilot
  – Balance between engagement and measurement
  – Collaboration with team of developers, designers, cognitive scientists, and psychometricians
Task Development

• **Challenge**: Create valid, reliable, and developmentally appropriate tasks

• **Solutions**:
  – Multiple tryouts with students
    • Less than 10 interviewed about storyboard
    • Small-scale tryout with 50 students in prototype format
    • Large-scale tryout with 300 students (national sample) close to final form, measured performance and ability to use CBA tools
Task Development

• **Challenge**: Provide environment to support student success

• **Solutions**:
  
  – Create multi-faceted tutorial about interface and frame the science problem
  – Make “help” buttons clear for additional support
  – Explicit introductory and section directions
  – Welcome & thank you maintains the scenario
Analysis & Scaling Challenges

• An IRT scale score was not reported for the Science ICTs because there were too few tasks
  – Three times as many tasks are being developed to support a scale in 2015

• Scenario-based complex tasks often invoke particular dependencies between items
  – Other factors besides proficiency may cause correlations across items
Innovations

• Use of Evidence-Centered Design
  – Technology and engineering literacy
  – Next-generation science ICTs
  – Other assessments
Framework

Practices
- Understanding Technological Principles
  - 42 Discrete
    - 39 (9) SBT
    - 81 Total
- Developing Solutions and Achieving Goals
  - 63 Discrete
    - 113 (19) SBT
    - 176 Total
- Communicating and Collaborating
  - 34 Discrete
    - 30 (13) SBT
    - 64 Total

Content Areas
- Technology and Engineering Literacy
  - 139 Discrete
    - 182 (21) SBT
    - 321 Total
- Technology and Society
  - 45 Discrete
    - 68 (7.5) SBT
    - 113 Total
- Design and Systems
  - 43 Discrete
    - 48 (7) SBT
    - 91 Total
- ICT
  - 51 Discrete
    - 66 (6.5) SBT
    - 117 Total

Assessment
Cognitive Items
- Understanding Technological Principles
  - 15 Discrete
    - 30 (6) SBT
    - 45 Total
- Developing Solutions and Achieving Goals
  - 17 Discrete
    - 28 (7) SBT
    - 45 Total
- Communicating and Collaborating
  - 13 Discrete
    - 10 (6) SBT
    - 23 Total
- Understanding Technological Principles
  - 21 Discrete
    - 3 (3) SBT
    - 24 Total
- Developing Solutions and Achieving Goals
  - 17 Discrete
    - 44 (8) SBT
    - 61 Total
- Communicating and Collaborating
  - 5 Discrete
    - 1 (6) SBT
    - 6 Total
- Understanding Technological Principles
  - 6 Discrete
    - 6 (2) SBT
    - 12 Total
- Developing Solutions and Achieving Goals
  - 29 Discrete
    - 41 (8) SBT
    - 70 Total
- Communicating and Collaborating
  - 16 Discrete
    - 19 (5) SBT
    - 35 Total

Background Questions
- 28
- 16
- 10
- 46
- 47
- 12
- 31
- 34
- 38