Design and Use of Innovative Science Testlets for Struggling Learners

Lori Andersen, Michelle Shipman, and Gail Tiemann
NCME 2018, University of Kansas
October 10, 2018
Agenda

1. Project Overview
2. Science Learning Maps
3. Innovative Testlets
4. Preliminary Cognitive Lab Findings

The contents of this presentation were developed under a grant from the Department of Education. However, those contents do not necessarily represent the policy of the Department of Education, and you should not assume endorsement by the Federal Government.
I-SMART Purpose

Improve achievement of multidimensional science standards for students with and without disabilities through accessible, learning map model-based assessments and reporting tools.
# I-SMART and Dynamic Learning Maps (DLM)

<table>
<thead>
<tr>
<th>DLM</th>
<th>I-SMART</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Operational alternate assessment</td>
<td>• Research &amp; development</td>
</tr>
<tr>
<td>• Students with significant cognitive disabilities</td>
<td>• Inform future formative and summative assessments</td>
</tr>
<tr>
<td></td>
<td>• Two populations</td>
</tr>
</tbody>
</table>

Innovations in Science Map, Assessment & Report Technologies
Learning Map Models

• Interconnected representation of ways in which students can develop knowledge, skills and understandings
  • Nodes represent skills
  • Connections represent order of learning

• Expanded science maps for the I-SMART project are based on existing DLM science maps
DLM Science Map Neighborhood
Close-up Map View

- SCI-588 Recognize that weight is conserved before and after reshaping.
- SCI-544 Recognize the weight of parts of an object equal to the weight of the object.
- SCI-452 Recognize that weight is conserved before and after heating and cooling.
- SCI-145 Compare weights of objects to show that weight is proportional to size.
- SCI-211 Compare weight of a substance before and after heating or cooling.
- SCI-449 Identify that weight is conserved before and after disassembly.
I-SMART Neighborhood Maps

• Each DLM science map represents one alternate content standard.

• Each I-SMART map includes the DLM science map and is connected to foundational, English language arts, and mathematics nodes.
Essential Elements

• Essential Elements (EEs) are alternate content standards that are linked to the *Framework for K-12 Science Education* and the *Next Generation Science Standards*

• Testlets measure EEs at four levels of complexity, known as linkage levels:
  • Initial
  • Distal (High school only)
  • Precursor
  • Target
EE Learning Map Neighborhoods

• Each linkage level contains four nodes in a cluster or mini-progression.

• Adjacent linkage levels have one common (overlapping) node.
Innovative Testlets

Michelle Shipman
Innovative Testlet Design

I-SMART testlets use innovative features that vary by linkage level:

- Embedded Universal Design for Learning (UDL) options
  - Phenomena-based
  - Choice
  - Wonder Question
UDL-Guided Design

Provide multiple means of Engagement
- Affective Networks: The “WHY” of Learning
  - Provide options for Recruiting Interest
    - Optimize individual choice and autonomy
    - Optimize relevance, value, and authenticity
    - Minimize threats and distractions

Provide multiple means of Representation
- Recognition Networks: The “WHAT” of Learning
  - Provide options for Perception
    - Offer ways of customizing the display of information
    - Offer alternatives for auditory information
    - Offer alternatives for visual information

Provide multiple means of Action & Expression
- Strategic Networks: The “HOW” of Learning
  - Provide options for Physical Action
    - Vary the methods for response and navigation
    - Optimize access to tools and assistive technologies
  - Provide options for Language & Symbols
    - Clarify vocabulary and symbols
    - Clarify syntax and structure
    - Support decoding of text, mathematical notation, and symbols
    - Promote understanding across languages
    - Illustrate through multiple media
  - Provide options for Expression & Communication
    - Use multiple media for communication
    - Use multiple tools for construction and composition
    - Build fluency with graduated levels of support for practice and performance

Provide multiple means of Self Regulation
- Provide options for Comprehension
- Provide options for Executive Functions

CAST (2018)
Essential Element Concept Map

Clearly specifies the evidence-centered design-based approach which includes the intended connection between the content, a testlet's design elements, and student observations.

- Specifies the skills and content required by the nodes at each linkage level.
- Provides guidance to item-writers in developing testlets and incorporating UDL options.
Essential Element Concept Map
EE.HS.LS2-2.I
**Example of Phenomenon Section**

<table>
<thead>
<tr>
<th>Phenomenon</th>
</tr>
</thead>
<tbody>
<tr>
<td>General mechanism: Plants get matter mainly from air and water. Plants get nutrients from soil (i.e., minerals). Matter moves through ecosystems as plants make their own food, plants are eaten by animals, animals eat other animals, and dead things are broken down by decomposers to make matter available to plants again. Not all matter is passed to the next level; some matter leaves at each level (e.g., excretion, breathing).</td>
</tr>
<tr>
<td>Examples of systems include specific organisms or ecosystems.</td>
</tr>
<tr>
<td>Example Phenomena: In a forest, oak trees grow. Oak trees make their own food with matter from air and water. Oak trees take in air through openings in their leaves. Oak trees also get nutrients from the soil. Squirrels eat leaves and acorns from the oak tree. Owls eat squirrels.</td>
</tr>
</tbody>
</table>
## Multidimensional Design – Nodes and Observations

<table>
<thead>
<tr>
<th>Nodes (order from map)</th>
<th>Description</th>
<th>Observation &amp; Example Questions to Ask</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCI.1-9</td>
<td>Use a model to trace the movement of energy through the ecosystem.</td>
<td>The student identifies the energy flow in the ecosystem. Example Questions: What is the energy flow in the ecosystem? What is the role of producers in the energy flow?</td>
</tr>
<tr>
<td>SCI.1-6</td>
<td>Recognize the interactions between living and non-living components in the ecosystem.</td>
<td>The student identifies the interactions between living and non-living components. Example Questions: How do living and non-living components interact? How do these interactions affect the ecosystem?</td>
</tr>
<tr>
<td>SCI.1-5</td>
<td>Identify the energy transfer in the ecosystem.</td>
<td>The student identifies the energy transfer in the ecosystem. Example Questions: What is the energy transfer in the ecosystem? How does energy flow through the ecosystem?</td>
</tr>
<tr>
<td>SCI.1-3</td>
<td>Recognize that the energy transfer in the ecosystem is finite.</td>
<td>The student identifies that the energy transfer in the ecosystem is finite. Example Questions: Is the energy transfer in the ecosystem finite? How does energy conservation affect the ecosystem?</td>
</tr>
<tr>
<td>SCI.1-2</td>
<td>Recognize that energy flow in the ecosystem is an ongoing process.</td>
<td>The student identifies that energy flow in the ecosystem is an ongoing process. Example Questions: How does energy flow in the ecosystem change over time? How does energy conservation affect the ecosystem?</td>
</tr>
<tr>
<td>SCI.1-1</td>
<td>Recognize that energy flow in the ecosystem is a continuous process.</td>
<td>The student identifies that energy flow in the ecosystem is a continuous process. Example Questions: How does energy flow in the ecosystem change over time? How does energy conservation affect the ecosystem?</td>
</tr>
</tbody>
</table>
Example of Wonder Question Section

<table>
<thead>
<tr>
<th>Wonder Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>The wonder question is presented at the beginning and revisited at the end of the testlet. The wonder question connects to a research-based misconception that can be resolved through inquiry activities in the testlet.</td>
</tr>
</tbody>
</table>

Example: What would happen to animals if all the plants died? Two answer options are presented, one of which is a common misconception.

Example: AO1 - Animals that eat other animals would survive. (misconception) AO2 - No animals would survive.

Over the course of the testlet, students should gain information that will help them reevaluate the wonder question at the end of the testlet. The flow of items should build to...
Provide Multiple Means of Engagement

- **Choice of Context**
  - Provides an option for recruiting interest
  - Found at the beginning of the testlet
  - Unscored

Example image:
Lisa and Zack will study animals from a farm for their science class project. Choose which student you would like to read more about.
Provides Multiple Means of Engagement

- **Wonder Question**
  - Provides option for self-regulation
  - Found near the beginning of the testlet
  - Unscored
  - Students return to wonder question at end of testlet
Provide Multiple Means of Engagement

- “How did you do?”
  - Provides option for self-regulation
  - Last item in the testlet
Provide Multiple Means of Representation

- **Science Narrative**
  - Provide options for
    - Comprehension
    - Language & Symbols
    - Recruiting Interest
  - Includes the phenomenon

Tim examines data for fall, spring, summer, and winter. Tim examines the population of wolves and moose. Tim examines the amount of food and shelter available. Tim makes a graph.
Provides Multiple Means of Representation

- Use of **Videos and/or Images** to support decoding
- Provides option for Language & Symbols

Tim goes to the park at different times of the year. In the fall, Tim notices dead leaves in the park. Tim observes that some of the dead leaves are in small pieces. Tim notices worms among the leaves.
Provides Multiple Means of Action & Expression

- Think about it...
  - Provides option for executive function
  - Used throughout the testlet
  - Unscored
  - Answer is provided on next screen
Research Questions

1. How do students interact with the features of innovative item types and with innovative testlets?
2. How much time is required to complete a testlet?
3. Do students interpret testlet contents as intended?
4. Do students’ responses represent the science performance expectations the items were designed to measure?
5. What are students’ and teachers’ perceptions of students’ experiences with the new testlets?
Phase 1

• Two target populations
• June 2018
• Two districts in two different states
• 15 sessions completed
• 5 teachers interviewed
• Video, audio, observation forms, screen capture recordings
Phase 1 Labs Completed

Overall Goal – 36 students
Phase 1 Progress – 15 students

<table>
<thead>
<tr>
<th></th>
<th>Initial – Group 1</th>
<th>Precursor – Group 1</th>
<th>Target – Group 1</th>
<th>Target – Group 2/3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elementary</td>
<td>4</td>
<td>NA</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Middle School</td>
<td>NA</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>High School</td>
<td>3</td>
<td>NA</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Phase 2 Plan – Fall 2018

Phase 2 Goal – 21 students

<table>
<thead>
<tr>
<th></th>
<th>Initial – Group 1</th>
<th>Precursor – Group 1</th>
<th>Target – Group 1</th>
<th>Target – Group 2/3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elementary</td>
<td>2</td>
<td>NA</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Middle School</td>
<td>NA</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>High School</td>
<td>3</td>
<td>NA</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>
Preliminary Results – Informing Test Development

• RQ 1 - Testlet features

• Choice
  • Precursor and Initial Levels
  • Students were aware of choices, experienced choices frequently during instruction
  • No difference in student engagement between two different choice options
Preliminary Results – Informing Test Development

RQ 2 - Testlet Time

<table>
<thead>
<tr>
<th>EL Initial</th>
<th>MS Precursor</th>
<th>MS Target</th>
<th>HS Initial</th>
<th>MS Target (Group 2/3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>17:53</td>
<td>12:02</td>
<td>17:41</td>
<td>18:10</td>
<td>18:05</td>
</tr>
<tr>
<td>15:51</td>
<td></td>
<td></td>
<td>11:46</td>
<td>13:29</td>
</tr>
</tbody>
</table>

Middle School students delivered substantial think aloud and retrospective comments.
Student comments re: choice

• Why did you pick that one?
  • Student 1: “Because pig is my favorite.” [Choice option pig or cow]
  • Student 2: "He's wearing a green shirt.” [Choice option Lisa or Zack]
    • Observer: “Do you like green?
    • Student 1: ”Yes"
Preliminary Results - Informing Technology

• **RQ 1 – Testlet features**
  
  • Delayed load of chicken video surprised students
  
  • Chicken video overly large on screen
    • Video issues addressed by media team
  
  • Scrolling issue
    • After scrolling down, focus of next screen did not return to top
    • Issue addressed by technology team
Item Tryout Next Steps..

• Recruit and complete phase 2
• Continue data analysis
• Disseminate results
Panel Discussion

• How do these products compare to existing assessments?

• How can these products benefit teachers and students?

• What are the implications of these findings for classroom assessment?

• How can this research benefit science instruction and assessment for learners who fall below their grade-level expectations?