I-SMART

The I-SMART project: Creating multi-dimensional science assessments using principles of Universal Design for Learning and fine-grained learning maps

National Conference on Student Assessment
Monday, June 24, 2019
Orlando, Florida
Innovations in Science Maps, Assessment and Reporting Technologies (I-SMART)

• A multi-state project funded through the U.S. Department of Education’s Enhanced Assessment Grants (EAG)

• Focused on Developing Innovative approaches to science assessments by using principles of Evidence Centered Design (ECD) and Universal Design for Learning (UDL)
Project Partners

• ATLAS (Accessible Teaching, Learning and Assessment Systems) at the University of Kansas
• CAST
• BYC Consulting
State Partners

• Maryland (Lead)
• New Jersey
• New York
• Oklahoma
• Missouri
Today’s Presenters

• Michelle Shipman – Assessment Development
• Gail Tiemann – Cognitive Labs and Evaluation
• Bob Dolan – Reporting Dashboard Development
• Shaun Bates – Missouri Department of Elementary and Secondary Education
Assignment Design:
Blending Evidence-Centered Design and Universal Design for Learning

Michelle Shipman
University of Kansas
Science Assessments for All Students

• Designing science assessments to engage higher-order thinking without increasing barriers

• Innovative design approaches are needed to develop science assessments linked to the Next Generation Science Standards (NGSS) that are accessible to all students
Testlet Design

- Learning Map Models
- Evidence-centered design framework (ECD: Mislevy, Steinberg & Almond, 2003)
- Universal Design for Learning (UDL: CAST, 2011)
- Essential Element Concept Map (EECM) is a document that specifies the connection between the content, a testlet's design elements, and student observations. (DLM, 2016, Bechard, et al., in press)
Innovative Testlet Design Features

• Both **Disciplinary Core Idea (DCI)** and **Science and Engineering Practice (SEP)** nodes are measured

• **Science phenomena** provides the contextual structure within the science narrative

• **12-16 items** that address **4 learning map nodes** within a single Essential Element and linkage level
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 options for Sustaining Effort & Persistence
    - Heighten salience of goals and objectives
    - Vary demands and resources to optimize challenge
    - Foster collaboration and community
    - Increase mastery-oriented feedback

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 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 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 Expression & Communication
    - Use multiple media for communication
    - Use multiple tools for construction and composition
    - Build fluencies with graduated levels of support for practice and performance
  - Provide options for Executive Functions

CAST (2018)

Innovations in Science Map, Assessment & Report Technologies
Embedded UDL Features

• Phenomena-based engagement
• Student choice
• Wonder Question
• Science narrative
• Embedded items
Provides Multiple Means of Engagement

Wonder Question

- Provides UDL option for self-regulation
- Found near the beginning of the testlet
- Unscored
- Students return to the Wonder Question at end of the testlet
Provide Multiple Means of Representation

Science Narrative

- Provides UDL options for
  - Comprehension
  - Language and symbols
- 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 Action & Expression

Think about it...

• Provides UDL option for executive function
• Used throughout the testlet
• Unscored
• Answer is provided on next screen
The EECM

- Built around a content standard
- Designed as a tool for item writers to integrate multiple frameworks
### Example EECM Sections

#### EE.HS.LS2-2

**Essential Questions for the Initial Level**
- Does the student understand that different objects can be members of the same category?
- Can the student identify common animals?
- Does the student recognize that different members of one type of organism comprise a population?
- Does the student recognize that food and shelter are needed for survival?

<table>
<thead>
<tr>
<th>Initial Level Name</th>
<th>Initial Level Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE.HS.LS2-2 I</td>
<td>Identify common animals and populations, recognize their survival needs.</td>
</tr>
</tbody>
</table>

**Vocabulary**

<table>
<thead>
<tr>
<th>Concepts</th>
<th>Words</th>
</tr>
</thead>
<tbody>
<tr>
<td>habitat needs of a species</td>
<td>food, shelter, survive</td>
</tr>
</tbody>
</table>

**Misconceptions**
- (F-66) The student does not distinguish categories of living things, such as animals.
- (SCI-315) The student cannot identify common animals.
- (SCI-527) The student does not recognize population. The student includes more than one type of organism when determining a population rather than only counting members of one species.
- (SCI-501) The student does not recognize that food and shelter are needed for survival. The student indicates nonessential items as needed for survival. The student confuses the scientific usage of the word food with its common usage.

<table>
<thead>
<tr>
<th>Information</th>
<th>Phenomenon</th>
<th>Wonder Question</th>
<th>Science and Engineering Practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plants and animals are categories of living things (LS2.A)</td>
<td>General Mechanism – Organisms live together as populations in ecosystems.</td>
<td>Not used at the initial level.</td>
<td>Mathematics and computational thinking</td>
</tr>
<tr>
<td>Identify common animals (LS2.A)</td>
<td>Example: A group of rabbits lives in the forest. Trees are in the forest.</td>
<td></td>
<td>Students can count animals in a population. They understand how to use numbers with meaning and can use simple graphs to compare quantities or notice patterns.</td>
</tr>
<tr>
<td>Recognize that groups of the same kind of living things live in the same area (population; LS2.A)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recognize food and shelter as needed for survival (LS2.A)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**Innovations in Science Map, Assessment & Report Technologies**
Example EECM Sections

<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-305</td>
<td>Linked node integrated Node 4 items</td>
<td>The student is presented with a simple food web (e.g., grass -&gt; rabbit -&gt; fox). The student identifies that the matter in the fox's food came from grass. Example Questions: What does the model show about how the [organism] gets matter? Which model shows how [organism] gets matter?</td>
</tr>
<tr>
<td>SCI-301</td>
<td>Integrated Node 3 items</td>
<td>The student is shown a partially complete food chain model (e.g., one organism or arrow is missing). The student is asked to fill in the missing item based on the description of the feeding relationships from an engagement activity story. Example Questions: Which food chain shows how matter moves? Put the plants and animals in the correct box to show how matter moves (drag and drop items). What goes between [organism1] and [organism2] to show how matter moves? (Are the types of arrows)?</td>
</tr>
<tr>
<td>SCI-307</td>
<td>Recognize that matter moves from the soil to plants to animals and back to the soil.</td>
<td>When shown an example of a cycle food web (e.g., grass -&gt; rabbit -&gt; fox -&gt; worm), the student identifies that food web shows that matter moves from grass to rabbit to fox to worm to soil. The student identifies that plants get nutrients from the soil, but not matter. (Note: Confusing food and nutrients is a misconception. Nutrients for plants are like vitamins for people.) Example Questions: What does the model show about how the [organism] gets matter? What does [character's] food chain show about matter?</td>
</tr>
<tr>
<td>DOT Node 3 items</td>
<td>Recognize that matter moves from the soil to plants to animals and back to the soil.</td>
<td>When asked, &quot;How does a plant get material it needs to grow?&quot;, the student indicates that plants get matter (carbon dioxide) from the air. For example, when asked, &quot;How does a tree get material it needs to grow?&quot;, the student indicates that trees take in air through their leaves to get the material they need to grow. Example Questions: What helps a [plant] get matter? How does [plant] get matter to grow? How does a [plant type] take in the material it needs to grow? What is the material that [plant type] uses to grow?</td>
</tr>
<tr>
<td>SCI-3011</td>
<td>Recognize that plants get matter from the air. (i.e., carbon dioxide).</td>
<td></td>
</tr>
</tbody>
</table>

Innovations in Science Map, Assessment & Report Technologies
Use of EECMs in Item Writing

Item writers were able to:

• Synthesize information for each linkage level in their assigned Essential Element

• Narrow their focus and become familiar with the skills and content required by the nodes in their assigned linkage level.

• Choose a phenomenon to explore in their testlet

• Create a Choice or a Wonder Question
The Item Writing Process

• Advance and in-person training
• Using the EECM as a guide
• Peer brainstorming and collaboration
• Storyboarding a testlet
• Peer review
• Drafting content
Item Writer Evaluation

• 83% of item writers rated the EECM as a “very effective” tool
• 83% of item writers rated brainstorming with colleagues “very effective”
• 100% of item writers rated feedback from staff as “very effective.”
The External Review Process

• Advance training and in-person training

• Individual ratings on assigned criteria
  • Content
  • Accessibility
  • Bias and Sensitivity

• Group discussion and recommendations
External Review Findings

• Panelist Recommendations
  • Most were concise and explicit
  • Many recommendations mentioned changing aspects of the testlets that were outside of the test design

• Trends in the data were used to inform decisions regarding item and testlet revisions
  • Clarify vocabulary
  • Accessible graphics
  • Accurate content within the science text
Panelist Evaluation

- 100% rated the following as effective or very effective:
  - Online Advance Training
  - Guide to External Review
  - Discussion with other panelists

- 100% rated the following as “agree” or “strongly agree”:
  - Staff were knowledgeable about the academic content
  - Experience was valuable as professional development
  - Would participate in future events
Summary

- Using the UDL guidelines and checkpoints across the test development process was a valuable tool for staff to self-assess.
- Integrating UDL and learning maps into an ECD based approach requires significant front-end effort.
I-SMART Cognitive Labs: Validity Evidence to Evaluate Innovative Test Features

Gail Tiemann, PhD
University of Kansas
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’ responses represent the science performance expectations the items were designed to measure?
4. What are students’ and teachers’ perceptions of students’ experiences with the new testlets?
Prototype Testlets

• Rich science narrative following an inquiry process and a science phenomenon
• Elementary, middle school, and high school grade bands
Prototype Testlets

• One essential element per testlet
• Four learning map model nodes
• 3-4 scored items per node
Features based on UDL Framework

• Choice of Topic
  • Initial and Precursor Linkage Levels only
  • Construct-relevant or character-based choice

• Media, unscored items to engage interest, self-assessment
Students

• Group 1 – students eligible for Dynamic Learning Maps alternate assessment

• Groups 2 and 3 – students with and without disabilities who are consistently not successful with grade-level content
Students

• Received instruction on the content
  • Teacher survey probed this information
• Any grade in the grade band
• Initial level – communicate an answer through any response mode
Students

• Precursor and Target Levels
  • Computer-based

• Initial Level
  • Facilitator administers 1:1
  • Answers entered into computer by facilitator
  • Teacher present to assist with administration and interpretation
## Labs Completed

<table>
<thead>
<tr>
<th>School Level</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>6</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>5</td>
<td>NA</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Total – 19 students  
States – 2, Schools - 3
**Results - RQ 1 Testlet features**

**Choice**
- **Initial Level n=11**
  - 8 of 11 students made intentional choice
- **Precursor Level n=2**
  - No difference in student engagement between two different choice options

Lisa will study animals on a farm for her science class project. You can help Lisa choose an animal to study. Choose which animal Lisa studies.

*BACK*  *NEXT*
Results - RQ 1 Testlet features

I Wonder (n=8)

• Middle School Target and Precursor
• Presented twice
• 1 changed correct to misconception
• 3 retained misconception
• 2 changed misconception to correct
• 2 correct both times

I wonder...
Russ wonders where food comes from. He wonders if he could survive without plants. If all the plants died, would humans still have food to eat?

If all the plants died, humans would eat animals.
If all the plants died, humans would not have any food.
Results - RQ 1 - Testlet features

Think About It (n=6)

• Middle School Target and Precursor
• Question followed by answer
• Occurs twice in testlet
• Mixed responses
• Second instance, 5 paused to answer out loud

Think about it.

Russ wonders where his food comes from. How can he find out the answer to his question?
Results - RQ 1 - Testlet features

Video (n=8)

- Middle School Target and Precursor
- Encourage interest, not required for answers
- 6 needed help to play
- Delayed loading startled students
- Tech concerns addressed

Russ learns about animals and plants. Russ observes what animals eat. Russ observes that chickens eat different foods. Russ observes that chickens eat corn.
Results - RQ 1 - Testlet features

Self-assessment (n=8)

- Middle School Target and Precursor
- All 8 answered 😊
## Results – RQ 2 Testlet Time

<table>
<thead>
<tr>
<th></th>
<th>Group</th>
<th>N</th>
<th>Item Count</th>
<th>Time Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choice-based</td>
<td>1</td>
<td>13</td>
<td>14-17</td>
<td>11:47 – 25:00</td>
</tr>
<tr>
<td>Extended Narrative - Target</td>
<td>1</td>
<td>2</td>
<td>16</td>
<td>17:41 – 18:20</td>
</tr>
<tr>
<td>Extended Narrative - Target</td>
<td>2/3</td>
<td>4</td>
<td>16</td>
<td>12:21 – 29:28</td>
</tr>
</tbody>
</table>

Middle School students delivered substantial think aloud and retrospective comments.
## Results – RQ 3 Content & Performance Expectations

<table>
<thead>
<tr>
<th>Group</th>
<th>Group</th>
<th>N</th>
<th>Construct-Relevant Responses</th>
<th>Number of Scored Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choice-based-Precursor</td>
<td>1</td>
<td>1</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>Extended Narrative - Target</td>
<td>1</td>
<td>2</td>
<td>10,11</td>
<td>14</td>
</tr>
<tr>
<td>Extended Narrative - Target</td>
<td>2/3</td>
<td>4</td>
<td>5, 10, 10, 14</td>
<td>14</td>
</tr>
</tbody>
</table>

Analysis based on item specifications – intended response process, misconceptions, guessing, unknown process
**Results – RQ 3 Content & Performance Expectations**

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Students with Evidence of Construct-Relevant Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elementary - Initial</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>High School - Initial</td>
<td>5</td>
<td>3</td>
</tr>
</tbody>
</table>

Construct-irrelevant evidence included picking items based on position, not looking at all choices, random choices. Construct-relevant evidence included teacher interpretations, instruction received, clear answer choices, answer options in variety of positions.
Results – RQ 4 Perceptions

• **Length**
  - 3 of 8 students too long, 5 just right or normal
  - Teachers did not comment

• **Difficulty**
  - 3 of 6 students at target-level felt too easy
    - 2 described repetition as a dislike
  - 3 teachers felt content too advanced at initial level
  - Concern about accessibility for students who do not eat
Results – RQ 4 Perceptions

• Media
  • Students liked - 1 suggested more pictures
  • Teacher suggested more realistic, larger pictures
  • Teachers of students at initial level, pictures were unfamiliar

• General Usability
  • Teacher – good flow of content from screen to screen.
  • Some unfamiliar layouts
Discussion

• Results and exploratory and formative
• Two additional, small rounds of data collection to be added to results.
Discussion

• UDL features were novel, evidence generally suggests features are engaging without adding barriers
  • Difficulty with I Wonder – potential lack of exposure to inquiry
  • Think About It – need more evidence, better probes
Discussion

• Longer than usual tests, but times within acceptable limits

• Students generally interpreting content as intended
  • Students at initial level did make correct selections, especially with more familiar content.
  • Two teachers concerned with difficulty, more item difficulty will be explored during pilot
Discussion

• Students generally liked content
• Media was a favorite, suggestions for improvement addressed in testing platform
• Teacher involvement critical for cognitive lab success, especially at initial level
Design of an Online, Learning-map-based Reporting Dashboard to Support Formative Assessment

Robert P. Dolan, Emma L. Starr, Cara Wojcik, Kim Ducharme, and Jose Blackorby

CAST, Inc.

CCSSO NCSA
June 24, 2019
Agenda

• Project Background
• Brief Introduction to Universal Design for Learning
• Teacher Dashboard Co-Design Methodology
• Design Findings
• Next Steps
Project Background
Goal

Design and evaluate a prototype dashboard to support teacher use of testlet results to inform instructional decision making, co-designed with teachers through a UDL lens
June 26, 2017

**Learning Map Model Neighborhood EEM.B.LSS-2**: Use models of food chains/waves to identify producers and consumers in aquatic and terrestrial ecosystems.

**Disciplinary Core Idea**: LS2.B: Cycle of Matter and Energy Transfer in Ecosystems.

**Science and Engineering Practices**: Developing and using models
The problem

Teachers are swimming (drowning) in student data, too often presented in unusable & non-actionable ways.

How can we make data displays—and the way they are used—more empowering and effective for teachers?
The approach

Apply UDL to co-design with teachers an interface that supports their leveraging of learning map models in using student test results for instructional decision-making
Brief Introduction to Universal Design for Learning
Universal Design for Learning (UDL)

A framework for embedding options and supports into curricula and learning experiences to expand learning opportunities for all learners
The Universal Design for Learning Guidelines

**Access**

- **Provide options for Recruiting Interest**
  - Optimize individual choice and autonomy (T.1)
  - Optimize relevance, value, and authenticity (T.2)
  - Minimize threats and distractions (T.3)

- **Provide options for Sustaining Effort & Persistence**
  - Heighten salience of goals and objectives (R.1)
  - Vary demands and resources to optimize challenge (R.2)
  - Foster collaboration and community (R.3)
  - Increase mastery-oriented feedback (R.4)

- **Provide options for Self Regulation**
  - Promote expectations and beliefs that optimize motivation (R.1)
  - Facilitate personal coping skills and strategies (R.2)
  - Develop self-assessment and reflection (R.3)

**Build**

- **Provide options for Perception**
  - Offer ways of customizing the display of information (P.1)
  - Offer alternatives for auditory information (P.2)
  - Offer alternatives for visual information (P.3)

- **Provide options for Language & Symbols**
  - Clarify vocabulary and symbols (L.1)
  - Clarify syntax and structure (L.2)
  - Support decoding of text, mathematical notation, and symbols (L.3)
  - Promote understanding across languages (L.4)
  - Illustrate through multiple media (L.5)

- **Provide options for Comprehension**
  - Activate or supply background knowledge (C.1)
  - Highlight patterns, critical features, big ideas, and relationships (C.2)
  - Guide information processing and visualization (C.3)
  - Maximize transfer and generalization (C.4)

**Internalize**

- **Provide options for Physical Action**
  - Vary the methods for response and navigation (P.1)
  - Optimize access to tools and assistive technologies (P.2)

- **Provide options for Executive Functions**
  - Guide appropriate goal-setting (E.1)
  - Support planning and strategy development (E.2)
  - Facilitate managing information and resources (E.3)
  - Enhance capacity for monitoring progress (E.4)

**Goal**

- **Expert learners who are...**
  - Purposeful & Motivated
  - Resourceful & Knowledgeable
  - Strategic & Goal-Directed
Dashboard Development
Teacher Co-Design Cadres

**Main Cadre:**
- 11 educators from four DLM partner states
- 4 sets of meetings
- Meetings of 1-5 cadre members, 2-4 I-SMART team members
- 90 minutes
- Video conferencing

**Gen Ed Focus Group:**
- 1 meeting
- Same format as above
- 2 gen ed science teachers (grades 6 & 8) from a MA school
Iterative Discovery / Design Process:

Cadre Meetings 1-3

• Recap of the previous design’s principal elements and features
• Walk-through of newly introduced screens and functions spotlighting design solutions resulting from teacher-generated feedback
• Facilitated discussion of prototype focusing on areas of clarity/confusion, features to change/add, most/least useful functions, and “Five Ws”

Cadre Meeting 4

• “Scavenger Hunt” usability testing session - teachers completed usability tasks to uncover any areas needing further refinement
• Cadre process reflection
Iterative co-design cycles
Iterative co-design cycles
Iterative co-design cycles
**Test results:**

**class overview**
Test results: student overview
Test results: detail view by class
Summary of Design Findings

• Teachers found the learning maps valuable for understanding student progress and supporting instructional decisions.
• However, scaffolding teacher’s use of the map is necessary; there is a learning curve that can be supported through multiple representations of the same data.
• Necessary to include aggregate view of class data to meet teachers’ instructional needs.
Final Cadre Findings

• In final usability/interpretability testing, cadre members were able to complete tasks effectively
• Feedback from cadre about final design was positive
• In final reflection, cadre members reported that they felt positive about the process, including that their ideas were used and that they developed professionally through participating
Next Steps
Upcoming Research Study

• Pilot study of science assessment system in 2020
  • Including evaluation of teacher dashboard through …
    • Interpretability and usability studies
    • Teacher interviews and focus groups
Comments & Questions

• State Partner Perspective

• Q&A
Contact Us...

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