The Development of Universally Designed, Fine-Grained Science Learning Map Models

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The Consortium is made up of a collection of state departments of education developing and using the Dynamic Learning Maps Alternate Assessment System.
I-SMART

Innovations in Science Map, Assessment and Reporting Technologies

An effort to bring rigorous science assessments to students with significant cognitive disabilities and any students who are not meeting grade-level standards.

It will include innovative score reports that will help teachers adjust their instruction based on assessment results.
Students with Significant Cognitive Disabilities (SCD)

- They have a disability or multiple disabilities that significantly impact intellectual functioning and adaptive behavior
  - 1% of all students/9% of students with disabilities
  - 81% of have an intellectual disability, autism, or multiple disabilities.
  - 67.6% of students are taught primarily in separate classrooms from their grade-level peers.
  - 76% of students use expressive speech to communicate (may be only 1, 2, or 3 words).
  - Almost 60% of all students across grade levels read at the first grade level or below.

*DLM Census Survey 2012-13 (44,000 students, 14 states)
Alternate Content Standards

- Alternate science content standards are used for teaching and assessing students with SCD:
  - Link to NGSS performance expectations, but have reduced depth, breadth, and complexity
  - 43 were developed for science
    (https://dynamiclearningmaps.org/about/model#essential-elements)
## Middle School

**Domain:**

- Physical

**Core Idea:**

- **PS2:** Motion and Stability: Forces and Interactions

**Topic:**

- **PS2.A:** Forces and Motion

**State Standard for General Education:**

- **MS-PS2-2:** Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

**Essential Element: EE.MS-PS2-2**

- **Target Level:** Investigate and predict the change in motion of objects based on the forces acting on those objects.

- **Precursor Level:** Investigate and identify ways to change the motion of an object (e.g., change an incline's slope to make an object go slower, faster, farther).

- **Initial Level:** Identify ways to change the movement of an object (e.g., faster, slower, stop).
Dynamic Learning Maps® Science Alternate Assessment

- Developed for use in English language arts and mathematics.
- Currently used in the science assessment based on the set of 34 alternate content standards.
- A cognitive model for science is in development and will be the basis of the next iteration of the science assessment.

(https://dynamiclearningmaps.org/about/tests)
Learning Map Model  
(Bechard et al., 2012)

- Learning map models use a small grain-size to represent incremental learning.
- In science, the learning map model describes development in multiple dimensions (DCI, SEP, CCC), resulting in a network of interconnected pathways.
Universal Design for Learning
(Meyer, Rose, & Gordon, 2014)

- 3 principles to reduce barriers to learning (CAST, 2018)
  - Focus on
    - Representation
    - Action and expression
- Knowledge of population characteristics used in creating the learning map
  - Prevalence of sensory and mobility disabilities
  - Nodes worded to be independent of sensory and mobility characteristics, when possible. Otherwise, alternate pathways are created around inaccessible nodes. (DLM, 2016)
Research Question

- How can we develop fine-grained learning map models that use principles of Universal Design for Learning to describe how all students can progress toward grade-level science alternate standards and provide appropriate points of access to NGSS-linked content for all students?
Learning Map Model Development

- Organized by *neighborhood*
  - one per alternate content standard

- Steps
  - Create hypothetical map models
    - Describe DCI and SEP components of alternate content standard
    - Literature review (preacademic to 12th grade)
    - Create nodes and connections
  - Internal review
  - External review
Development of Process and Criteria

Phase 1
Pilot Asynchronous Process

Phase 2
Test Revised Process

Phase 3
Facilitated Panel Process
Phase 1

- Adaptation of process used with ELA and mathematics learning map models (*DLM*, 2016)
- Asynchronous online process piloted with four learning map neighborhoods (95 nodes)
- Reviewers were experts in science and/or special education from 8 states

Findings:
- Lack of consensus
- Challenging to ensure common understanding of nodes

Revisions
- Review criteria were refined
- Provide example node observations
# Learning Map Model Review Criteria

<table>
<thead>
<tr>
<th>Category</th>
<th>Content Criteria</th>
<th>Accessibility Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Node</strong></td>
<td>Node has a clear relationship with the EE.</td>
<td>The node content is accessible to students with the most significant cognitive disabilities.</td>
</tr>
<tr>
<td></td>
<td>Node is appropriately sized (i.e., distinct from surrounding nodes and contains a single concept).</td>
<td>The node content is free of significant barriers for students with sensory impairments, limited mobility, or limited communication abilities.</td>
</tr>
<tr>
<td><strong>Connection</strong></td>
<td>Connections are logical and accurate, reflecting incremental development of a knowledge or skill by connecting a less complex node to a more complex node.</td>
<td>The connection represents an appropriate learning sequence for students with the most significant cognitive disabilities.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The connection describes a logical learning sequence for students with sensory impairments, limited mobility, or limited communication abilities.</td>
</tr>
</tbody>
</table>
Phase 2

- Test refined criteria with three learning map model neighborhoods (104 nodes)
- Reviewers from eight states
- Major findings:
  - Refined criteria streamlined the process
  - Node observations were helpful
  - Lack of consensus still an issue
- Revisions
  - Develop facilitated panel process
Phase 3 Method

- Educators recruited from five states (I-SMART states)
  - Each panel had 2 special educators and 2 science educators
- Advance training and materials
- On-site training and practice
- Process
  - Individual ratings
  - Table discussion and panel recommendations
Phase 3 Results

- 7 learning map neighborhoods were evaluated
  - 293 nodes and 431 connections

- 2-step post panel review process
  - Step 1 - accept recommendations that meet criteria for logic, consistency with the neighborhood map, and consistency with the research.
  - Step 2 - discuss recommendations that may not meet criteria and accept or reject based on consensus decision
    - 56% of recommendations were forwarded to step 2
    - 30% of node and 49% of connection recommendations were rejected
Conclusions

- The facilitated panel process yielded more actionable information
  - Panels able to reach consensus after discussion
  - Accessibility evaluations were better informed by content expertise
  - Able to collect more complex feedback from panels
    - More elaborate rationales
    - Redrawings of map sections
- Common understandings of node content is the most challenging issue for this process
  - Observations and wording are critical
  - Fine grain size makes evaluating connections more challenging
Implications

- Process for evaluating hypothetical cognitive models both for science content and accessibility before assessments are developed and empirical data are collected
- Refinement of the learning map model as a construct
- How to provide access to NGSS-based science content to students with significant cognitive disabilities
For more information contact

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