Impact of Multidimensionality of New Science Standards on Student Performance and Alternate Assessment Development

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Purpose of Session

• Better understand how the new multidimensional science standards (based on the *Framework for K-12 Science Education* and the NGSS) impact alternate assessment development and student performance.

• Discuss implications for students and teachers and assessment design and reporting.
Session Questions

1. What is the relationship between student responses to test items and item dimensionality?

2. Are there associations between student responses to test items and Science and Engineering Practices (SEPs) the items measure?

3. What implications do the findings have for instruction and assessment?
Session Agenda

- Brief description of DLM Science Assessment system - Sue Bechard
- Description of study and results - Brooke Nash
- Implications for students and teachers - Melissa Gholson
- Implications for assessment design and reporting - Shaun Bates
- Audience feedback
BRIEF OVERVIEW OF DLM SCIENCE
A Framework for K-12 Science Education

• 3 Dimensions
  – Disciplinary Core Ideas
    » Grouped by discipline (PS, ESS, LS)
    » Each group has 3 to 5 topics
  – Science and Engineering Practices
    » 8 practices that scientists and engineers use
    » Described as sets of smaller skills for each grade span
  – Crosscutting Concepts
    » 7 overarching concepts that span multiple science disciplines (e.g., patterns)
Performance Expectations are the “standards”

3. Interdependent Relationships in Ecosystems: Environmental Impacts on Organisms

Performance Expectations

Science and Engineering Practices

Disciplinary Core Ideas

Crosscutting Concepts

Connections to
- Other science disciplines at this grade level
- Other DCIs for older and younger students
- Common Core State Standards in Mathematics and Language Arts
# Middle School

<table>
<thead>
<tr>
<th>Domain:</th>
<th>Physical</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Core Idea:</strong></td>
<td><strong>PS2:</strong> Motion and Stability: Forces and Interactions</td>
</tr>
<tr>
<td><strong>Topic:</strong></td>
<td><strong>PS2.A:</strong> Forces and Motion</td>
</tr>
<tr>
<td><strong>State Standard for General Education:</strong></td>
<td><strong>MS-PS2-2:</strong> 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.</td>
</tr>
<tr>
<td><strong>Essential Element: EE.MS-PS2-2</strong></td>
<td><strong>Target Level:</strong> Investigate and predict the change in motion of objects based on the forces acting on those objects.</td>
</tr>
<tr>
<td></td>
<td><strong>Precursor Level:</strong> 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).</td>
</tr>
<tr>
<td></td>
<td><strong>Initial Level:</strong> Identify ways to change the movement of an object (e.g., faster, slower, stop).</td>
</tr>
<tr>
<td><strong>Connections to Science Practices</strong></td>
<td>Planning and Carrying Out Investigations</td>
</tr>
<tr>
<td><strong>Connections to Crosscutting Concepts</strong></td>
<td>Stability and Change</td>
</tr>
<tr>
<td><strong>Connections to ELA Essential Elements</strong></td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Connections to Mathematics Essential Elements</strong></td>
<td><strong>EE.6.EE.1-2:</strong> Identify equivalent number sentences. <strong>EE.7.EE.4:</strong> Use the concept of equality with models to solve one-step addition and subtraction equations.</td>
</tr>
</tbody>
</table>
9 EEs assessed at each grade band, covering 14 topics across 10 DCIs and 3 domains:

- Elementary - grades 3-5
- Middle School - grades 6-8
- High School - grades 9-12

Each target level EE references one DCI and one SEP

- 7/8 SEPs are addressed across grade bands (all except: asking questions and defining problems)
Design of the DLM Science Assessment

Linkage levels:
T=Target
P=Precursor
I=Initial
Test Administration

• Science testlets are adaptive
  – The first testlet administered is based on the student’s academic/communication skills
  – Subsequent testlets are determined by the student’s performance

• Initial level testlets are delivered off-line
• Precursor and Target level testlets are computer-delivered
STUDY METHODS AND RESULTS
Data

• Student response data from the 2017 spring operational window.

• Parameters:
  – As of May 8th, 2017 (completed testlets)
  – 5th grade only

• Sample size = 2,300 students
DCIs and SEPs

- 4 SEPs are measured in 5th grade
  - Planning and carrying out investigations
  - Engaging in argument from evidence
  - Developing and using models
  - Analyzing and interpreting data

- 8 DCIs are measured in 5th grade
Items

- 46 items measure a DCI only
  - These are considered the unidimensional items (i.e., DCI only)

- 35 items measure both a DCI and a SEP
  - These are considered the multidimensional items (i.e., DCI+SEP)
Logistic Regression

• Does item dimensionality predict student response, after accounting for item difficulty?

• Predictor variables entered in blocks:
  – Block 1 = item difficulty (p-value)
  – Block 2 = item dimensionality code
    • 0 = unidimensional (DCI only)
    • 1 = multidimensional (DCI+SEP)

• Three separate regression analyses conducted; one per linkage level
## Initial Level

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>β</th>
<th>SE</th>
<th>Wald</th>
<th>Sig.</th>
<th>Exp(β)</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-value</td>
<td>3.38</td>
<td>0.14</td>
<td>564.34</td>
<td>.000</td>
<td>29.33</td>
<td>22.21 – 38.75</td>
</tr>
<tr>
<td>Dimensionality</td>
<td>0.24</td>
<td>0.45</td>
<td>27.67</td>
<td>.000</td>
<td>0.79</td>
<td>0.53 – 3.06</td>
</tr>
<tr>
<td>Constant</td>
<td>-1.34</td>
<td>0.06</td>
<td>509.47</td>
<td>.000</td>
<td>0.26</td>
<td>0.23 – 0.29</td>
</tr>
</tbody>
</table>
## Precursor Level

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>β</th>
<th>SE</th>
<th>Wald</th>
<th>Sig.</th>
<th>Exp(β)</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-value</td>
<td>4.15</td>
<td>0.17</td>
<td>616.18</td>
<td>.000</td>
<td>63.25</td>
<td>45.59 – 87.73</td>
</tr>
<tr>
<td>Dimensionality</td>
<td>0.09</td>
<td>0.03</td>
<td>7.61</td>
<td>.000</td>
<td>0.92</td>
<td>1.03 – 1.16</td>
</tr>
<tr>
<td>Constant</td>
<td>-2.06</td>
<td>0.10</td>
<td>393.18</td>
<td>.000</td>
<td>0.13</td>
<td>0.10 – 0.16</td>
</tr>
</tbody>
</table>
## Target Level

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>β</th>
<th>SE</th>
<th>Wald</th>
<th>Sig.</th>
<th>Exp(β)</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-value</td>
<td>4.77</td>
<td>0.15</td>
<td>1041.23</td>
<td>.000</td>
<td>118.08</td>
<td>88.32 – 157.76</td>
</tr>
<tr>
<td>Dimensionality</td>
<td>0.16</td>
<td>0.05</td>
<td>11.13</td>
<td>.001</td>
<td>0.85</td>
<td>1.07 – 1.30</td>
</tr>
<tr>
<td>Constant</td>
<td>-2.61</td>
<td>0.10</td>
<td>723.45</td>
<td>.000</td>
<td>0.07</td>
<td>0.06 – 0.09</td>
</tr>
</tbody>
</table>
Interpretation of Results

• For all linkage levels, item dimensionality was a statistically significant predictor of item response, after controlling for item difficulty.
  – May be an artifact of large number of cases
• In comparison to unidimensional items (DCI only), multidimensional items (DCI+SEP) increased the log odds probability of a correct response.
  – However, the odds ratios were close to one and therefore likely negligible.
**Crosstabs**

- Are there associations between student responses to test items and specific practices the items measure?
- **Table layout:**
  - Rows = item scores (0/1)
  - Columns = science and engineering practices
  - Layered by linkage level
  - Values = percent of students
## Crosstabs

<table>
<thead>
<tr>
<th>Linkage Level</th>
<th>Item Score</th>
<th>Planning &amp; carrying out investigations</th>
<th>Engaging in argument from evidence</th>
<th>Using &amp; developing models</th>
<th>Analyzing &amp; interpreting data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td>60.4%</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>39.6%</td>
</tr>
<tr>
<td>Precursor</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td>34.7%</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>65.3%</td>
</tr>
<tr>
<td>Target</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td>26.2%</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>73.8%</td>
</tr>
<tr>
<td>Total</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td>26.2%</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>73.8%</td>
</tr>
</tbody>
</table>
Summary of Results

• The evidence is inconclusive as to whether or not students are more likely to answer items correctly about a particular DCI when they are presented in a multidimensional context with a SEP.
  – More research is needed to evaluate across grades and with more items.
Summary of Results continued

• Some SEPs may provide a context for DCIs that make the multidimensional items easier.
  – More research is needed to evaluate across grades and with more items.
Next Steps

• Evaluate the relationship between SEPs and the DCIs across grades.

• Evaluate how students with the most significant cognitive disabilities attain these skills. Do they attain them independently or in tandem?
Implications for Students and Teachers

Melissa Gholson
Implications for students and teachers

• What have teachers discovered about students’ ability to demonstrate knowledge of content in the context of applying a science practice?
• What have been the challenges for instruction?
• Have there been any surprises?
• Have there been shifts in performance expectations for students with SCD?
Essential Elements and Concept Development

- Teachers discovered students’ have the ability to demonstrate knowledge of content in the context of applying a science practice.

- Teachers reported during surveys and observations that students were excited about the content and they felt confident in delivery.

- Teachers gave examples of how the this supported concept development for their students and provided them guidance and support for how to integrate other elements so that they were not teaching standards in isolation.
Challenges for Instruction

• Believed science content was “too difficult” or “abstract” for their students. Some educators felt the standards were inappropriate for their students and doubted that the instruction would be relevant for the population.

• In the beginning educators often felt inadequate in their own ability to instruct on the content and felt they needed more professional development.

• Many teachers wanted guidance on what “to do” for the grades not tested.

• Some teachers felt they did not have adequate materials or resources.
Surprises

• Gaining entrance into the general education classroom and working with typical peers.
• The increase of use of the instructionally embedded assessments.
• Educators have embraced the idea of instruction of multiple standards.
• Released testlets encouraged teachers how to design instruction to support students and preparation of the assessment.
• Improved understanding of test design among some educators who used the blueprint.
Released Testlets

Practice

Sci Student Practice Activity
Take Test

Sci Teacher Practice Activity
Take Test

Science 5.ESS1-2 P
Take Test

Max sets a dinner table. Max uses paper plates and cloth napkins. Max wants to protect Earth’s resources when cleaning up.

Max cleans up after dinner. Max puts the paper plates in the recycling bin. How does this protect trees?

More trees will be used to make paper plates.
Fewer trees will be used to make paper plates.
The same amount of trees will be used to make paper plates.
Things Teachers Were Excited About

- **Science Instructional Activities**
- Picture response cards are included in the TIP for testlets that require them
- Use of common materials on materials list
- Released testlets
Science Resources

Science Resources

for Alaska, Iowa, Illinois, Kansas, Maryland, Minnesota, Missouri, Oklahoma, West Virginia, and Wisconsin

Science assessments are only available during the spring window.

Training for test administrators who will administer Dynamic Learning Maps science assessments is built into your state's MapIt training.

- Science Blueprint Phase 1 (pdf)
- pool of available preliminary Essential Elements (EEs) for Science
- Essential Elements for Science (pdf) 1/23
- Development of DLM Essential Elements for Science (pdf)
- a short description of how Essential Elements in science were developed
- Guide to Practice Activities & Released Testlets for Science (pdf)
- Terminology indicators and analysis with maps and KITE/Client
- About Science Tasklet Information Pages (pdf)
- Science Materials Collections for Spring 2017 Assessment (pdf) 2/28
  - list of common science materials by grade, including materials to use with alternate test forms for students with visual impairments

Released Testlets and Sample TIPs

- Released Testlet Elementary 3 E023.11
- Released Testlet Middle School H5L91.2.1
- Released Testlet High School HSLS2.3.P
- Sample TIP Elementary
- Sample TIP Middle School

Required Training

Required test administrator training for teachers participating in 2016-17 DLM testing is available on a state-driven schedule. The Guide to DLM Required Test Administrator Training (pdf) is a great place to start, with information about accessing the DLM MapIt training site for your first login.

Science Instructional Activities

The DLM Science Consortium developed several model science instructional activities that are intended to support teachers who are beginning to use the DLM Science Essential Elements during instruction. Activities for each grade span (Elementary, Middle, and High School) are located below.

EE.5.ESS1-1: The Sunlight Months
EE.5.L15: 1: Food Chains
EE.5.P3.1-1: Energy in the Sun
EE.6.5.L13-4: Weather Watchers
EE.6.5.L15-3: What's Around the Earth
EE.6.5.L15-2: Chemical Changes
EE.6.5.L15-3: Conserving Natural Resources
EE.6.5.L15-2: Respiration System
Have there been shifts in performance expectations for students with SCD?

- Due to demand the alternate assessment advisory team developed additional activities addressing science and merged it within their preexisting units created for instruction.

- Teachers during test administration observations were excited about the progress and higher levels of interaction between students and peers.

- Increased opportunity for multiple settings and generalized learning.
High Expectations & Developmental Appropriateness

• Project-based and interactive learning has benefits for students at all levels of the educational spectrum including those who have intellectual disabilities.

• Many educators expressed increased engagement of their students around science content.

• As a result educators saw increased retention of content in their students.

Shaun Bates

IMPLICATIONS FOR ASSESSMENT DESIGN AND REPORTING
Topics

• What are the challenges in assessing multiple dimensions within each EE?
• Are there considerations for testlet design and/or delivery?
• What information should be included on assessment reports that would be beneficial to teachers?
• What are the implications for learning progressions in science?
Challenges in Assessing Multiple Dimensions

• Identifying if the content or the practice may be the lack of student understanding.

• Build the interconnections of English Language Arts and mathematics
Considerations for Testlet Design and/or Delivery

• The Essential Elements currently support 3 levels as compared to English language arts and mathematics.

• How to build a system to meet the diversity of the population and depth of the Elements.
Assessment Reports

• Design and development of reports that provide information that lead to change in instruction.

• Secondary report of SEP’s?

• Connecting English language arts and mathematics for a picture of the whole child.
Implications for Learning Progressions

• The Essential Elements currently support 5 levels in English language arts and mathematics.

• Complete the science map to ensure the learning progressions and interconnections have been identified, vetted and provide useful information.
THANK YOU!

For more information:

www.dynamiclearningmaps.org

http://dynamiclearningmaps.org/sci_resources