Defining the NGSS Domain to be Assessed: Challenges and solution approaches

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Kevin King (Washington)
April McCrae (Delaware)

Presentation at the 2017 RILS (Reidy Interactive Lecture Series)
Sponsored by the Center for Assessment
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Overview

• Aspects of domain definition for assessment

• Some key challenges of domain definition for NGSS

• Some principles and solution approaches

• Presentations by states working on NGSS assessments
  – California (Kathleen Scalise, University of Oregon)
  – Washington (Kevin King, WestED)
  – Delaware (April McCrae, Delaware Dept. of Education)

• Discussion
Domain definition for NGSS assessment

• Content/skills
• Expertise/performance
• Assessment vs. instruction vs. other
• Assessment validity argument
• Documents that embody domain definition for assessment
Definition of NGSS content/skills

• Domain of “science” content(/skills/dispositions)
  – Scope
    • Dimensions: NGSS’ Scientific & Engineering Practices (SEP), Disciplinary Content Ideas (DCI), and Cross-Cutting Concepts (CCC)
    • Specific knowledge/skills: 39 DCI sub-ideas; 8 SEP, 7 CCC
    • Combinations
      – Performance Expectations (PEs) to define assessment targets
      – 1-D, 2-D, 3-D (definition of CCC)
      – If multiple-dimension, can/should be pulled apart in scoring or analysis for assessment?
  – Sequence
    • Temporal order (e.g., grade/band-specific)
    • Logical dependencies over time (within and across grades)
Definition of expertise/performance

• Cognitive complexity
  – What is presented
  – Question/problem: What it takes to respond
## Cognitive Rigor Matrix – Science (Hess)

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy</th>
<th>Webb’s DOK Level 1: Recall &amp; Reproduction</th>
<th>Webb’s DOK Level 2: Skills &amp; Concepts</th>
<th>Webb’s DOK Level 3: Strategic Thinking/Reasoning</th>
<th>Webb’s DOK Level 4: Extended Thinking</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Apply</strong></td>
<td>Follow simple procedures (recipe-type directions)</td>
<td>Select a procedure according to criteria and perform it</td>
<td>Design investigation for a specific purpose or research question</td>
<td>Select or devise approach among many alternatives to solve a problem</td>
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<td>Calculate, measure, apply a rule (e.g., rounding)</td>
<td>Solve routine problem applying multiple concepts or decision points</td>
<td>Conduct a designed investigation</td>
<td>Conduct a project that specifies a problem, identifies solution paths, solves the problem, and reports results</td>
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<td>Apply algorithm or formula (e.g., area, perimeter)</td>
<td>Retrieve information from a table, graph, or figure and use it to solve a problem requiring multiple steps</td>
<td>Use concepts to solve non-routine problems</td>
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<td></td>
<td>Make conversions among representations or numbers, or within and between customary and metric measures</td>
<td>Construct models given criteria</td>
<td>Use &amp; show reasoning, planning, and evidence</td>
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<td>Translate between problem &amp; symbolic notation when not a direct translation</td>
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</table>

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• Cognitive/performance complexity in context
  – Retention how long after instruction
    • Assess grade level/grade span?
    • Instruct grade level/review grade span?
  – Similarity to what, how was instructed (application/transfer)
  – Support/scaffolding... free-form
  – Integration of knowledge, skills
  – Individual/collaborative
Definitions for assessment vs. other uses

- Purposes: conceptual, instructional, assessment, other uses

- Domain definition for assessment may differ

Conceptual definition of science domain

Definition of science domain to be assessed

Conceptual definition of science domain to be instructed

Transfer
• **Claim** about person/performance in relation to domain, and intended uses

• Assessment designed to provide sufficient **evidence** to inform claims
  
  – Test design
  
  – Assessment task/item design and scoring

• How information from evidence will be **combined** to inform claims (collection of evidence) and intended uses [measurement models, comparability]
Documents that embody domain definition

- Content standards’ elaboration in terms of domain definition
- Claims (and theory of action)
- Achievement/performance level descriptors
- Reports
  - Student annual score reports’ categories/dimensions
  - Combined and derivative scores’ reports (e.g., trend, growth, gaps)
- Test blueprints
- Item/task templates/detailed specifications including scoring templates
Some challenges to NGSS domain definition

• Need domain definition of aspects in addition to NGSS standards and Performance Expectations

• Breadth of NGSS; sampling represented in PEs
NGSS breadth

• 39 DCI sub-ideas, 8 SEP, 7 CCC = 2,184 distinct “things”

• SEP/DCI/CCC (and PEs) by grades K-5 and grade spans for middle and high school
Sparse sampling in PEs

• The PEs designate specific combinations of SEP, DCI, and CCC. Generally the sampling across all the PE at a grade is so sparse that it would be difficult to claim the NGSS have been represented adequately or coherently.

• At a grade span, the PE cumulatively sample the SEP and CCC relatively more, but still sample the DCI fairly sparsely.
### Number of NGSS Scientific & Engineering Practices in the Performance Expectations by DCI Disciplines

<table>
<thead>
<tr>
<th>Grade</th>
<th>AQDP</th>
<th>DUM</th>
<th>PCOI</th>
<th>AID</th>
<th>UMCT</th>
<th>CEDS</th>
<th>EAE</th>
<th>OECI</th>
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<td><strong>Grade 5</strong></td>
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<td>3-5 ETS</td>
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PS = Physical Science; LS = Life Science; ESS = Earth & Space Science; ETS = Engineering/Technology Science
AQDP = Asking Questions and Defining Problems; DUM = Developing and Using Models; PCOI = Planning and Carrying Out Investigations
AID = Analyzing and Interpreting Data; UMCT = Using Mathematics and Computational Thinking; CEDS = Constructing Explanations and Designing Solutions; EAE = Engaging in Argument from Evidence; OECI = Obtaining, Evaluating, and Communicating Information
<table>
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<tr>
<th>Grade 5</th>
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<td>LS4.D, Biodiversity and Humans</td>
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5-LS1-1
5-LS2-1
5-LS2-1

Some solution principles & approaches

- Attend to domain definition up front and elaborate and articulate your specifications of the NGSS for assessment; avoid retro-fitting item development to claims and reporting structures (some iteration expected)

- Make your test-level claims coherent (may need to modify or adapt PEs); test-level not the same as item level!

- Focus and simplify the NGSS
  - Reduce content scope
  - Cluster SEP and possibly CCC

- Consider test designs that provide more “assessment space,” e.g., matrix sampling, through-course, multiple EOC

- Specify where application and transfer fit for you, in instruction and assessment
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